International journal of Agronomy and Plant Production. Vol., 2 (5), 219-225, 2011
Available online at http:// www.victorquestpub.com
ISSN 2051-1914 ©2011 VictorQuest Publications

Effect of Pit Seeding on Soil and Vegetation Properties in Imam Kandi Rangelands, Iran

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Abstract

Mountainous and steep rangelands in Iran like other rangelands, even with more priority, in addition to proper management operations in short term, conducting rangeland improving operations such as pasturing, also needed. To pasturing planting in steep and felsig mountainous areas seed pit seeding method is used. In order to evaluation the effect of pi seeding on some soil and vegetation properties in parts of seed rangelands by *Agropyron,* Imam Kandi basin, Urmia, was selected. After field observation in 2011 at both pit seeding and control treatments, using a systematic randomized method, six 100-m long transects were randomly located in each area and ten 1 m^2 plots were placed at equal distances along each transect. Soil and vegetation properties in both treatments analyzed using independent-t test by SPSS software. Results showed that due to pit seeding soil electrical conductivity (EC), organic matter, nitrogen, phosphorous and potassium in first depth significantly increased compared to control while pH and carbonate calcium equivalent (CCE) decreased. In second depth, EC, CCE, organic matter, nitrogen, phosphorous increased compared to control while pH and potassium decreased by conducting pit seeding. Vegetation properties (canopy cover, yield, density and litter) in pit seeding treatment significantly increased compared to control (P<0.01). Mean values of perennial grasses and perennial forbs significantly increased in pit seeding treatment (P<0.01). It could be said that pit seeding has positive effect on soil and vegetation properties in Imam Kandi rangelands.

Keywords: pit seeding, vegetation properties, growth forms, Imam Kandi rangelands.

Introduction

Rangelands in Iran, in most areas due to excessive exploitation, palatable species have declined over time and been replaced by less desirable and sometimes toxic species (*Peganum harmala, Avena sativa, Cenchrus ciliaris, Sorghum spp.,* etc.) (Azarnivand & Zare Chahoki, 2008). In some regions plant species were removed and soil is exposed to wind and water erosion (Mesdaghi, 2007). Reduction of canopy cover, the destruction of structure of surface soil, and soil compaction as a result of overgrazing by livestock are some of the most significant factors degrading grassland (Taylor *et al*., 1993; Manzano and Na´var, 2000) Altering plant community and soil properties by severe overgrazing leads to rangeland degradation and desertification (Steffens *et al*., 2008). To prevent this continuing degradation on these rangelands, it is essential to conduct restoration operations such as shrubing, seeding associated with furrow, pit seeding and etc to improve the vegetation and stabilize the soil surface to reduce wind and water erosion and improve ecosystem function (Moghaddam, 2007). Rangelands reclamation and improvement caused quantitative and qualitative increase in forage yield and maximize livestock products(Azarnivand & Zare Chahoki, 2008).

The main goal of restoration is to achieve a plant community that is nutritious and productive for animal production, resilient to grazing and that stabilizes the soil surface against water and wind erosion (Mesdaghi, 2007). Mountainous areas cover more than 60% of the total area of Iran. These areas due to having steep slopes are not proper for cultivation and exploited as pasture for livestock grazing. Heavy grazing over the years reduced vegetation cover in terms of quality and quantity and valuable rangeland species replaced by improper and invaluable species. So, mountainous and steep rangelands in Iran like other rangelands, even with more priority, in addition to proper management operations in short term, conducting rangeland improving operations such as pasturing, also needed. To pasturing planting in steep and felsig mountainous areas which using of machinery for planting is impossible, seed pit seeding method is used (Azarnivand and Zare Chahooki, 2008).

