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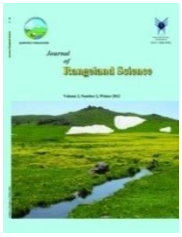

Full Length Article:

Studying the Effect of Index Species *Astragalus ammodendron* on Associated Plants *Agropyron tauri* and *Bromus tomentellus* from Different Aspects (Case Study: Arak Province-Shazand, Iran)

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Manuscript Received: 26/12/2011
Manuscript Accepted: 11/06/2012

Abstract. The aim of this research was to investigate the effect of index species, *Astragalus ammodendron* on the associated plants of *Agropyron tauri* and *Bromus tomentellu*s from different aspects in Shazand rangeland in southwest of Markazi province. The effects of species density and distribution pattern and then index species on the soil properties were studied. Based on the randomized – systematic method, 4 transects with a length of 50 m were established. To find the relationships between index and associated plants, 30 points were randomly chosen along the transects and the number of species was counted from these points to a 50 cm distance in different aspects. Along the transects, the distribution pattern of index plants and their presence and absence were determined. To find the effects of index species on soil properties, soil samples were taken and soil properties were determined in laboratory. Data were analyzed using SPSS software. The results showed that *Astragalus ammodendron* density with *Agropyron tauri* and *Bromus tomentellu*s were similar to the east and west aspects and near distances. *Astragalus ammodendron* distribution pattern was randomized with a tendency toward the clumped pattern. The effect of *Astragalus ammodendron* on the soil characteristics was not significant except for the north aspect. Generally, it is concluded that the effect of *Astragalus ammodendron* (index species) on *Agropyron tauri* and *Bromus tomentellu*s densities was not significant.

Key words: Shazand, Index species, Associate plants, Density, Distribute pattern.

Introduction

The plant influential interaction with each other and environment context can be considered under different categories. Plant distribution pattern is one of the most important characteristics of plant communities and it refers to the spatial placement of species against each other (Malhado and Peter, 2004). The plants are distributed as randomly and non-randomly in each geographical district or in each place where the plants are grown therein. Non-random distribution is in turn divided into regular and clumped forms (Moghaddam, 2008). By knowing the distribution pattern of index species in the growth place, we could better examine the vegetation cover of that area and express our opinion more accurately regarding the interaction of species. By establishing the vegetation cover and its development, the physical and chemical characteristics of soil such as soil texture, water reserve content and its nutrient elements are improved. These categories may be as follows: plant distribution pattern, plant effect on soil, comparison of species density, correlation among species, coexistence, competition, prevention, etc. Afkham Sho'ara (1995) pointed out the positive effects of *Haloxylon* spp planting on increasing the canopy cover and changing the plant composition in Khorasan. He noted that these changes were directly related to *Haloxylon* spp presence and its density which enhanced a micro climate. In addition, the amount of organic materials, nitrogen, phosphour and potassium elements contained in the soil beneath *Haloxylon* Spp are increased. Kröpfi *et al.,* (2002) stated that through the absorption of precipitation in its canopy, *Larrea divaricata* species reduces the moisture content under its canopy. Consequently, the growth of plants living under it was limited. Singh and Rathod (2002) by reviewing the effect of adjacent plants on growing *Cassia angustifolia* in the control sandy region in the desert areas of India concluded that the production of three species including *Acacia tortilis, Prosopis juliflora* and *Calligonum polygonoides* show *a* positive effect on the growth of *Cassia angustifolia*. Darrouzet-Nardi *et al.,* (2008) studied the effect of *Artemisia rothrockii* species on the soil nitrogen cycle and associated plants and found that it may result in the increase of reduced soil nitrogen content and on the other hand, it may enhance the growth and breeding of its associated plants. Jafari *et al.,* (2004) examined the effects of *Haloxylon aphyllum* and *Calligonum comosum* on the physical and chemical characteristics of sandy hills located in Rig Boland, Kashan. Their results proved that these species increased the content of soil organic matter which may result in improving the soil structure in long-term and increasing the contents of phosphour, nitrogen and potassium as well.

Materials and Methods

Study Area Features

Shazand is located in a distance of 37 km from southwest of Arak city, Iran. The study area is perched on a geographical position of 49° and 52' of eastern longitude and 33° and 45' to 34° and 20' of northern latitude. According to Umbrian method, it is classified under cold semi-arid climate. Its maximum annual temperature is between 32°C to 36°C and its annual average of temperature is estimated 14°C. Annual precipitation of this area is 311.6 mm and soil moisture regime is xeric.

