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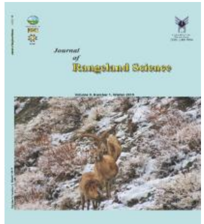

Research and Full Length Article:

Impact of Organic, Inorganic and Superabsorbent Polymer Materials on Soil Properties under Plant Community of *Nitraria schoberi* in Deserts of Semnan, Iran

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Abstract. Improving water use efficiency and soil properties are two major factors for sustainable development in desert areas. Therefore, this research aims to study the effectiveness of a biological hydrogel, plant vegetation layer, sand and barley straw with rain harvesting techniques through micro-catchment operation on some soil properties including pH, Nitrogen, Electrical conductivity, Sodium Absorption Ratio, Phosphorous, Sodium, Potassium, Calcium, Magnesium, Organic Matter and Soil moisture under cultivation of Nitraria schoberi. using a split plot design with micro-catchment at two levels as main factor and mulch treatment in five levels as sub factor using a completely randomized block in three replications for 2 years (2015 to 2016) in Natural Resources Research Station, Semnan, Iran. Data analysis was carried out using software SAS 9.1. The results of the analysis of variance showed that main effect of Micro-catchment was significant only for organic matter ($P<0.01$). The main effect of mulch treatments was significant for all of traits ($P<0.01$) except soil Ca and OM. Also, all four mulch treatments held significantly more moisture as compared to the control. The mulch by environment interaction effect was significant for EC, N, and Mg^{2+} ($P<0.05$) and Na^+ and Ca^{2+} ($P<0.01$). Thus, considering the effects of present mulch on soil factors types and soil moisture, and considering the price, availability and conditions of the area, they can be used to restore these areas biologically. Considering the abundance of sand mineral matters and straw in the country and cost of each material, the use of sand and straw in comparison with the Plantbac and bio-hydrogel will be more economical. If the purpose is to produce herbal essences or certain enzymes from the plant due to high value of sales of these materials, Plantbac and bio-hydrogel may be applied as an amendment.

Keywords: Amendments, Soil properties, *Nitraria schoberi*, Semnan

Introduction

Desertification is one of the major problems of this century, threatening millions of people around the world directly and indirectly. Today, human being knows that indiscriminate utilization of natural resources brings unintended results, and attempts to improve its methods of exploitation and management along with the prevention of further destructions. Hence, considering appropriate measures to improve the soil in arid and desert areas and optimal use of precipitation are necessary (Yang *et al.*, 2014). These two factors are central to the success and feasibility of land restoration projects, especially biological land treatments. It is nearly half a century since land management activities started after the nationalization of natural resources. These activities mainly included measures like land protection and vegetation establishment with operations such as furrowing and pitting (Azarnivand *et al.*, 2004). The purpose of all these methods was to protect or restore vegetation in the destroyed areas. In deserts containing wind sediments, vegetation plays a major role in reducing wind speed and soil erosion (Sheikh, 2014). One way to use saline soils and hoard water is to identify and use drought tolerant plants with industrial, economic, aesthetical and conservational values (Wang, 2011). Also, vegetation improves soil stability and reduces salinity. One of the most commonly used methods is the restoration of vegetation through planting (Azimi *et al*., 2016). However, lack of moisture and uneven precipitation distribution and high evapotranspiration rate lead to loss of new seedlings (especially in the critical periods of establishment) and failure of planting projects in arid areas. In addition, high cost of these projects and water for seedling irrigation are to be considered as two serious problems preventing proper implementation of these projects at the beginning of the planting period.

One strategy to restore the degraded lands is the use of non-oil mulches, which are materials or coatings intended to prevent from water evaporation and weed growth and to increase soil fertility. Non-oil mulches include a variety of synthetic chemical polymers, lime, gypsum, plant gums and other natural materials. Another strategy is to use hydrogels. Hydrogels (super-absorbents) are polymer network gels capable of holding solvents in their structure. The gel can be either polymer or other compounds. Hydrogels are super-absorbents, which hold water hundred times than its own weight (for example 400-1500 g of water per gram of dry hydrogel) (Bowman and Evans, 1990). Their functions are determined by their chemical properties such as molecular weight, hydrogel-forming conditions, soil chemical properties or irrigation water quality.

