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Some Facilitators Effects on Alfalfa and Sainfoin Growth in Restoration of Dry-Farming Lands (Study Area: Balekhlichay Watershed, Ardabil, Iran)

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ABSTRACT

Aims The effects of potassium silicate nanoparticles (PSN) and effective microorganisms (EM) were studied on the growth of alfalfa (*Medicago sativa* L.) and sainfoin (*Onobrychis sativa* Lam.) and soil.

Materials & Methods Split-split plot in a complete randomized block design with three replications was used for this experiment. Planting time in two seasons (autumn and spring) as the main plot, facilitators in five levels, including control, PSN (500 and 1000mg/lit), and EM (1 and 2%), as sub-plots and two legume species as sub-sub plot were studied in the field. In the four-leaf step of plants, PSN and EM were added in three steps as a solution.

Findings The highest amount of plant viability (80, 82.22%), height (59, 68.33cm), basal diameter (13.33, 16.66cm), canopy cover (993.33, 1242.66cm^2), leaf area index (67.79, 84.93cm^2), relative water content (70.46, 88.32%), chlorophyll (0.87, 0.72mg.g^{-1}), photosynthesis rate (27.29, 28.49μmolco$_2$.cm^{-2}s^{-1}), number of inflorescence (57.33, 56N/m^2) and 1000-grain weight (33.30, 3.89g.m^{-2}) were in sainfoin (EM2%) and alfalfa (PSN1000mg/lit), respectively. Total biomass (423.87 and 374.50g.m-2) was maximum in PSN1000mg/lit for both species. EM and PSN caused desirable effects on the soil characters of species substrates ($p<0.01$). The maximum value of all studied soil characters belonged to PSN1000. Additionally, autumn sowing compared to spring planting enhanced the studied traits of planted species and their substrate soil.

Conclusion The usage of appropriate PSN and EM concentration in this study to restore dry-farming lands and improve species growth and forage yield can be suggested.

Keywords Forage Production; Legumes; Soil Characters; Sowing Date

CITATION LINKS

[1] Land use mapping and ecological ... [2] Land use change effects on plant and soil ... [3] The release of dormancy, a wake-up call ... [4] Role of assisted natural remediation in ... [5] Role of nanoparticles in growth and development ... [6] Influence of silicon and nano-silicon on ... [7] Effects of potassium silicate and nanosilica ... [8] Effects of silica and silver nanoparticles ... [9] Effects of nanopriming and bioprimingon on ... [10] Impact of effective microorganisms on yields and ... [11] Effect of Effective Microorganisms (EM) on nutrient contents in substrate ... [12] Effects of the integrated use of effective microorganisms ... [13] Varying the vegetative and morphological traits of Thymus ... [14] Legumes in sustainable ... [15] The effects of cutting intervals and seeding rates on forage yield ... [16] Investigation of Effective Microorganisms (EM) impact in water stress condition on growth of almond ... [17] Rangeland plants potential for phytoremediation of contaminated soils with lead, zinc ... [18] The effect of severity and duration of sodium chloride stress on ... [19] Leaf area estimation by a simple and non-destructive ... [20] Investigating lead and zinc uptake and accumulation by ... [21] Effect of high air and soil temperature on yield ... [22] Crop ... [23] Investigating the effects of sowing date ... [24] Alleviation of field water stress in wheat cultivars by using ... [25] The effect of sodium silicate and silica nano particles ... [26] The effects of nitrogen doses applied at different growing ... [27] Effects of silicon dioxide nanoparticles on biological and ... [28] Silicon uptake and accumulation ... [29] Influence of nano-priming on Festuca ovina seed ... [30] Effect of some growth facilitators on the growth ... [31] Influence of "Effective Microorganisms" ... [32] Effect of application of EM spraying on ... [33] Impact of biological effective microorganisms ... [34] effect of nanosilica and silicon sources on plant growth promoting ... [35] Rice straw fermentation using lactic acid ... [36] Effect some of the growth treatments ...

Introduction

Dryland farming has been developed in large areas in Iran. In some areas, due to the lack of proper observance of land-use or inappropriate land practices, as well as physiographic, climatic, and edaphic sensitivities, these lands have been set aside from the cultivation system, which had been destroyed or eroded [1]. The alteration from the rangeland habitat to arable lands could change the species composition and reduce soil quality and vegetation cover [2]. Thus, they should be converted to appropriate land use, which in Iran has been defined as a project with the name of ‘‘dry land conversion to rangeland”, aiming to conserving soil and water conservation and producing forage for livestock [1].

Furthermore, one of the critical stages in the plants’ life cycle (such as forage species) is germination and early seedlings to succeed in planting projects [1]. One of the methods to improve the seedling establishment is the use of nanoparticles and biofertilizers. Facilitators can change soil metals’ behavior, their accessibility to plants, toxicity, and leaching potential [4]. The use of nanoparticles as a facilitator is a considerable opportunity to enhance plant production and minimize environmental hazards [5]. Many field experiments under different soil and climate conditions and various plants have shown that the application of nano silicon improves the characteristics of seed germination, plant establishment, and crop quality and yield [6-9]. EM is a commercial biofertilizer, and studies indicate that EM may influence development conditions for microorganisms living in a given soil, thus affecting plant health and development [10]. Also, EM may have affected the availability of nutrients [11]. Thus, the use of EM increases plant growth and subsequently enhances crop yield [12]. Research showed that the nanoparticles 1000 and 500mg/lit had a greater effect on the vegetative and morphological traits of *Thymus kotschyanus* than EM 2 and 1% did. However, both substances were effective compared to control [13].