Field Operation

For studying the effect of index species on the associated plants, vegetation type was selected, then locality type was sampled in an area which was indicative of whole type characteristics. Firstly, for the coverage percentage and each species density, the

index and associated species were identified. To review the variations of density, vegetation cover and characteristics of area, the dominant species was selected at 30 points. Then, index species in its four directions (north, south, east and west) and associated plants were counted in the intervals of 10 cm to the distance of 0.5 m of index species (Fig. 1). To determine the distribution pattern of index species in the area under consideration according to the random-systematic method, four transects having 100 m length were selected. Then, four points at the beginning of transects were randomly selected and transects were extended from these points. Along each established transect, 25 points at 4 m intervals were selected and the measurement was done randomly at 15 points out of 25 points. In each randomly selected point, its distance to the nearest plant, the plane distance to the nearest neighbor and the randomly selected point distance to the second nearest plant were measured. Through these data, the spatial indices were calculated and the number of plant bases in the plots was counted, as well. In addition, using these data, quadrant indices of distribution were calculated. Then, for reviewing the effect of index species on the associated plants through bed soil, the soil was sampled from the depth of 15 cm within four plots and the physical and chemical characteristics of soil under the bushes of *Astragalus ammodendron* and non-planted (control) area were compared.

Laboratory and Statistical Analyses

To measure the soil texture, hydrometric method was applied. Accordingly, the contents of clay, lime and sand in the samples were determined. Chemical analysis of soil, pH, Electrical Conductivity (EC), the content of lime, organic carbon, phosphour, nitrogen and potassium in soil were measured (Jafari Haghighi, 2003). The collected data were analyzed using Spss v. 17. In order to compare the physical and chemical characteristics of soil between the area under the bushes and non-planted (control) one, ANOVA analysis was used.

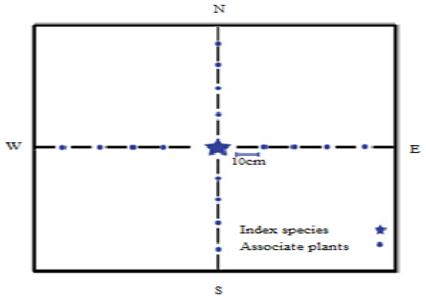

Fig. 1. Sampling of density in the area of study

Results

The maximum density of index species of *Astragalus ammodendron* was found around the species at the distance of 40-50 cm in western direction and the minimum density was at 0-10 cm distance of four species directions (north, south, east and west). The maximum density of associated species of *Agropyron tauri* was found around the index species of *Astragalus ammodendron* at of 40-50 cm distance of eastern direction and the minimum density was at 30-40 cm distance of eastern direction of index species. The maximum density of *Bromus tomentellus* and its minimum density (identified as the second associated species*)* were found at distances of 10-20 cm in north direction of this species, 20-30 cm of southern direction and 20-30 cm and 30-40 cm of eastern direction of index species, respectively. To compare the density variations of index and associated species, the average of each species in four main directions (north, south, east and west) was calculated and illustrated in (Figs. 3 and 4). In (Fig. 3), the average density values of two species, namely *Astragalus ammodendron* and *Agropyron tauri* in eastern and western directions were the same, but in the north

and south directions, they were different. As shown in (Fig. 4), the average density values of two species, *Astragalus ammodendron* and *Bromus tomentellus* as the index and associated plants were the same in north and south directions, but they were not the same in the east and west directions.

Determining Distribution Pattern of Index Species

Totally, the distribution of *Astragalus ammodendron* followed a random pattern with a tendency toward clumped distribution (Table 2).

Table 1. Comparison of density of index species of *Astragalus ammodendron* to associated plants of *Agropyron tauri* and *Bromus tomentellus*

Aspects	Species	0-10	10-20	20-30	30-40	40-50
N	*Astragalus ammodendron*	0.00	0.00	0.00	0.13	0.13
	Agropyron tauri	0.30	0.40	0.20	0.06	0.20
	Bromus tomentellus	0.86	0.80	0.13	0.30	0.53
S	*Astragalus ammodendron*	0.00	0.00	0.00	0.06	0.13
	Agropyron tauri	0.30	0.46	0.53	0.26	0.46
	Bromus tomentellus	0.46	0.53	0.00	0.30	0.30
E	*Astragalus ammodendron*	0.00	0.00	0.06	0.00	0.13
	Agropyron tauri	0.26	0.53	0.20	0.00	0.66
	Bromus tomentellus	0.26	0.30	0.00	0.00	0.26
W	*Astragalus ammodendron*	0.00	0.06	0.00	0.20	0.26
	Agropyron tauri	0.20	0.53	0.26	0.40	0.40
	Bromus tomentellus	0.13	0.53	0.46	0.26	0.53