Different methods of collecting rainwater are exercised in arid areas concerning compensation for water scarcity (García-Torres *et al.*, 2001; FAO 2003). It is possible to use rain water harvesting techniques along with absorbent materials and amendments, tailoring to the conditions of the area in micro and even macro scales. These measures can guarantee the success of seedlings establishment and water use efficiency to some extent (Sheikh, 2014). As previously stated and regarding the rich background of applying oil mulches in Iran and elsewhere, some adverse environmental properties might be conceived for oil mulches. They also require expensive transportation costs and could be replaced with new and more compatible materials (Rezaee, 2009). Therefore, this research takes a closer look at the effectiveness of some amendments along with rain water harvesting techniques on some soil properties under cultivation of *Nitraria schoberi*.

Materials and Methods

Study area

The study was carried out over years in Semnan Natural Resources Research Station, Iran as a typical desert area receiving an average precipitation of 109.3mm. Most of rain falls in winter. The evaporation rate reaches to 2582.3 mm considering 3134.5 sunny hours, average annual temperature of 18°C, minimum relative moisture of 23% and 19 annual frosting days. This area is characterized by an arid and cold climate based on the de Marton method (www.semnanweather.ir/index.php).

Soil amendments

Biological hydrogel was tested for first time in arid region in Iran. It was made by Polymer Research Institute of Iran. Biological hydrogel is in fact a mixture of microbial elements with plant polymers, which has a potential to store water up to 40% of its own weight, and unlike super-absorbents, biological hydrogels prevent from salt accumulation by diluting salts in the root zone. The pH of this mulch ranges between 7± 0.5; given a 90% seed germination success rate, it imposes no salt and phytotoxic stresses on plants. Hydrogels act as a growth medium for soil microorganisms and lead to a better soil biological activity. In dry areas, the mucilage layer created by this mulch around the roots can prevent from water stresses (Alharbi, 2015; Zhao *et al.*, 2014; Jordán *et al.*, 2010). Plantbac contains albumin biopolymers, water, minerals, and decomposable herbal elements and lasts for 5 to 8 years. Plantbac can restore the soil structure and prohibit soil from water and wind erosion. Release and absorption of essential nutrients are two major functions of Plantbac. In combating the desertification, preserving soil moisture with these types of mulches can help vegetation cover to be re-established quickly (Plantbacter.com).

Research Methodology

First in June 2015, the seeds were planted in plastic pots (diameter of 10 cm and height of 10 cm with sandy clam loam texture) in the nursery of Hasanabad station located in Damghan, Iran and then transferred to Semnan research station. After that, seedlings were planted in field as a split plot design with a completely randomized block design with 3 replications and 10 observations in December 2015. The first irrigation was performed immediately after planting seedlings. The treatments were inter-row systems (micro-catchment) and non-micro-catchment. The height of the ridges is 40 to 100 centimeters and their distance is 2 to 10 meters. Micro-catchment is triangular cross-sectional ridge or embankments that are made along the main slope of the field. Ridge can be compressed or covered with insulating or waterproofing materials to increase the runoff coefficient. Runoff from ridges is stored among them (García-Torres *et al.*, 2001; FAO 2003). Mulch and moisture absorbent materials had five levels (biological hydrogel or biological mulch, Plantbac, sand, straw and control). For the Plantbac treatment (Dimensions: 80×60×2 cm; Weight: 1.8 kg; Water absorption capability: 10l/m^2; Erosion resistance: 5-8 years), first half of a full piece and then two halves of pieces were put at the bottom of the pit (depth of 50 cm) and then above it at a distance of 20 cm. Finally, the seedlings and the soil were put (Iranian Polymer institute). For biological hydrogel, 140 liter of water was added in a barrel of 220 liters and was heated to 80◦C. Then, 40 liters of concentrated hydrogel were added to dilute it. Then, 2 liters were placed in the soil under the plant and 1 liter in soil around the seedling. For sand treatment, sand with 5 cm thick (sand grain with 2 to 5 mm in diameter) was placed in the plant shade section. For straw treatments, the same function was done (Jiménez et al., 2017). Time of doing above treatment was in

December 2015. Finally, the seedlings were planted. Rainwater harvesting techniques were implemented tailoring to the condition of the area (slope, climatic factors, soil depth, etc.) as inter-row systems for all repetitions. Four irrigations (15 June, 15 July, 15 August and 15 September) were considered for summer of the first year. The volume of water for irrigation was considered at a level between the wilting point and the field capacity that comes to 15 liters. Finally, water use efficiency was determined based on the volume of water consumed (constant against to control) in relation to the dry matter achieved for treatments. Eventually, soil sampling was conducted according to the instructions. Then, the samples were transferred to the laboratory and prepared for further analysis.