Pit seeding is one the seeding methods in which considered pasture plants seed placed on excavated holes and then covered by soil. Among the procedures for artificial renewing of vegetation life, pit seeding is the only method that used labor-work, so that has more job making property and is a native procedure which doesn't require any machinery (Azarnivand and Zare Chahooki, 2008). Many workers studied the effect of pit seeding on soil and vegetation properties. Mout et al. (2011) found that due to seeding after three years mean of organic matter, phosphorous and calcium is increased while acidity, electrical conductivity, potassium and magnesium is decreased. Jafari et al. (2009) concluded that mean nitrogen, phosphorous, potassium and organic matter in grass cultivation treatment were significant compared to control, so that nitrogen and organic matter increased compared to control, while potassium and phosphorous were decreased and eventually concluded that grass cultivation has the positive effects on soil properties. Robertson et al. (1970) reported that pitt seeding in Texas was successful and improved rangelands yield and status. Sheydayi and Karimi (1973) reported that seeding in poor rangelands of Zarand, Iran, by alfa alfa and grasses increased yield by 12 times.

Based on literatures, we hypothesize that pit seeding improved soil and vegetation properties therefore, increased rangeland productivity and finally degraded the rangelands. The present study in addition to evaluate the general properties of vegetation cover such as canopy cover percentage and yield, studied the soil properties in pit seeding treatments. Therefore the objective of this research was to statistically investigate and comparing the studied factors in soil and vegetation cover in pit seeding treatment and control site and evaluation it's suitability and efficiency in Imam Kandi rangelands, Urmia, Iran.

Method and Materials

The Imam Kandi basin is located in West Azerbaijan province within the political limits of Urmia town, Iran. The study area is located at 37° 48' 40" S to 37° 51' 9" N and 45° 3' 42.5" W to 44° 59' 47" E (Figure 1). The average altitude is 1539 m ranging from 2230 m to 1280 m and the catchment area is 14.2 square kilometers with average slope of 28.6°. This region has a cold semi-arid climate with mean long-term rainfall of 386 mm. Mean annual temperature is 11.3 °C. The region soil type classified as Typic Haploxerept based on soil taxonomy.

Sampling in each area was conducted using a systematic randomized method. Six 100-m long transects were randomly located in each area and ten 1 m^2 plots (n= 120) were placed at equal distances along each transect (n=12). Within each plot we measured species present, canopy cover percentage, plant species yield and density, percentage of ground covered by litter and percentage of bare ground. Canopy cover percentage, yield and growth forms (perennial grasses, annual grasses, perennial forbs, annual forbs and shrubs) were determined separately in each plot. Yield was estimated by clipping at the end of the flowering phase of dominant species. Grasses were clipped at 1 cm height before weighing while forbs were clipped at basal height and shrubs were clipped to remove current season's growth.

Soil sampling was conducted in the center of vegetation plots. In studied sites two randomly selected plots per each vegetation transect were sampled by taking cores at depths of 0-30 cm and 30-60 cm. A composite sample was made for each transect, giving a total 24 samples. The soil samples for each depth per site were analyzed in the laboratory of the department of Natural Resources, Tehran University. The samples were passed through a two millimeter sieve before analyzing for organic matter (Walkley & Black, 1934), total nitrogen content using Kjeldal (Bremmer & Mulvaney, 1982), the amount of available phosphorus by P-Olsen (Olsen & Sommers, 1982), potassium (Boltz & Howel, 1978), EC and pH, carbonate calcium equivalent (CCE) percent (Sparks, 1996).