The nitrogen-fixing increases soil fertility and reduces inorganic fertilizers’ requirements, including the legumes’ lively characters [14]. To restore low-yielding dry-farming lands, the cultivation of high-value legume species such as sainfoin and alfalfa can be reasonable. Hence, the hypothesis of this research was: the use of the facilitators such as PSN (1000 and 500mg/lit) and EM (2 and 1%) can help to improve viability, vegetative, physiological, and yield characters of alfalfa and sainfoin and soil characteristics. Also, we sought to investigate which treatment was more effective than others on studied characters?

Materials and Methods

Study area: Balekhlichay watershed (1058 km^2) is located in Ardabil province, northwest of Iran (38°12’44” N and 48°17’46” E with an altitude range from 1150 to 4811m above sea level, mean annual rainfall and mean temperature range at the low and high altitude are 299-766 mm and 3.9-7.9 °C, respectively) and the study area slope is at the range of 12-60% (Figure 1).

Description of Alfalfa and Sainfoin: Alfalfa (*Medicago sativa* L.) and sainfoin (*Onobrychis sativa* Lam.) are herbaceous perennial flowering legumes from the Fabaceae family. These plants are cultivated as important silage, grazing, and forage crop [15]. Seeds of alfalfa and sainfoin were bought from PakanBazr Company (Isfahan, Iran). Table 1 shows some of the alfalfa and sainfoin seed features. A germination test was conducted to evaluate seeds vigor on Petri dishes, and the results are shown in Table 1.

Properties of PSN and EM: Sigma Aldrich Company supplied powder of PSN. Figure 2 presents the characteristics of PSN. The morphological study of these nanoparticles was conducted by scanning electron microscope (SEM). EM was bought from Emkanpazir Pars Company (Shiraz, Iran). EM consists of water, sugarcane molasses, photosynthetic bacteria, lactic acid bacteria, and yeast [16].

Methodology: Split-split plot in a complete randomized block design with three replications was used for this experiment. This experiment was conducted under rainfed conditions at two planting times in spring and autumn 2018 in the field of Balekhlichay watershed dry-farming lands. Planting time in two seasons (autumn and spring) as the main plot, facilitators in five levels, including control, PSN (500 and 1000mg/lit) and EM (1 and 2%), as sub-plots and species in two levels, including alfalfa and sainfoin as sub-sub plot were studied.

First, a selected dry-farming land was plowed and plotted. Each plot was split into three subplots. Within each subplot, 15 holes were drilled, and five seeds were seeded. The planting depth was 2cm. When the plants had four primary leaves, PSN and EM added to each clump's soil as a solution. Treatments of PSN and EM in three steps and ten days apart were added to soil as a solution. During the growing season, weeds were removed mechanically, without the use of chemical pesticides.

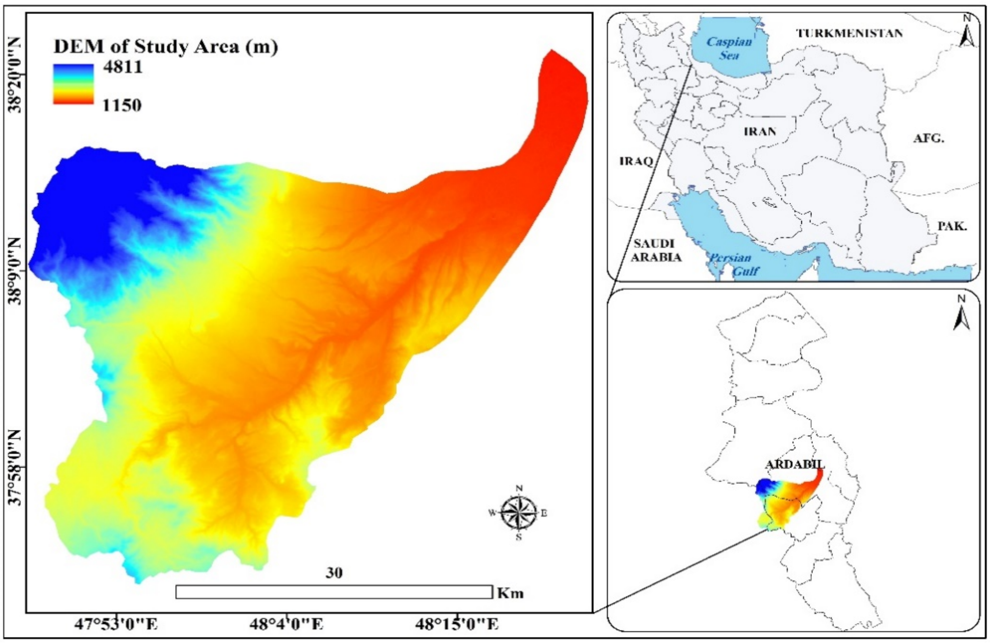

Figure 1) The location of the study area

Table 1) Some features of the alfalfa and sainfoin seeds

Species	Alfalfa	Sainfoin
Seed viability (%)	95	90
Purity (%)	95	95
1000 seed weight (g)	3	23
Seed moisture content (%)	8	7
Germination Percentage (%)	92	66
Germination Velocity (Number/day)	20	9

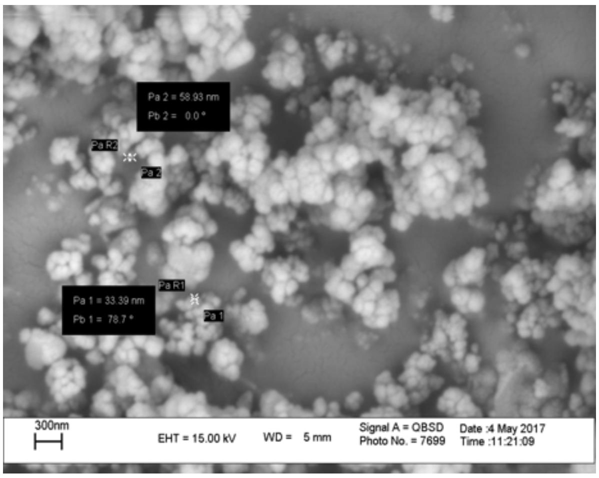

Figure 2) Scanning electron microscopy (SEM) image of potassium silicate nanoparticles