After sampling, 3 samples at each repetition with 5 treatments, 15 samples in general for micro-catchment and also 15 samples for non- micro-catchment were taken. Amount of each sample was 2 kg and they were taken from the depth of 30 cm of soil. Time of first sampling was before adding materials (mulches and hydrogels) and after first irrigation in October 2015 and second time was after two years in July 2017 (during plant flowering); soil and plant samples were transferred to the laboratory for further analysis. The pH and EC were measured at soil saturation using a pH meter and a conductivity meter, respectively. Other factors were measured as follows: sodium absorption ratio (SAR) based on the ratio between calcium and magnesium cations relative to sodium, soil organic matter by Walkley-Black method (Nosetto *et al*., 2006), nitrogen by Kjeldahl device model V40, phosphorus by Olsen method (Olsen, 1982), calcium and magnesium by complexometric method, potassium and sodium by flame photometry, and moisture content by weighing soil samples at two wet and dry statuses.

Data normality for each trait was tested by Shapiro-Wilk, Kolmogorov-Smirnov, Cramér–von Mises and Anderson-Darling tests. Data analysis was done as a split plot in a completely randomized blocks design with three replications. The environmental factor with two levels (micro-catchment and non-micro-catchment) and mulch application with five levels (control, Plantbac, bio-hydrogel, straw, and sand) were included in data analysis as independent variables. The analysis was performed using SAS software version 9.1.3. The means comparison was performed using the LSD test.

Results

The results of the analysis of variance for soil properties [pH, Electrical Conductivity (EC), Sodium Adsorption Ratio (SAR), Organic Matter (OM), Phosphorus (P), Potassium (K^+), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Nitrogen (N), sodium (Na^+), and moisture content] are presented in Table 1. The effect of environments (Micro-catchment) was significant only for organic matter ($P<0.01$). The main effect of mulch treatments was significant for all of traits ($P<0.01$) except Ca^{2+} and OM. The mulch by environment interaction effects were significant for EC, and Mg^{2+} ($P<0.05$) and Na^+ and Ca^{2+} ($P<0.01$). The means comparison was made in the first stage for the main effect. For some traits such as EC, Mg^{2+}, N, Na^+ and Ca^{2+}, mulch by environment interaction effects were significant; no means comparison was made for their main effects.

Table1. Analysis of variance of the split plots in a randomized block design

SOV	DF	MS										
		pH	EC	SAR	OM	Na^+	P	K^+	Moisture	Ca^{2+}	Mg^{2+}	N
Replication	2	0.013^{ns}	0.084^{ns}	0.43^{ns}	0.00001^{ns}	1.44^{ns}	0.009^{ns}	3109.4^{ns}	1.34^{ns}	9.54^{ns}	26.5^{ns}	0.00006^{ns}
Environment (E)	1	0.011^{ns}	4.975*	0.2^{ns}	0.00167**	30.03*	0.07^{ns}	16680.3^{ns}	22.07^{ns}	6.12^{ns}	182.0^{ns}	0.00075^{ns}
Error1	2	0.05	0.228	0.49	0.00001	0.872	0.078	3178.9	2.57	0.83	32.5	0.00009
Mulch (M)	4	0.178**	0.305**	0.85**	0.00165^{ns}	25.86**	0.238*	224.8^{ns}	14.35**	111.05**	281.9**	0.00118**
M×E	4	0.002^{ns}	0.179*	0.342^{ns}	0.00037^{ns}	14.02**	0.104^{ns}	6436.8^{ns}	0.75^{ns}	91.67**	110.7*	0.00022*
Error2	16	0.005	0.044	0.048	0.00061	2.17	0.078	4221.5	0.544	16.77	28.41	0.00007
CV (%)		0.96	4.26	4.9	34.16	4.82	36.02	10.21	7.49	27.8	6.64	23.33

* and **=significant at probability level of 5%, and 1%, respectively
SAR=sodium adsorption ratio, OM=organic matter

The main effects of Micro-catchment on OM

The results of the analysis of variance showed that only the effect of environments (Micro-catchment) was significant (P<0.01) (Table 1). Therefore, the mulch treatments had no significant effect on soil OM. The results showed that soil OM was significantly higher in the non-micro-catchment as compared with the micro-catchment application (Fig. 1).