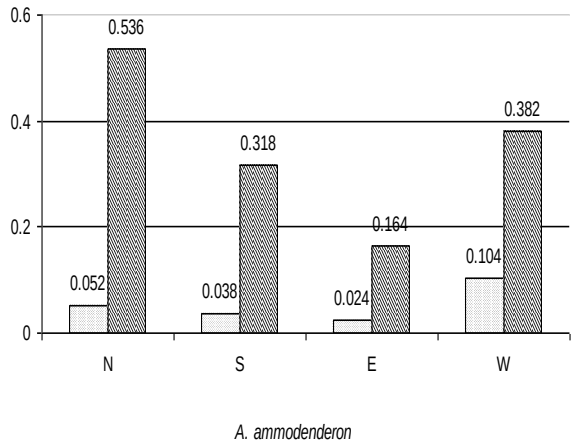

Fig. 3. Comparison of density of index species of *Astragalus ammodendron* to associated species of *Bromus tomentellus*

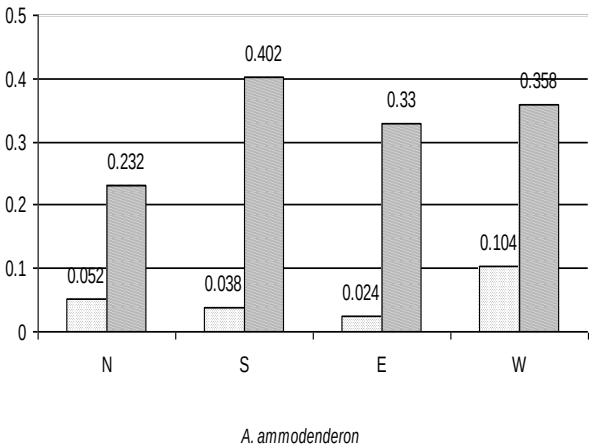

Fig. 4. Comparison of density of index species of *Astragalus ammodendron* to associated species of *Agropyron tauri*

Table 2. Value of Indexes of spatial and quadrant of distribution pattern of *Astragalus ammodendron*

Indexes of Spatial and Quadrant	Calculated Value	Distribution Pattern
Johnson and Zimer's Index	1.21	Regular distribution
Eberhart Index	1.70	Random distribution With tendency toward Clumped
Pielou's Index	0.01	Regular distribution
Hopkines index	0.54	Random distribution With tendency toward Clumped
Holgate index	0.08	Random distribution With tendency toward Clumped
Variance /Mean index	1.23	Random distribution With tendency toward Clumped
Green,s index	1.32	Clumped distribution
Lioyd,s Index	1.076	Random distribution With tendency toward Clumped
Morisita's Index	1.07	Random distribution With tendency toward Clumped
Standardized Index of Morisita	0.27	Random distribution With tendency toward Clumped

observed in other characteristics.

Effect of Index Species on Physical and Chemical Soil Characteristics

Physical and chemical characteristics of soil in the study area are estimated and presented in (Table 3). Variance analysis was made regarding the characteristics of clay, silt, sand, lime, organic substance, pH, EC, nitrogen, potassium, phosphor and the ratio of carbon to nitrogen which are given in (Table 4). These results indicated that there is only a significant difference of 5% regarding the content of nitrogen in first and second depths between the soils in an area under the bushes of *Astragalus ammodendron* or *Agropyron tauri* and non-planted (control) one. Therefore, the nitrogen content in the soils under the bushes of *Astragalus ammodendron* is less than the associated species of *Agropyron tauri*, *Bromus tomentellus* and non- planted (control) area. No significant differences are observed in other characteristics.

Table 3. Physical and chemical characteristics of soil of species and no planted (control)

Species	Depth	P (ppm)	K (ppm)	N ٪	C/N	pH	٪OM	Lim ٪	Sand ٪	Silt ٪	Clay ٪
Astragalus ammodendron	Top soil	±2.22 37	±18.92 335	±0.01 0.08	±0.64 6.42	±0.03 6.95	±0.09 0.93	±0.19 0.50	±4.03 33.16	±1.50 21.24	±3.74 45.60
	Deep soil	±2.30 27.20	±50.58 258	±0.01 0.07	±0.56 6.10	±0.12 7.00	±0.06 0.73	±0.05 0.45	±1.89 34.16	±1.73 17.74	±1.50 48.10
Agropyron tauri	Top soil	±5.41 42.7	±104.42 380	±0.02 0.13	±0.82 8.62	±0.07 7.17	±0.57 2.07	±0.06 0.82	±3.92 15.66	±0.50 20.24	±3.50 28.10
	Deep soil	±1.37 36.7	±101.32 280	±0.01 0.09	±1.67 7.72	±0.20 7.81	±0.37 1.27	±0.21 0.72	±6.80 45.16	±2.16 20.74	±4.99 34.10
Bromus tomentellus	Top soil	±3.39 41.35	±100.45 345	±0.01 0.11	±0.96 9.50	±0.07 6.97	±0.25 1.10	±0.22 0.65	±8.66 50.66	±2.08 19.74	±6.68 29.60
	Deep soil	±1.13 36.3	±115.18 320	±0.01 0.09	±0.43 8.22	±0.09 6.92	±0.09 1.32	±0.21 0.72	±9.39 51.16	±2.58 18.74	±7.18 30.10
no planted (control)	Top soil	±2.96 41.95	±111.64 340	±0.01 0.08	±0.64 7.95	±0.11 7.07	±0.12 1.18	±0.11 0.60	±6.35 46.66	±1.41 20.74	±5.00 32.60
	Deep soil	±3.94 34.35	±64.81 260	±0.01 0.07	±2.99 6.37	±0.07 7.08	±0.42 1.12	±0.12 0.61	±6.39 42.16	±1.29 17.47	±5.68 40.10