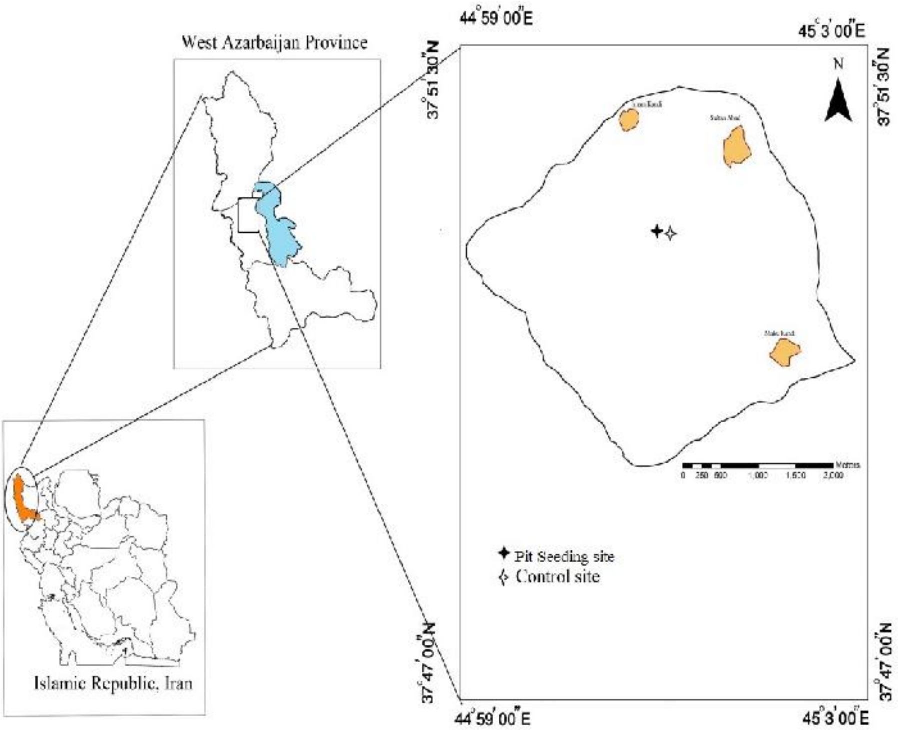

Figure 1. Geographical location of studied sites, Imam Kandi rangeland, Urmia, Iran

To compare the soil properties in pit seeding site with control and soil horizons as well as vegetation properties in both sites independent-t test were used. Since data normality assumption is essential for data analyzing, Data were tested for normality before statistical analysis using the Anderson Darling test (Steel & Torrie, 1980). Statistical analysis of each of the measured variables was conducted with SPSS ver. 15.

Results

The list of species encountered in the study area was prepared which essential in vegetation cover studies. Floristic list and palatability classes of existed species were presented in Table 1.

Table 2 the evaluation of soil properties in the pit seeding and control treatments at 0-30 and 30-60 cm depths. Results of Table 2 showed that due to pit seeding soil EC, organic matter, nitrogen, phosphorous and potassium significantly increased compared to control while pH and CCE decreased.

Results of Table 2 showed that mean values of EC, CCE, organic matter, phosphorous and calcium increased and pH and potassium decreased compared to control. Independent-t test results indicated that mean values of organic matter, nitrogen and potassium had significant difference ($P<0.05$).

Table 3 shows the mean values and results of comparison of vegetation cover between pit seeding and control treatments by using t-test. Results showed that in pit seeding treatments mean values of canopy cover, yield, density, litter percent compared to control treatment significantly increased ($P<0.01$).

Table 4 present the mean values of each growth forms in pit seeding and control treatments. Independent t-test results show that all growth form means (perennial grasses, annual grasses, perennial forbs, annual forbs and shrubs) at the pit seeding treatment were different from the control treatment ($P<0.01$). Each of the growth form properties for perennial grasses, perennial forbs increased in pit seeding treatment compared to control treatment, except density, while annual grasses, annual forbs and shrubs in control were greater than the exclusion treatment ($P < 0.01$).