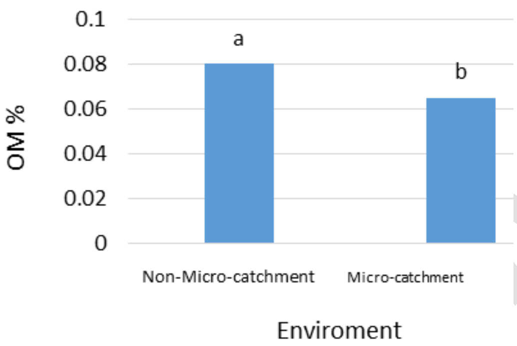

Fig. 1. Means comparison of the micro-catchment effect on organic matter

The main effects of mulch treatments on pH, SAR, P and Soil moisture

Analysis of variance showed that the effect of mulch was significant on soil pH (P<0.05) (Table 1). All four mulch treatments had significantly lower mean pH values than the control (Fig. 2). Sand and straw had the lowest pH, and the control had the highest pH on the contrary. Bio-hydrogel and Plantbac treatments had no significant difference and were placed after control treatment (Fig. 2).

The analysis of variance for Sodium Absorption Ratio (SAR) showed a significant effect for mulch application (P<0.01) (Table 1). Means comparisons showed that SAR values were lower in Plantbac, bio-hydrogel and sand treatments as compared with the control group. Results also showed that straw mulch had no significant effect on the SAR. The lowest SAR was detected for the Plantbac treatment (Fig. 2).

Result of analysis of variance showed that the effect of mulch was significant on phosphorous (P) (P<0.05) (Table 1). The results showed that sand, straw and bio-hydrogel treatments did not make any significant changes in phosphorus content as compared with the control (Fig. 2). However, Plantbac treatment had the highest phosphorus value and had a significant difference with the control (Fig. 2).

The results of the analysis of variance showed a significant effect of mulch treatments on soil moisture (P<0.01) (Table 1). Mulching effect on soil moisture was significant for all four mulch treatments as compared with the control. The highest moisture content occurred in the straw and bio-hydrogel treatments (Fig. 2).