Characteristics of Soil and Plants: Chemical characteristics of the soil were measured by pursuing standard methods [17], including pH, electrical conductivity (pH and EC; Saturation extract), organic matter (OM; Walky and black method), total nitrogen (N%; Kjeldahl method), available phosphorus (P; Elson method) and available potassium (K; Flame photometer photometry method). The studied plant traits were plant height, basal diameter, canopy cover, total biomass, number of fluorescence, viability, 1000-grain weight, total chlorophyll, photosynthesis rate, and leaf area index that measured at the end of plants growth [18-21]. The relative water content of the leaf was determined by the following equation [22].

$$RWC= (FW- DW / SW- DW) \times 100 \quad (1)$$

Where FW: Fresh leaf weight immediately after sampling, DW: Dry weight of leaf after drying in an oven, and SD: Saturated leaf weight after placing in distilled water.

Data analysis: The normality of data for species and soil was done using Kolmogorov-Smirnov. Also, the homogeneity of data was evaluated by Leven's test. The statistical processing was conducted using the General Linear Model (GLM). Means comparisons were conducted using Duncan's multiple range test. All statistical analyses were performed using SPSS 22.

Findings

Effects of PSN and EM on Viability of Alfalfa and Sainfoin: In spring planting, PSN500, PSN1000, EM1, and EM2 treatments increased plant viability by 4.31, 4.04, 30.85 and 32.25% in sainfoin and 13.25, 18.71, 9.43 and 10.90% compared to the control in alfalfa, respectively. In autumn planting, PSN500, PSN1000, EM1, and EM2 treatments increased plant survival by 25.58, 31.63, 59.41, and 73.91% in sainfoin 46.66, 64.44, 18.82, and 37.78% in alfalfa, compared to the control, respectively. EM 2 and PSN1000 were the most effective treatments in both autumn and spring planting on the viability of sainfoin (80.00, 54.66%) and alfalfa (82.22, 55.00%), respectively (Diagram 1).

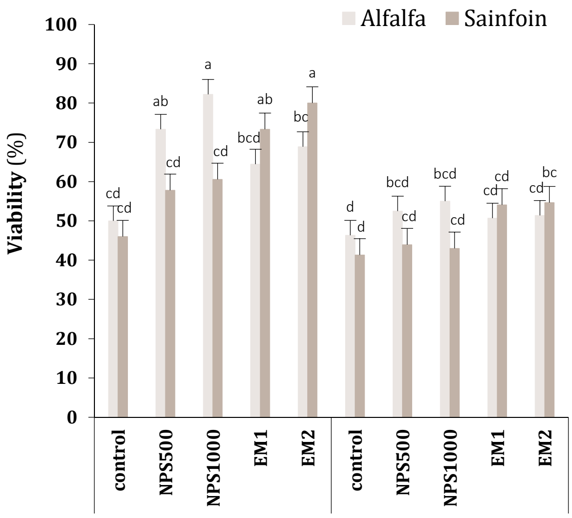

Diagram 1) Effects of PSN and EM at two planting times on viability of sainfoin and alfalfa; The values with common letters are not differed significantly ($p<0.05$)

Effects of PSN and EM on Vegetative Traits of Alfalfa and Sainfoin: In autumn planting, PSN500, PSN1000, EM1, and EM2 treatments increased plant height by 0.94, 11.43, 61.88, and 68.57% in sainfoin and 52.26, 53, 44.78 and 29.11% in alfalfa, compared to the control, respectively. The height of sainfoin in autumn planting was higher in EM2 (57.33cm), whereas it was more effective on the alfalfa of PSN1000 (68.33cm). However, this trait was the highest in spring planting for both species in PSN1000 (20.66 and 14.38cm for sainfoin and alfalfa, respectively; Table 2).

In autumn planting, PSN500, PSN1000, EM1, and EM2 treatments increased collar diameter by 17.67, 35.33, 100.18, and 135.51% in sainfoin 75.03, 78.56, 50.05, and 28.62% in alfalfa, compared to the control, respectively. The basal diameter was higher in autumn planting in sainfoin in EM2 (13.33cm) and higher for alfalfa in PSN1000 (16.66cm). Whereas in spring planting, this was the opposite, with a diameter of 7.66cm for sainfoin in PSN1000 and 3.16cm for alfalfa in EM2 (Table 2).

In autumn planting, PSN500, PSN1000, EM1, and EM2 treatments caused an increase of canopy cover by 13.87, 25.38, 47.77, and 68.07% sainfoin and 51.98, 77.78, 47.21 and 30.47% in alfalfa, compared to the control, respectively. The canopy of sainfoin cover in autumn planting was higher in EM2 than in other treatments (993.33cm^2), and in alfalfa, PSN1000 had a stronger effect on this characteristic (1242.66cm^2). Nevertheless, in spring planting, the differences between the treatments were not significant in both species. However, PSN1000 and EM2 had the highest effect on sainfoin (268.33cm^2) and alfalfa (82.00cm^2), respectively (Table 2).

Effects of PSN and EM on Physiological Traits of Alfalfa and Sainfoin: In autumn planting, PSN500, PSN1000, EM1, and EM2 treatments increased leaf area by 43.22, 70.25, 46.22 and 80.20% in sainfoin and 64.13, 97.41, 60.11 and 64.27% in alfalfa, compared to the control, respectively. Sainfoin leaf area in autumn planting was higher in EM2 than in others (67.79cm^2), whereas the treatment of PSN1000 had a stronger effect on alfalfa (84.93cm^2). In spring planting, this trait showed a higher value for both species in the PSN1000 (sainfoin 52.53 and alfalfa 60.04cm^2; Table 3).

