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Application of zeolite and geohumus superabsorbent on establishment and some growth indices of *Nitraria schoberi* L.

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ABSTRACT

Using Superabsorbent is one of the solutions to water shortages in arid and semi-arid regions. In order to evaluate the effect of zeolite and geohumus on the growth of *Nitraria schoberi* L. species, a factorial experiment in a completely randomized design was conducted with nine replications in Kashan city. The treatments consisted of various zeolite levels (0, 10 and 15 wt%) and geohumus (0, 100, 150, 250 gr for hole) and irrigation (normal irrigation, low irrigation). This study showed that superabsorbent application has a positive effect on establishment and other indices such as plant height, large and small canopy diameter and collar diameter. The highest survival percentage was observed in superabsorbent application (100%) and the lowest was measured in control treatment of low irrigation (the soil free of modifying substances) (78%). Also, the most growth indices of the plant are related to the treatment of 250 g geohumus with low irrigation treatment. Based on the results, it was found that adding superabsorbent on soil causes more establishment and improves vegetative growth traits. Also, considering the economical price of zeolite superabsorbent compared to geohumus as well as its abundance in Iran, it is recommended to use in order to increase irrigation intervals and reduce costs in desertification projects.

1. Introduction

Iran has a warm and arid climate and its annual rainfall is low. Super-arid and arid climate of Iran cover the area about 573,884 and 472,562 km^2 of the country respectively [20]. The most important limiting factor in these areas is water resources. In addition to the shortage of rainfall, the temporal and spatial distribution is also very inadequate and unsuitable. Lack of water and desertification are serious problems in many parts of the world because these two problems pose the serious threats to development and establishment of vegetation (Puoci, 2008).

Therefore, the effective use of modern technologies in improving the efficiency of water resources is vital [16]. Use of super adsorbent polymer (SAP) is one of these tools which is dry and sugar-like substances that has the ability in absorbing and maintaining aqueous solution to several times of its weight.

These types of polymers are highly applicable for increasing vegetation cover in degraded and contaminated soils [22–13]. Superabsorbent polymers increase the soil water durability in soil and reduce irrigation repetition by 50% [11].

Super absorbent polymers can hold up to 200–500 ml of water per gram of dry polymer [6]. These materials with high water absorption and preservation of water, increase the efficiency of rain and increase irrigation intervals in the case of soil irrigation [18–27] Zeolite (rosaceous-boiling rocks) was introduced in 1756 by the Swedish mineral explorer Eksel Fredrik Kronstad [23].

Now, more than 50 types of natural zeolites have been identified, which clinoptilolite is the most abundant material [28]. The most common type of zeolite used in agriculture and natural resources is clinoptilolite. The cationic exchange capacity of clinoptilolite is about 2.25 meq/gr [8].

Therefore, this material can be used in sandy soils, especially in desert soils, to increase the water retention and irrigation intervals of plants in the pot and also in field operations [12–17].

Geohumus as another polymeric-organic complex produced in Germany is a superabsorbent of water and soil booster. This material is directly mixed with soil and absorbs water up to 40 times compared to its weight. Using of Geohumus, improves root formation, faster and better growth of plants and more yields. Armand Pisheh et al. [3] reported that application of zeolite can reduce the adverse effects of drought stress on the production of abnormal seedlings and increase germination and seedling dry weight in canola seeds. In this regard Bandak [4] studied the effect of using two super absorbent including of A200 and Stokozosverbe on the vegetative characteristics of *Apripex cancesnes* seedlings planted in the pot. Results showed that both superabsorbents used in this study had a positive effect on the establishment,

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survival and germination characteristics of the *Atriplex cancesnes*. The effect of Stockosorb on the improvement of the studied traits was greater than the A200. Also, Shahriari et al. [24] reported that soil type, amount of super absorbent, irrigation type and irrigation period had a significant effect on fresh weight of the plant, so that the use of superabsorbants even in desert soils can be effective in the biological regeneration of *Nitraria schoberi* species. In this regard, Jafari et al. [19] investigated the application of A200 and silicate super adsorbent hydrogels on soil moisture storage and establishment of *Atriplex canescens* in arid areas. The results showed a positive effect of both superabsorbent additions on establishment and survival rates of *Atriplex cancesnes* seedlings and improvement of vegetative characteristics. Also, Ramazani [25] evaluated the effects of various amounts of adsorbent hydrogel of A200 and silicates on the establishment of plant species of *Atriplex*, *Haloxylon* and *Nitraria* in desert of Eshtehard (Alborz province). They reported the use of both superabsorbents have positive effect on establishment and survival percentage of *Atriplex*, *Haloxylon* and *Nitraria* schoberi and improvement of the measured traits.