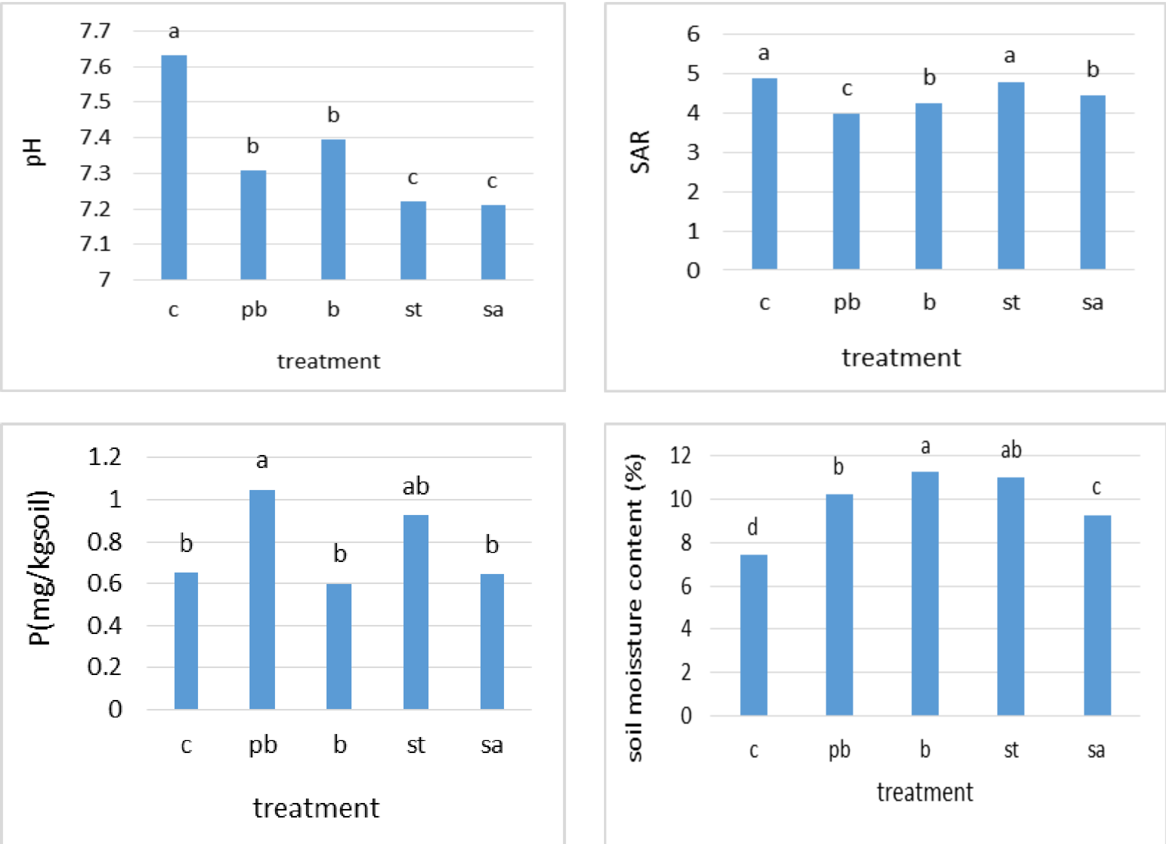

Fig. 2. Means comparison of the mulches effect on pH, SAR, P and Soil moisture. Other symbols mean biological hydrogels (b), PLANTBAC vegetation layer (pb), sand (sa) and barley straw (st)

Mulches by environments interaction effect on EC, N and Mg^{2+} (P<0.05) and Na^{+} and Ca^{2+}

The results of the analysis of variance showed significant effects of mulch× environment for EC (P<0.05) (Table 1). The best combination of environments with mulch was determined as micro-catchment coupled with sand and straw mulches to reduce soil EC since there was no difference between Plantbac and control in the micro-catchment (Table 2). In addition, apart from bio-hydrogel mulch that did not change EC in both micro-catchment and control, other mulches in combination with the micro-catchment application caused a significant reduction in soil EC against the non-micro-catchment. Additionally, the results showed that all mulches in non-micro-catchment condition were better than the control. The EC Average for the three bio-hydrogel, straw and sand treatments was significantly lower than that for the Plantbac and control. Therefore, these three mulches are recommended for EC reduction in the non-micro-catchment cultivation. Also, four mulches of sand, straw, Plantbac and control had less EC values than hydrogel mulch in micro-catchment status (Table 2).

The results of the analysis of variance showed mulch by environment interaction effects on Calcium (Ca^{2+}) (P<0.01). The highest amount of Ca^{2+} was obtained in the micro-catchment environment and Plantbac treatment (Table 2). Likewise, in the non-micro-catchment environment, the amount of Ca^{2+} for Plantbac and biological hydrogel treatments was significantly higher than the control. In the micro-catchment environment, Plantbac and straw mulch had higher Ca^{2+} as compared to the control. Generally, the amount of Ca^{2+} in the Plantbac treatment was the highest one in both the non-micro-catchment and micro-catchment environments (Table 2).

The results of the analysis of variance showed significant effect of mulch by environments for Magnesium (mg^{2+}) ($P<0.01$) (Table 1). The highest mg^{2+} was obtained in the non-micro-catchment environment and the control treatment (Table 2).

The results of the analysis of variance showed significant effect of mulch by environments for Sodium ($Na^{+)}$ ($P<0.05$) (Table 1). The highest amount of Na^{+} was obtained in the non-micro-catchment environment and control treatment (Table 2). Also, in the non-micro-catchment environment, Na^{+} of all treatments was significantly lower than the control. Only the Plantbac treatment had a Na^{+} level lower than the control in Micro-catchment environment (Table 2).

The results of the analysis of variance showed the significant effect of mulch by environments for nitrogen ($N^{)}$ ($P<0.05$) (Table 1). The highest total N occurred in micro-catchment environment and hydrogel treatment (0.066) (Table 2). Also, in non-micro-catchment treatment, total N in hydrogel (0.037), PLANTBAC (0.041) and straw (0.032) treatments were significantly higher than the control (0.016), but total N in sand treatment did not have any significant differences. Three treatments of PLANTBAC (0.043), bio-hydrogel (0.066) and straw (0.047) had significant differences with the control (0.021) in the micro-catchment environment while total N in the sand treatment was similar to that in the control (Fig. 6).

Table2. Means comparison of the mulches by environments interaction effect of on EC, N, Na, Ca and Mg.