In autumn planting, the application of PSN500, PSN1000, EM1, and EM2 treatments caused an increase of relative leaf water content by 34.14, 41.63, 52.04, and 84.35% in sainfoin and 64.87, 110.18, 45.83, and 67.92% in alfalfa, compared to the control, respectively. The highest relative leaf water content in autumn planting was in EM2 (70.46%) and alfalfa PSN1000 (88.32%) treatments. However, in spring planting, potassium PSN1000 was the most effective treatment in both sainfoins (48.61%) and alfalfa (60.07%; Table 3).

In autumn planting, PSN500, PSN1000, EM1, and EM2 treatments increased chlorophyll content by 294.71, 263.14, 350.50, and 521.85% sainfoin and 72.29, 77.09, 68.31 and 19.50% in alfalfa, compared to the control, respectively. However, total chlorophyll of sainfoin was higher in autumn planting in EM2 (0.87mg.g-1) in alfalfa PSN1000 (0.72mg.g^{-1}). In spring planting, PSN1000 produced more chlorophyll in both sainfoin (0.68mg.g^{-1}) and alfalfa (0.67mg.g^{-1}; Table 3).

In autumn planting, PSN500, PSN1000, EM1, and EM2 treatments caused an increase of photosynthesis rate by 25.58, 25.56, 34.33, and 36.04% in sainfoin and 61.40, 66.49, 61.21, and 61.44% in alfalfa, compared to the control, respectively. The highest photosynthetic rate in autumn planting was in EM2 (27.29μmolco$_2$.m^{-2}s^{-1}), and alfalfa PSN1000 (28.49μmolco$_2$.m^{-2}s^{-1}). Nevertheless, in spring planting, PSN1000 was the most effective treatment for both sainfoin (21.66μmolco$_2$.m^{-2}s^{-1}) and alfalfa (24.33μmolco$_2$.m^{-2}s^{-1}; Table 3).

Effects of PSN and EM on Yield Parameters of Alfalfa and Sainfoin: In autumn planting, PSN500, PSN1000, EM1, and EM2 treatments increased the number of inflorescences by 3.98, 3.98, 50.50, and 70.32% in sainfoin and 61.40, 66.49, 61.21, and 61.44% in alfalfa, compared to the control, respectively. The number of inflorescences in autumn planting was higher in sainfoin treated with EM2 (57.33N.m-^{2}) and in alfalfa treated with PSN1000 (56N.m-^{2}). However, in spring planting, PSN1000 resulted in a higher number of inflorescences in both alfalfas (14.38N.m-^{2}) and sainfoin (20.66N.m-^{2}; Table 4).

In autumn planting, PSN500, PSN1000, EM1, and EM2 treatments caused an increase of 1000-grain weight by 85.91, 93.74, 48.52, and 74.30% in sainfoin and 21.33, 29.67, 13 and 6.33% in alfalfa, compared to the control, respectively. The highest seed weight of 1000-grain weight was obtained in autumn planting under EM2 (33.30g.m^{-2}) for sainfoin and PSN1000 (3.89g.m^{-2}) alfalfa. Nevertheless, in spring planting, PSN1000 was the most effective treatment for both sainfoin (20.87g.m^{-2}) and alfalfa (2.94g.m^{-2}; Table 4).

In autumn cultivation, PSN500, PSN1000, EM1, and EM2 treatments increased total plant biomass by 20.54, 41.03, 20.70, and 28.60% in sainfoin 28.27, 45.30, 21.16, and 4.69% in alfalfa, compared to the control, respectively. Total biomass in both species was more affected by PSN in autumn planting, and it was 423.87 and 374.50g.m^{-2} in sainfoin and alfalfa, respectively. There were no significant differences between treatments in spring planting. However, the highest biomass was obtained in sainfoin (311.77g.m^{-2}) and alfalfa (207.66g.m^{-2}) in PSN1000 (Table 4).

Effects of PSN and EM on Characteristics of The Substrate Soil under The Species: According to the information in Table 5 and its continuation, the following cases are extracted:

The substrate soil porosity of sainfoin in both spring (47.33%) and autumn (43.67%) planting was better than EM2, and the substrate soil porosity of alfalfa was better in both spring (48.00%) and autumn (48.33%) planting in PSN1000.

The substrate soil moisture was higher in autumn planting than in spring, and under both species, EM was more effective than nanoparticles in maintaining soil moisture (sainfoin 6.87 and alfalfa 6.66%, both at EM 2%).

Regarding the pH and EC of the substrate soil under both species, it can be mentioned that there was no significant change in the use of treatments in either spring or autumn compared to control. However, EM2 under both species slightly increased the pH with a slight difference compared to the other treatments (sainfoin 7.79 and alfalfa 7.85). Additionally, EC under sainfoin was slightly higher in EM2 and alfalfa in PSN1000 (0.26dS.m^{-1} or both species).

The percentage of soil organic matter under both species was higher in autumn planting than in spring planting, and this value was higher in spring and autumn planting in both PSNs (0.90 and 0.97% under sainfoin as 1.04 and 1.09% under alfalfa, respectively).

Soil nitrogen also increased under both species in autumn planting than in spring planting, and EM2 treatment increased this parameter for sainfoin substrate 0.28% and 0.31% in spring and autumn planting, respectively; furthermore, PSN1000 treatment increased it in alfalfa substrate 0.27 and 0.34% in spring and autumn planting, respectively.

The substrate soil phosphorus was higher in autumn planting than in spring planting, and in both species, EM played a more effective role in soil phosphorus enhancement than nanoparticles did (sainfoin 30.08 and 31.18mg.kg^{-1} and alfalfa 27.18 and 28.33mg.kg^{-1} in spring and autumn planting, respectively, both at EM 2%).

The substrate soil potassium was also higher in autumn planting than in spring planting, and in both species, PSN was more effective than EM in increasing soil potassium (sainfoin 167.96 and 197 mg.kg^{-1} and alfalfa 193 and 199.33 mg.kg^{-1} in spring and autumn planting, respectively, both at PSN1000).