Concerning the application of zeolite, the results of Salehi et al. [2] showed that zeolite had a significant effect on flower yield, number of flowers per plant, plant height of *Matricaria chamomilla* herb. Finally, Khodadadi (2016) by analyzing the studies on superabsorbent and their effects on soil and plant reported that adding superabsorbent into soil, especially in arid and semi-arid soils, improves soil structure, increases moisture storage, and reduces irrigation frequencies. These structural effects remain for three to five years.

In spite of the relatively so much use of superabsorbants in the agricultural sector, these materials have been used less in the natural resources sector. Accordingly, there is a need for more research in the field of natural resources. Therefore, this research was carried out with the aim of examining the effect of different levels of zeolite and geohumus and also irrigation intervals on the establishment as well as the some growth characteristics of the *Ni. schoberi* plant under the influence of drought stress.

2. Materials and methods

2.1. Study area

This research was conducted in the International Research Center of Coexistence with Desert - Kashan Research Station affiliated to the College of Agriculture and Natural Resources, University of Tehran. The location is 51° 30′ E longitude and 34°5′ N latitude and its elevation is 945 m above sea level.

As a long term (1999–2105) In the desert parts, rainfall is between 50 and 150 mm and the maximum absolute temperature is more than 40 °C, annual evapotranspiration is more than 20–25 times of the annual precipitation and relative humidity is less than 20% (Kashan Weather bureau).

2.2. Characteristics of Nitraria schoberi

Nitraria is from the genus Nitraria and from the family Zygohphyllaceae. These plants are woody and much branched and has spiny and roughly branches. Wooden and spiny shrubs have a height of 80–50 cm and a canopy diameter of 1.1–1.5 m, which consists of pushing 5–7 stems in the form of stems, and in the right side with branches. Leaves are fleshy, lateral stems at the bottom are sharp and furrowed. This species can be used to prevent soil erosion, stabilize the sand dunes, and create suitable cover for saline lands [20].

2.3. Characteristics of materials used

In this study, two superabsorbent materials, which are: 1- Clinoptilolite zeolite at three levels (0, 10, and 15 wt%) and 2- geohumus levels (German product manufactured by Coma Company University of Tehran at four levels (0.100, 150, 250 g per hole).

2.4. Preparing the planting area

The zeolite based on the determined levels (0, 10 and 15% by weight of the pit soil) and geohumus (values of 0, 100, 150 and 250 g) was mixed with soil extracted from each pit (The depth of the holes was 50 and the diameter was about 40–50 cm). The mixture was completely homogeneous. In addition to cultivate treatments, irrigation and low irrigation treatments were applied so that in irrigated treatment the seedlings were irrigated every 30 days once and in irrigation treatments, they were irrigated every 45 days for 18 months. The data were analyzed by SPSS software version 22 using factorial experiment in a completely randomized design with 9 replications. The effect of three factors including irrigation interval, material type and material levels on vegetative characteristics of Ni. *schoberi* were investigated. The mean comparisons of data were conducted using Duncan's test [15].

3. Results

3.1. Percentage of plant survival in irrigation and low irrigation treatment

The percentage of plant survival after 18 months was investigated. Investigate the effect of superabsorbent application at different levels on the survival rate of planted seedlings was the purpose of this study. Regarding the fact that only one seedling was planted in each hole, statistical analysis was not possible and the results as survival percentage were shown in the form of Table 1. The highest survival percentage was in the superabsorbent application treatment (100%) and the lowest was in low irrigated control treatment (soil free of modifying substances) (78%). It did not show any significant difference with irrigation treatment (Table 1).

3.2. Interaction between irrigation intervals, type of materials and materials level on the characteristics of the plant

The effect of irrigation level, type and level of amended material on plant height, large canopy diameter, small canopy diameter and collar diameter were investigated. The results of variance analysis of the mentioned traits are presented in Table 2.

3.3. Seedlings height

The results of variance analysis in Table 2 show that, the independent (main) effects of irrigation level, type and level of material on plant height is significant. The interaction effect between irrigation level and material level and also the interaction effect of material type and material level on the height of the plant were significantly higher than the control treatment.

Interaction between irrigation intervals and type and level of polymers on plant height were significant at 1% level. Maximum height belongs to 250 g of geohumus with regular irrigation interval (60.22 cm)

Table 1
Percentage of seedling survival rate in different levels of superabsorbent in irrigation and low irrigation treatments.

Date	Superabsorbent level	Survival rate	
		Irrigation treatment	Low irrigation treatment
2017/08/20	Control	89	78
	10% of soil weight	100	100
	15% of soil weight	100	100
	100 g geohumus	100	100
	150 g geohumus	100	100
	250 g geohumus	100	100

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