Table 4. Results of variance analysis of soil characteristics of study area

Factors	Changes Source	DF	MS	F
Clay1	Between Groups	3	254.25	2.56 $^{n.s}$
	Error	12	95.91	
Clay2	Between Groups	3	245.2	2.21 $^{n.s}$
	Error	12	111	
Silt1	Between Groups	3	1.66	0.189 $^{n.s}$
	Error	12	8.83	
Silt2	Between Groups	3	8	0.50 $^{n.s}$
	Error	12	16	
Sand1	Between Groups	3	290.91	1.98 $^{n.s}$
	Error	12	146.91	
Sand2	Between Groups	3	200	1.11 $^{n.s}$
	Error	12	179	
Lim1	Between Groups	3	0.187	1.15 $^{n.s}$
	Error	12	0.162	
Lim2	Between Groups	3	0.068	0.628 $^{n.s}$
	Error	12	0.109	
OM1	Between Groups	3	1.2	2.92 $^{n.s}$
	Error	12	0.416	
OM2	Between Groups	3	0.291	0.87 $^{n.s}$
	Error	12	0.334	
pH1	Between Groups	3	0.042	1.73 $^{n.s}$
	Error	12	0.024	
pH2	Between Groups	3	0.031	0.426 $^{n.s}$
	Error	12	0.072	
EC1	Between Groups	3	0.002	0.895 $^{n.s}$
	Error	12	0.002	
EC2	Between Groups	3	0.001	0.526 $^{n.s}$
	Error	12	0.001	
N1	Between Groups	3	0.002	2.92*
	Error	12	0.001	
N2	Between Groups	3	0.001	3.19*
	Error	12	0.00	
K1	Between Groups	3	1666	0.049 $^{n.s}$
	Error	12	33783	
K2	Between Groups	3	2491	$^{n.s}$ 0.082
	Error	12	30291	
P1	Between Groups	3	26.48	$^{n.s}$ 0.486
	Error	12	54.51	
P2	Between Groups	3	77.8	* 3.24
	Error	12	24	

Discussion and Conclusion

The results indicate that the index species of study area had a relatively weak relationship with soil factors. This may be due to the lack of significant relationship between the types of soil and intended species which may be caused by little litter production of the species or independence and sensitivity of these species to the edaphic conditions of their growth place. Density comparison of associated species including *Agropyron tauri* and *Bromus tomentellus* around the index species of *Astragalus ammodendron* showed that the maximum densities of associated species and index species were not in the same direction and distance. Comparing the minimum density of species showed that the density of two associated species of *Agropyron tauri* and *Astragalus ammodendron* was the same in the eastern and western directions. Increasing the species density may be attributed to the slope of area (the area slope is directed toward the west-east) which may cause the seeds to fall the downstream of gradient. Distribution pattern of *Astragalus ammodendron* had a tendency toward the clumped distribution. In other words, in this pattern, other individuals may influence each individual. The research done by Zare Chahooki and Tavili (2009) who determined the distribution pattern of *Zygophyllum eurypterum, Ephedra strobilacea, Haloxylon aphyllum* and *Cornulaca monacantha* in the south of Nayyer, Yazd province confirms these results. The nature of distribution of *Astragalus ammodendron* due to seeding under the bushes and desirable moisture conditions under the bushes is so that they are placed as triplet, quadruplet or quintuple in the most parts which may prevent the presence of other species between the bushes. The results of our study regarding the soil characteristics of study area indicate that the nitrogen content of *Astragalus ammodendron* as an index species is less than non-planted (control) area. Since the concentration of nitrogen in the leaves of Leguminosae family is greater than stems (Malakuti and Homaee, 1994), this reduction may indicate the slight decomposition of litter in this species or short-term establishment of this species in the region which is confirmed by poor soil evolution in the region. Therefore, in accordance with the results of this research, index species of *Astragalus ammodendron* has had no effect on two associated species of *Agropyron tauri* and *Bromus tomentellus*. These results are not in accordance with the results achieved by Mohebbi (2009) who considered the effect of index species of *Artemisia sieberi* on the associated species of *Stipa barbata* and obtained the positive effect of *Artemisia sieberi* on the growth of *Stipa barbata*.

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