Table 2) Effects of PSN and EM at two planting times on vegetative traits of sainfoin and alfalfa

Planting time	Facilitators treatment	**Plant height** (cm)		**Basal diameter** (cm)		**Canopy cover** (cm^2)	
		Sainfoin	**Alfalfa**	**Sainfoin**	**Alfalfa**	**Sainfoin**	**Alfalfa**
Autumn	**0**	35.00^{b}	44.66^{c}	5.66^{bc}	9.33^{d}	591.00^{c}	699.00^{c}
	PSN 500	35.33^{b}	68.00^{a}	6.66^{b}	16.33^{a}	673.00^{bc}	1062.33^{ab}
	PSN 1000	39.00^{b}	68.33^{a}	7.66^{b}	16.66^{a}	741.00^{abc}	1242.66^{a}
	EM 1	56.66^{a}	64.66^{ab}	11.33^{a}	14.00^{b}	873.33^{ab}	1029.00^{ab}
	EM 2	59.00^{a}	57.66^{b}	13.33^{a}	12.00^{c}	993.33^{a}	912.00^{bc}
Spring	**0**	6.16^{d}	6.16^{e}	0.83^{d}	0.83^{f}	43.66^{d}	30.33^{d}
	PSN 500	16.33^{c}	8.16^{de}	2.00^{d}	1.66^{ef}	115.00^{d}	35.00^{d}
	PSN 1000	14.83^{c}	12.50^{d}	5.50^{bc}	1.83^{ef}	268.33^{d}	34.00^{d}
	EM 1	11.33^{cd}	11.83^{d}	3.16^{cd}	2.83^{ef}	92.00^{d}	78.00^{d}
	EM 2	11.00^{cd}	10.00^{de}	1.66^{d}	3.16^{e}	71.33^{d}	82.00^{d}

Those values found with the common letter per column are not differed significantly ($p<0.05$).

Table 3) Effects of PSN and EM at two planting times on physiological traits of sainfoin and alfalfa

Planting time	Facilitators treatment	**Leaf area index** (cm^2)		**The relative water content of leaf** (%)		**Chlorophyll** ($mg.g^{-1}$)		**Photosynthesis rate** ($\mu molco_2.m^{-2}s^{-1}$)	
		Sainfoin	**Alfalfa**	**Sainfoin**	**Alfalfa**	**Sainfoin**	**Alfalfa**	**Sainfoin**	**Alfalfa**
Autumn	**0**	37.62^{d}	43.02^{f}	38.22^{e}	42.02^{e}	0.14^{d}	0.41^{ab}	20.15^{d}	17.47^{d}
	PSN 500	53.88^{b}	70.61^{b}	51.27^{cd}	69.28^{b}	0.55^{c}	0.70^{a}	25.35^{b}	27.76^{a}
	PSN 1000	64.05^{a}	84.93^{a}	54.13^{bc}	88.32^{a}	0.50^{c}	0.72^{a}	25.32^{b}	28.49^{a}
	EM 1	55.01^{b}	68.88^{b}	58.11^{b}	61.28^{c}	0.63^{b}	0.69^{a}	26.87^{a}	27.43^{a}
	EM 2	67.79^{a}	70.67^{b}	70.46^{a}	70.56^{b}	0.87^{a}	0.49^{ab}	27.29^{a}	27.82^{a}
Spring	**0**	23.54^{e}	34.35^{g}	30.70^{f}	29.35^{f}	0.24^{c}	0.17^{b}	18.70^{e}	14.85^{e}
	PSN 500	48.11^{bc}	49.13^{de}	42.05^{e}	55.31^{cd}	0.51^{b}	0.60^{ab}	21.92^{d}	19.42^{c}
	PSN 1000	52.53^{b}	60.04^{c}	48.61^{d}	60.07^{cd}	0.68^{a}	0.67^{a}	22.66^{c}	24.33^{b}
	EM 1	38.01^{d}	46.16^{ef}	40.62^{e}	53.08^{d}	0.53^{b}	0.43^{ab}	20.32^{d}	16.72^{d}
	EM 2	43.71^{cd}	54.16^{d}	48.11^{d}	55.47^{cd}	0.52^{c}	0.44^{ab}	20.59^{d}	16.65^{d}

Those values found with the common letter per column are not differed significantly ($p<0.05$).

Table 4) Effects of PSN and EM at two planting times on yield parameters of sainfoin and alfalfa

Planting time	Facilitators treatment	**Number of fluorescence** ($N.m^{-2}$)		**1000-grain weight** ($g.m^{-2}$)		**Total biomass** ($g.m^{-2}$)	
		Sainfoin	**Alfalfa**	**Sainfoin**	**Alfalfa**	**Sainfoin**	**Alfalfa**
Autumn	**0**	33.66^{b}	34.00^{b}	12.14^{bc}	3.00^{bcd}	300.55^{C}	257.74^{c}
	PSN 500	35.00^{b}	51.33^{a}	22.57^{ab}	3.46^{ab}	362.29^{b}	330.60^{b}
	PSN 1000	35.00^{b}	56.00^{a}	23.52^{ab}	3.89^{a}	423.87^{a}	374.50^{a}
	EM 1	50.66^{ab}	50.00^{a}	30.17^{a}	3.39^{abc}	362.76^{b}	312.28^{bc}
	EM 2	57.33^{a}	48.66^{ab}	33.30^{a}	3.19^{bcd}	386.51^{b}	269.84^{c}
Spring	**0**	9.00^{d}	10.64^{c}	10.79^{d}	2.50^{e}	300.74^{C}	188.51^{d}
	PSN 500	15.12^{cd}	12.61^{c}	16.31^{cd}	2.72^{de}	310.55^{C}	203.85^{d}
	PSN 1000	20.66^{c}	14.38^{c}	20.87^{bc}	2.94^{cde}	311.77^{C}	207.66^{d}
	EM 1	11.29^{cd}	10.83^{c}	16.56^{cd}	2.67^{de}	305.42^{C}	200.84^{d}
	EM 2	13.21^{cd}	13.12^{c}	18.30^{cd}	2.90^{cde}	308.21^{C}	200.86^{d}

Those values found with the common letter per column are not differed significantly ($p<0.05$).