Environment	Mulch	EC	Na	Ca	Mg	N
Non-micro-catchment	control	5.893 a	36.994 a	9.05 c	88.36 a	0.016 e
	Plantbac	5.428 b	29.235 cd	19.40 ab	87.11ab	0.041bc
	Bio-hydrogel	5.144 bc	29.309 cd	23.21 a	82.41 bc	0.037bc
	Straw	5.034 cd	32.410 b	9.46 c	77.70 cd	0.032cd
	Sand	5.181 bc	29.941 c	14.8b c	77.82 cd	0.022de
Micro-catchment	control	4.602 def	30.515 bc	8.40 c	87.6 ab	0.021de
	Plantbac	4.584 ef	26.904 d	20.27ab	74.74 d	0.043bc
	Bio-hydrogel	4.789 cde	30.873 bc	12.04c	85.56 abc	0.066a
	Straw	4.381 f	29.662 c	19.81 ab	61.83 e	0.047b
	Sand	4.252 f	29.931 c	10.89 c	79.02 bcd	0.021de

Means by at least one similar letter are not statistically significantly different from each other

Discussion

Against the present result, Chaudhry *et al*. (2004) and Jiménez *et al.* (2017) showed that the greatest reduction of soil organic matter occurred under straw due to the presence of higher volumes of organic matter in this mulch. The reason for the present result may be little decomposition of straw in arid area of Semnan. According to the results, effect of Micro-catchment was significant ($P<0.01$) and the mulch treatments had no significant effects on soil OM because the time and the condition for decomposition were not sufficient and suitable to have effects on soil organic matters. In contrast, Ni *et al*. (2016) and Pakdel *et al.* (2013) showed that mulching consistently improves soil organic matter.

About pH, all mulch treatments had significantly lower mean pH values than the control because these mulches conserve the moisture to decrease the pH and salt concentration. Sand and straw had the lowest pH because they act as a layer on soil surface and reduce moisture evaporation. About hydrogel and PLANTBAC, pH was a little more because they are not acting as a coating. Like the present results, Billeaud and Zajicek (1989) reported that mulching with four types of organic mulches significantly decreases pH in soil with sandy loam texture. However, Iles and Dosmann (1999) found that inorganic (sand) and organic (straw) mulches remarkably increase soil pH in soils. Like the results, Ni *et al*. (2016) showed that soil pH was higher in the sand treatment as compared to the control treatment. The decrease in soil pH was pronounced in the mulch treatments compared to the control (Alharbi, 2015). Taken together, these results suggest that the effect of mulches on soil pH depends on the material used in their fabrication as well as soil texture.

According to the present research results, mulch application did not reduce the SAR because the time and the condition for decomposition were not sufficient and suitable to have effects on SAR but Chaudhry *et al*. (2004) demonstrated the benefits of organic mulching for soil sodicity control because of reduced evaporation and decreased salt concentration. Therefore, soil mulching led to the conservation of water, less evapo-concentration of the salts existing in the irrigation water and the soil solution. According to Aragüés *et al.* (2014) and Jiménez *et al.* (2017), Sodium adsorption ratio (SAR) increased in all treatments, but the increases were meaningfully lower under mulch application as compared to bare soils due to the reduced evaporation and the concomitant decrease in salt evapo-concentration.

According to the present research results, mulch application (Plantbac and straw) had more phosphorous against the control. Soil moisture can help organic mulch to be decomposed and influence the amount of soil phosphorus. Like the present research results, Pakdel *et al*. (2013) and Ni *et al.* (2016) showed that sand mulching provides phosphorous in the soil. Also, Chalker (2007) concluded that since organic mulches decompose under appropriate water and temperature, phosphorous are released into the soil.

Ni *et al.* (2016) and Zhao *et al*. (2014) showed that all mulch types had significant effects on soil moisture. The reason may be as follows: Covering soil surface by sand and straw can reduce evaporation and increase soil moisture content. Also, surface mulches facilitated water infiltration and soil-water storage according to Jiménez *et al.* (2017). Lei *et al.* (2004) and Ma and Li (2011) stated that mineral mulches (sand) are impervious to water vapor and expected to conserve soil moisture more efficiently than organic mulches; maybe other mulches cover all surfaces but sand cannot cover surface properly. Therefore, soil moisture could be evaporated from the soil.

Pakdel *et al*. (2013) suggested that mulch can reduce soil EC in two ways; a) mulches reduced water evaporation from soil and led to less salt accumulation in soil, and b) water soluble solids might be absorbed by mulch layer and led to lower EC. Moreover, Hild and Morgan (1993), Zhao *et al*. (2014) and Jiménez *et al*. (2017) found that mulch could lower water evaporation and retain soil moisture; so, it led to lower EC. Also, Ma and Li (2011) and Wang *et al.* (2011) reported the effectiveness of soil mulching to lower soil salinity for several annual crops in China (Wang *et al*., 2011).