Table 5) Effects of PSN and EM facilitators at two planting times on the substrate soil characters of sainfoin and alfalfa

Planting time	**Autumn**					**Spring**				
Facilitators treatment	**0**	**PSN 500**	**PSN 1000**	**EM 1**	**EM 2**	**0**	**PSN 500**	**PSN 1000**	**EM 1**	**EM 2**
Soil Porosity (%)										
Sainfoin	33.33^{e}	38.33^{cd}	41.33^{c}	41.66^{bc}	43.67^{b}	31.33^{e}	37.00^{cd}	46.33^{a}	41.33^{c}	47.33^{a}
Alfalfa	32.66^{d}	45.00^{b}	48.33^{a}	41.66^{c}	47.00^{ab}	31.00^{d}	44.66^{b}	48.00^{a}	41.66^{c}	45.00^{b}
Soil moist (%)										
Sainfoin	4.12^{f}	5.51^{c}	5.96^{b}	6.69^{a}	6.87^{a}	4.11^{f}	4.48^{e}	4.94^{de}	5.11^{cd}	5.73^{b}
Alfalfa	4.75^{f}	5.98^{bc}	5.99^{bc}	6.35^{ab}	6.66^{a}	4.74^{f}	5.34^{e}	5.41^{de}	5.73^{cde}	5.77^{cd}
pH										
Sainfoin	7.61^{d}	7.71^{bc}	7.70^{c}	7.87^{a}	7.89^{a}	7.76^{b}	7.75^{b}	7.73^{bc}	7.74^{bc}	7.63^{d}
Alfalfa	7.61^{d}	7.60^{d}	7.69^{b}	7.64^{c}	7.75^{a}	7.63^{c}	7.61^{d}	7.70^{b}	7.65^{c}	7.69^{b}
EC ($dS.m^{-1}$)										
Sainfoin	0.25^{ab}	0.25^{ab}	0.24^{abc}	0.25^{ab}	0.26^{a}	0.21^{d}	0.22^{d}	0.23^{cd}	0.23^{cd}	0.24^{abc}
Alfalfa	0.21^{c}	0.26^{a}	0.26^{a}	0.24^{b}	0.24^{b}	0.21^{c}	0.28^{a}	0.27^{a}	0.23^{bc}	0.24^{b}
OM (%)										
Sainfoin	0.86^{d}	0.95^{ab}	0.97^{a}	0.92^{abc}	0.93^{ab}	0.85^{d}	0.88^{bcd}	0.90^{bc}	0.87^{cd}	0.89^{bcd}
Alfalfa	0.84^{d}	0.89^{cd}	1.09^{a}	0.87^{cd}	0.88^{cd}	0.85^{d}	0.92^{c}	1.04^{b}	0.88^{cd}	0.89^{cd}
N (%)										
Sainfoin	0.21^{c}	0.26^{b}	0.26^{b}	0.29^{ab}	0.31^{a}	0.21^{c}	0.24^{b}	0.25^{b}	0.27^{ab}	0.28^{ab}
Alfalfa	0.21^{d}	0.33^{a}	0.34^{a}	0.24^{cd}	0.24^{cd}	0.21^{d}	0.25^{bc}	0.27^{b}	0.23^{cd}	0.23^{cd}
P ($mg.kg^{-1}$)										
Sainfoin	24.33^{c}	25.82^{bc}	26.12^{abc}	31.17^{a}	31.18^{a}	22.51^{c}	25.37^{bc}	26.43^{abc}	27.32^{abc}	30.08^{ab}
Alfalfa	25.45^{b}	26.23^{ab}	26.86^{ab}	28.14^{a}	28.33^{a}	25.40^{b}	25.50^{ab}	26.62^{ab}	27.01^{ab}	27.18^{ab}
K ($mg.kg^{-1}$)										
Sainfoin	156.00^{d}	195.00^{a}	197.00^{a}	166.33^{bc}	170.00^{b}	154.66^{d}	166.00^{bc}	167.66^{bc}	161.00^{cd}	165.67^{bc}
Alfalfa	176.00^{de}	197.00^{a}	199.33^{a}	176.33^{d}	186.00^{c}	172.66^{e}	191.00^{b}	193.00^{b}	176.33^{d}	185.33^{c}

Those values found with the common letter per column are not differed significantly ($p<0.05$).

Discussion

In the present research, autumn sowing enhanced the studied traits of planted species and their substrate soil. With the long growing season during the fall that was made possible by the change of planting date, viability, yield, vegetative, and physiological traits increased. Seasonal factors such as low temperature, high light, and short days stimulate some plants' yield and production [22]. Planting date significantly affected plant height, number of spikes per m^2, number of grains per spike, grain yield, and average crop growth rate, which is consistent with the present study [1].

Concerning the influence of PSN and EM on some characters of sainfoin and alfalfa, the results showed that all studied factors in the PSN1000 treatment were highest for alfalfa compared to the control. Perhaps the most important explanation for this result is the large specific surface area and nano-silica reactivity [7]. Silicon exists in the epidermis tissue of plant secretory organs, such as leaves preventing evaporation and excessive penetration of the plants' fungal hyphae [24]. Also, silicon increases plant growth by improving the mechanical strength of leaves and stems from light absorption, and the photosynthetic capacity of the plant is increased [25]. It seems that the number of inflorescences and 1000-grain weight are important components of yield [26] and can be considered effective criteria in increasing yield in range planting programs. Alfalfa seed pre-sowing with nanoSiO_2 positively influenced plant height, tillers, yield, wet, and dry root mass [27].

Moreover, in other researches, it is noted that alfalfa seed pre-sowing with nanoSiO_2 causes to increase plant transpiration and chlorophyll, carotenoids, and photosynthetic pigments [28]. The results obtained by [29] indicated the negative effect of PEG stress on *Festuca ovina* seed germination and the positive influence of nanopriming technique to improve germination and growth of *F. ovina*, as in the present study, this happened. Besides, this study's results were consistent with the study results as the effect of some growth facilitators on the growth parameters *Onobrychis sativa* Lam. in the greenhouse about growth and functional characteristics of this species [30].

The amount of all factors (except total biomass) was maximum in EM 2% treatment compared to that of sainfoin control. One reason for this effect may be that EM enhances the chemical decomposition of organic matter and motivates its mineralization, releasing more nutrients into the rhizosphere [31]. This increases the establishment and growth of plants. Other studies indicate the positive effect of EM on biometric parameters of plants [16, 32]. EM enhanced all growth factors of sainfoin compared to the control. The reason for the increase is probably that EM has beneficial effects on the uptake of nutrients by plants. EM application accelerates the volume of the root system of rootstocks and increases the leaf surface area and the growth of the level of absorption of leaf [33]. Application of EM positively affected the number of formed inflorescences and the number of leaves in *Gerbera jamesonii*, and the diameter of flowers in roses [11].

According to the results in both autumn and spring planting, EM2% and PSN1000 were the most effective treatments on most of the substrate soil factors of sainfoin and alfalfa. The availability of acid, silicic, silicate-sodium, micron silica, and tetraethyl silicate might somewhat increase the value of available nitrogen, phosphorus, and potassium of soil and decrease pH [34]. EM also releases more nutrients into the soil-plant system [31]. Lactic acid bacteria in EM cultures are especially responsible for decomposing materials such as lignin and cellulose in the soil organic matters [35]. Also, the EM (1% level) was the most effective one in increasing soil pH, and the potassium silicate nanoparticles (500mg/L level) were the most effective treatment in increasing nitrogen, OC percentage, and EC of the soil under *F. ovina* [36]. Also, the reason for the reduction in the soil pH in PSN treatments is probably that hydrated silica is formed through Si-O linkage to water molecules and reduces pH [20].

Conclusion

To convert damaged dry-farming land ecosystems to rangeland, both plants and soil are needed to be recovered. In this regard, in the present study, PSN and EM facilitators were used. In general, the results showed that all studied traits of both species were higher in autumn planting than in spring planting. Furthermore, in autumn, sainfoin planting, EM, and especially its 2% concentration positively affected the traits. In alfalfa, nano silicate potassium and especially its 1000 concentration improved further the studied traits of plants and soil. The seeds of sainfoin and alfalfa can be stimulated for germination when there is enough moisture in the soil. Therefore, it is necessary to consider the cultivation season in replanting the lands with these species, and it is suggested that planting be done in the autumn. To promote better establishment, growth, and yield of the mentioned species and restore the dry-farming lands, it is recommended that more effective treatments be used for each species.

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References

1- Ghorbani A. Land use mapping and ecological capability evaluation of dry farming lands (based on slope) for converting to pasture in Zilbar-Chay watershed using GIS. Geogr Space. 2015;14(48):103-22. [Persian]

2- Hashemi Rad M, Ebrahimi M, Shirmohammadi E. Land use change effects on plant and soil properties in a mountainous region of Iran. J Environ Sci Manage. 2018;21:47-56.

3- Née G, Xiang Y, Soppe WJJ. The release of dormancy, a wake-up call for seeds to germinate. Curr Opin Plant Biol. 2017;35:8-14.

4- Adriano DC, Wenzel WW, Vangronsveld J, Bolan NS. Role of assisted natural remediation in environmental cleanup. Geoderma. 2004;122(2-4):121-42.

5- Farooqui A, Tabassum H, Ahmad A, Mabood A, Ahmad A, Zareeen Ahmad I. Role of nanoparticles in growth and development of plants: A review. Int J Pharma Bio Sci. 2016;7(4):22-37.

6- Abdul Qados AMS, Moftah AE. Influence of silicon and nano-silicon on germination, growth and yield of faba bean (Vicia faba L.) under salt stress conditions. J Exp Agric Int. 2015;5:509-24.

7- Dehghanipoodeh S, Ghobadi C, Baninasab B, Gheysari M, Shirani Bidabadi S. Effects of potassium silicate and nanosilica on quantitative and qualitative characteristics of a commercial strawberry (Fragaria×ananassa cv. 'camarosa'). J Plant Nut. 2016;39(4):502-7.

8- Abbasi Khalaki M, Ghorbani A, Moameri M. Effects of silica and silver nanoparticles on seed germination traits of Thymus kotschyanus in laboratory conditions. Rangel Sci. 2016;6(3):221-31.

9- Moameri M, Alijafari E, Abbasi Khalaki M, Ghorbani A. Effects of nanopriming and bioprimingon on growth characteristics of Onobrychis sativa Lam. under laboratory conditions. J Rangel. 2018;12:101-11. [Persian]

10- Frąszczak B, Kleiber T, Klama J. Impact of effective microorganisms on yields and nutrition of sweet basil (Ocimum basilicum L.) and microbiological properties of the substrate. Afr J Agric Res. 2012;7:5756-65.

11- Górski R, Kleiber T. Effect of Effective Microorganisms (EM) on nutrient contents in substrate and development and yielding of Rose (Rosa x hybrida) and Gerbera (Gerbera jamesonii). Ecol Chem Engin S. 2010;17:505-13.

12- Lindani N, Bvenura C. Effects of the integrated use of effective microorganisms, compost and mineral fertilizer on greenhouse-grown tomato. Afr J Plant Sci. 2012;6(3):120-4.