According to the present research results, the sand treatment was not significant because the time and the condition for decomposition of sand (mineral materials against organic materials) were not sufficient and suitable to have effects on soil Ca^{2+} content. Sand mulches always contain fewer nutrients (Ca^{2+}) and are difficult for microorganisms to decompose, but Ni *et al.* (2016) showed that sand mulching provides Ca^{2+} in the soil because the period of their research was 30 years. Also, Iles and Dosmann (1999), Chalker (2007), Mikkelsen (1994) and Jiménez *et al*. (2017) stated that organic mulches decomposed easier and more Ca^{2+} was released into the soil.

Also, in the non-micro-catchment and micro-catchment environments, Plantbac, straw, and sand had significantly lower mg^{2+} than the control group. In general, straw treatment in the micro-catchment environment had the least amount of mg^{2+} (Table 2) because the time and the condition for decomposition were not sufficient and suitable to have effects on soil mg^{2+} (Jiménez *et al*., 2017). Ni *et al.* (2016) showed that straw mulch provides mg^{2+} in the soil because the period of research was 30 years. Also, Iles and Dosmann (1999) and Jiménez *et al*. (2017) showed that straw mulch provides more mg^{2+} in the soil against the control. Chalker (2007) stated that organic mulches decompose easier and more mg^{2+} is released into the soil.

The Plantbac treatment had a Na^+ level lower than the control in Micro-catchment environment. This shows that the reserved moisture in soil because of the mulches can reduce the amount of cations like Na^+ in soil (Chalker, 2007). Also, Iles and Dosmann (1999), Chalker (2007), Jordán (2010) and Jiménez *et al*. (2017) stated that the mulch treatment has lower Na^+ against the control. Another reason for lower Na^+ in mulch treatments against the control is that Na^+ in contrast to other cations is lower in mulches; so, after decomposition, its amount would be lower in soil. The reason for lower content in mulches is that the plant does not need much Na^+ and the excessive amount of Na^+ in soil disturbs its structure and diffuses the soil particles.

Brown and Whitford (2003) stated that N content in straw treatment was higher than the control. The sand treatment was not significant because the time and the condition for decomposition of sand (mineral materials against organic materials) were not sufficient and suitable to have effects on soil nitrogen. Sand mulches always contain fewer nutrients and are difficult for microorganisms to decompose (Ni *et al.*, 2016) but other researchers such as Brown (2003) showed that straw mulch did not result in greater soil nitrogen. Although sand mulch can conserve soil moisture, it may also lead to long-term decrease in total organic N (Yang, 2014).

About economic assessment, economic appraisal of planting can be seen in the region in the second year (Table 3) (Kianian, 2016). Economic assessment was done in the first year too. In the second year, the total cost of site seedlings was 500000 Rials, the total cost for 150 seedlings at a distance of 3 meters for Plantbac 60 * 80, hydrogel, straw and sand was 3333.3, 3333.3, 3333.3 and 3333.3 Rials, respectively. Their total cost per hectare for the research site of Plantbac 60 * 80, hydrogel, straw and Sand was 4409171, 4409171, 4409171 and 4409171 Rials, respectively. Considering the cost of reducing water in the second year, it is estimated that the cost of 5 irrigation intervals in the first year decreased by 200,000 Rials, which reduces the amount of 1,500,000 Rials as the total cost of the first year per seedlings by 10,000 Rials, which makes it economically viable on a large scale. From the second year onwards, if it is fully deployed and protected, there will not be any need for this water in the second year, and the plant will be able to meet its needs by its roots. In the second year, the total cost for each seedling was 3333.3 Rials for 150 seedlings in the site.

Conclusion

Water availability and soil chemical and physical properties play major roles in the establishment and growth of seedlings in arid and desert areas. Improving water use efficiency and soil improvement are two major elements of a sustainable development plan for these areas. This study believes that sand and straw mulches are the best measures to lower soil pH. For EC, sand and straw mulches coupled with micro-catchment were the best treatments, but in non-micro-catchment cultivation, all mulches were compared with the control. Average EC values in straw and sand mulches were significantly lower than Plantbac and control. Therefore, these three mulches could be recommended to reduce soil EC regarding their suitable price. The treatments had no significant effects on soil OM, but soil OM in the non-micro-catchment environment was significantly higher than the micro-catchment environment. Both environments and mulch treatments were not significantly different regarding the average amount of potassium. In case of phosphorous, Plantbac outperformed other treatments. Hence, Plantbac is mainly recommendable for soils with phosphorus limitations. The highest Ca^{2+} level occurred in Plantbac treatment in both the non-micro-catchment and micro-catchment environments. The highest total N occurred in micro-catchment environment and hydrogel treatment. Also, in non-micro-catchment treatment, total N in hydrogel, PLANTBAC and straw treatments was significantly higher than the control. As a result, Plantbac, bio-hydrogel and straw are applicable tools to improve alkaline soils. Magnesium in three treatments of Plantbac, straw and sand in non-micro-catchment and the micro-catchment environment was lower in comparison with the control. The straw mulch had the least amount of Mg^{2+} in the micro-catchment environment. The average values of Na^{+} were significantly lower in all treatments compared with the control, but in micro-catchment, only Plantbac had lower Na^{+} than the control. Thus, Plantbac is suitable for desert areas with alkaline soils. The lowest soil moisture content was recorded under sand mulches compared with the highest one under the straw and bio-hydrogel treatments. All four treatments had a significant effect on soil moisture in desert areas where the biggest threat to the seedling establishment is the lack of adequate moisture. This study concludes that mulches enable the establishment of seedling in harsh arid and desert areas considering their effectiveness for soil moisture preservation, their prices and availability. Besides, mulches conserve the soil against erosion agents, harness sand blasts and the movement of dunes.

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تاثیر مواد معدنی، آلی و فراجاذب پلیمری بر خصوصیات خاک تحت جامعه گیاهی قره داغ (*Nitraria schoberi*) در اراضی بیابانی سمنان

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چکیده. بهبود کارایی مصرف منابع آب و خصوصیات خاک، دو عامل مهم توسعه پایدار در مناطق بیابانی است. از این رو، در این تحقیق تاثیرگذاری هیدروژل زیستی، لایه‌ی گیاهی پلانت‌بک، ماسه و کاه و کلش جو به همراه روش استحصال آب باران از طریق عملیات میکروکچمنت (جمع آوری آب در محل‌های کوچک) بر برخی ویژگی‌های خاک شامل pH، N، EC، SAR، P، Na، K، Ca، Mg، مواد آلی و رطوبت خاک تحت کشت گونه بیابانی قره‌داغ (*Nitraria schoberi*)، به صورت طرح کرت‌های خردشده به همراه میکروکچمنت در دو سطح به عنوان عامل اصلی و تیمارهای مالچ در ۵ سطح به عنوان عامل فرعی با استفاده از طرح پایه بلوک‌های کامل تصادفی با ۳ تکرار به مدت ۲ سال (از سال ۱۳۹۴ الی ۱۳۹۶) در ایستگاه تحقیقات منابع طبیعی استان سمنان مورد بررسی قرار گرفت. تجزیه و تحلیل داده‌ها با کمک نرم-افزار SAS انجام شد. نتایج تجزیه واریانس نشان داد، که اثر اصلی میکروکچمنت فقط بر مواد آلی خاک معنی دار بود ($P<0.01$). اثر اصلی تیمارهای مالچ بر کلیه صفات ($P<0.01$)، بجز کلسیم و مواد آلی خاک معنی دار بود. همچنین هر چهار تیمار مالچ بطور معنی داری دارای رطوبت بیشتر از شاهد بودند. اثر متقابل مالچ در میکروکچمنت بر روی صفات EC و منیزیم و نیتروژن ($P<0.05$) و سدیم و کلسیم ($P<0.01$) معنی‌دار بود. بدین ترتیب با توجه به موثر بودن اثرات مالچ‌های حاضر بر روی انواع عوامل خاکی و رطوبت خاک و با توجه به قیمت هر کدام، در دسترس بودن و شرایط منطقه، می‌توان آنها را جهت احیای بیولوزیک مناطق بیابانی بکار برد. با توجه به وفور ماده معدنی ماسه و کاه و کلش در کشور و با توجه به هزینه استفاده از هر ماده، استفاده از ماسه و کاه و کلش در مقایسه با پلنت‌بک و هیدروژل زیستی به لحاظ صرفه اقتصادی مناسب‌تر خواهد بود، اما در مواردی که هدف تولید اسانس‌های گیاهی یا آنزیم‌های خاص از گیاه است، با توجه به ارزش بالای حاصل از فروش این مواد، می‌توان از پلانت‌بک و هیدروژل زیستی به عنوان اصلاح کننده بهره جست.

کلمات کلیدی: اصلاح‌کننده‌ها، خصوصیات خاک، قره‌داغ (*Nitraria schoberi*)، سمنان