13- Abbasi Khalaki M, Ghorbani A, Esmali Ouri A, Shokouhian AA, Jafari AA. Varying the vegetative and morphological traits of Thymus kotschyanus L. affected potassium silicate nanoparticles, superabsorbent hydrogel, effective microorganisms, and animal manure. Biosci J. 2019;35:115-25.

14- Atienza SG, Rubiales D. Legumes in sustainable agriculture. Crop Pasture Sci. 2017;68:i-ii.

15- Atis I, Celiktasafiz N, Can E, Yilmaz S. The effects of cutting intervals and seeding rates on forage yield and quality of alfalfa. Turk J Field Crops. 2019;24(1):12-20.

16- Shokouhian AA, Davarynejad GH, Tehranifar A, Imani A, Rasoulzadeh A. Investigation of Effective Microorganisms (EM) impact in water stress condition on growth of almond (Prunus dulcis Mill) Seedling. J Basic Appl Sci Res. 2013;3(2S):86-92.

17- Moameri M, Jafari M, Tavili A, Motasharezadeh B, Zare Chahouki MA. Rangeland plants potential for phytoremediation of contaminated soils with lead, zinc, cadmium and nickel (Case study: Rangelands around national lead & zinc factory, Zanjan, Iran). J Rangel Sci. 2017;7(2):160-71.

18- Hatamnia AA, Valadbeigi T, Abbaspour N. The effect of severity and duration of sodium chloride stress on growth and some biochemical and photosynthesis parameters of tobacco (Nicotiana tabacum L.). J Plant Process Funct. 2017;6(19):139-52. [Persian]

19- Shabani A, Sepaskhah AR. Leaf area estimation by a simple and non-destructive method. Iran Agric Res. 2017;36(2):101-5.

20- Moameri M, Jafari M, Tavili A, Motasharezadeh B, Zare Chahouki MA, Madrid Diaz F. Investigating lead and zinc uptake and accumulation by Stipa hohenackeriana trin and rupr. in field and pot experiments. Biosci J. 2018;34.

21- Gulluoglu L, Arioglu H, Bakal H, Onat B. Effect of high air and soil temperature on yield and some yield components of peanut (Arachis hypogaea L.). Turk J Field Crops. 2018;23(1):62-71.

22- Koochaki A, Sarmadnia GH. Crop Physiology. Mashahd: Ferdowsi University of Mashhad Press; 2012. [Persian]

23- Baygi Z, Saifzadeh S, Shirani Rad AH, Valadabadi SA, Jafarnejad A. Investigating the effects of sowing date on growth indices and yield and yield components of spring

wheat cultivars in Neyshabur. J Manag Syst. 2017;30(2):1-18. [Persian]
24- Maghsoudi K, Emam Y, Ashraf M, Arvin MJ. Alleviation of field water stress in wheat cultivars by using silicon and salicylic acid applied separately or in combination. Crop Pasture Sci. 2019;70(1):36-43.
25- Roohizadeh G, Majd A, Arbabian S. The effect of sodium silicate and silica nano particles on seed germination and growth in the Vicia faba L. Tropical Plant Res. 2015;2(2):85-9.
26- Kara K. The effects of nitrogen doses applied at different growing periods on the quality and yield of oil type sunflower (Helianthus annuus l.) varieties. Turk J Field Crops. 2018;23(2):195-205.
27- Zmeeva ON, Daibova EB, Proskurina LD, Petrova LV, Kolomiets NE, Svetlichnyi VA, et al. Effects of silicon dioxide nanoparticles on biological and physiological characteristics of Medicago sativa L. nothosubsp. varia (Martyn) in natural agroclimatic conditions of the subtaiga zone in western Siberia. BioNanoSci. 2017;7:672-9.
28- Ma JF, Yamaji N. Silicon uptake and accumulation in higher plants. Trends Plant Sci. 2006;11:392-7.
29- Abbasi Khalaki M, Ghorbani A, Dadjou F. Influence of nano-priming on Festuca ovina seed germination and early seedling traits under drought stress, in laboratory condition. ECOPERSIA. 2019;7:133-9.
30- Moameri M, Alijafari E, Ghorbani A. Effect of some growth facilitators on the growth parameters Onobrychis sativa Lam. in greenhouse. J Plant Res Iranian J Biolog. 2020;32(4):886-95. [Persian]
31- Daly MJ, Stewart DPC. Influence of "Effective Microorganisms" (EM) on vegetable production and carbon mineralization-a preliminary investigation. J Sustain Agric. 1999;14(2-3):15-25.
32- Wielgosz E, Dziamba S, Dziamba J. Effect of application of EM spraying on the populations and activity of soil microorganisms occurring in the root zone of spring barley. Pol J Soil Sci. 2010;43:65-72.
33- Zydlik P, Zydlik Z. Impact of biological effective microorganisms (EM) preparations on some physico-chemical properties of soil and the vegetative growth of apple-tree rootstocks. Nauka Przyr Technol. 2008;2(1):1-8.
34- Karunakaran G, Suriyaprabha R, Manivasakan P, Yuvakkumar R, Rajendran V, Prabu P, et al. effect of nanosilica and silicon sources on plant growth promoting rhizobacteria, soil nutrients and maize seed germination. IET Nanobiotechnol. 2013;7(3):70-7.
35- Gao L, Yang H, Wang X, Huang Z, Ishii M, Igarashi Y, et al. Rice straw fermentation using lactic acid bacteria. Biores Technol. 2008;99(8):2742-8.
36- Abbasi Khalaki M, Moameri M, Ghorbani A. Effect some of the growth treatments on several soil characteristics in Festuca ovina planting bed. The 2nd National Conference on Natural Resources and Sustainable Development in Zagros, Sharekord, Iran. Tehran: Civilica; 2019. [Persian]