Table 1. Floristic table and vegetation palatability classes at study sites

Species	Location	Botanical family	Life form
Cousinia atropatana	both sites	Asteraceae	Shrub
Achillea setacea (III)	control	Asteraceae	Shrub
Gundelia tournefortii	both sites	Asteraceae	Forb
Noaea mucronata	both sites	Chenopodiaceae	Shrub
Astragalus effusus	control	Fabaceae	Forb
Astragalus gossypinus	control	Fabaceae	Shrub
Onobrychis gaubae	pit seeding	Fabaceae	Forb
Hypericum perforatum	control	Hypericaceae	Forb
Stachys inflata	pit seeding	Lamiaceae	Forb
Salvia virgata	control	Lamiaceae	Forb
Teucrium polium	pit seeding	Lamiaceae	Forb
Thymus koschyanus	control	Lamiaceae	Shrub
Acantholimon sp	pit seeding	Plumbaginaceae	Shrub
Aegilops sp	pit seeding	Poaceae	Grass
Agropyron elongatum	pit seeding	Poaceae	Grass
Agropyron trichophorum	pit seeding	Poaceae	Grass
Melica persica	control	Poaceae	Grass
Bromus tectorum	both sites	Poaceae	Grass
Bromus tomentellus	both sites	Poaceae	Grass
Dactylis glomerata	pit seeding	Poaceae	Grass
Festuca ovina	both sites	Poaceae	Grass
Hordeum fragile	pit seeding	Poaceae	Grass
Poa bulbosa	control	Poaceae	Grass
Bromus dantoniae	control	Poaceae	Grass
Rheum ribes	control	*Polygonaceae*	Shrub
Crucianella gilanica	both sites	Rubiaceae	Forb
Galium verum	control	Rubiaceae	Forb

Table 2. Comparison the mean values of soil properties between pit seeding and control treatments at both depths

Properties	0-30 (cm)		30-60 (cm)	
	Control	pit seeding	Control	pit seeding
pH	0.05a ± 7.44	0.10a± 7.33	0.03A ± 7.70	0.09A ±7.57
EC_e (ds/m)	0.00b ± 0.29	0.00a ± 0.42	0.01A ± 0.18	0.00A ± 0.21
Calcium Carbonate Equivalent (CCE) (%)	0.57a ±5.17	0.30a ±4.09	0.48A ± 7.92	0.56A± 9.43
Organic matter (%)	0.19b ± 2.33	0.09a ± 3.28	0.02B ± 1.01	0.14A± 1.49
Nitrogen (%)	0.00b ± 0.15	0.00a ±0.27	0.00B ± 0.05	0.00A ± 0.08
Phosphorous (ppm)	0.94b ± 13.31	0.63a ± 21.11	0.39A ± 6.54	0.36A±7.06
Potassium (ppm)	5.9b ±199.8	5.8a ± 384.7	12.07B±4 152.7	4.30A± 109.86

Means differ if they have a different letter at $p < 0.05$.

Table 3. descriptive data and comparison the vegetation properties between studied sites using t-test

Site	Canopy cover (%)	Yield (kg/ha)	Density (m^2)	litter (%)
pit seeding	62.95a	744.3a	21.57a	17.39a
Control	49.01b	347.89b	34.71b	12.06b

Means differ if they have a different letter at $p < 0.01$.

Table 4. mean values and independent-t test results for comparison the growth forms between pit seeding and control sites

Growth form	Site	Canopy cover (%)	Composition (%)	Yield (kg/ha)	Density (m^2)	Sig
Perennial grasses	pit seeding	34.66	54.68	415.19	4.3	0.000**
	Control	15.32	31.08	103.29	12.36	
Annual grasses	pit seeding	4.28	6.79	63.43	4.82	0.000**
	Control	8.08	16.4	67.64	7.98	
Perennial forbs	pit seeding	15.83	24.97	188.09	7.85	0.000**
	Control	12.62	25.6	84.3	6.77	
Annual forbs	pit seeding	4.7	7.45	46.63	3.1	0.000**
	Control	6.81	13.82	54.29	5.3	
Shrubs	pit seeding	3.41	5.38	30 .95	1.39	0.000**
	Control	6.16	12.49	38.34	2.28	

** Significant difference at one percent level

Discussion

Effect of pit seeding on soil properties

Pit seeding decreased soil pH compared to control treatment. Reduction of soil pH in pit seeding treatments could result from high vegetation biomass or dense root system and high soil organic matter, more active microorganism metabolism in the rhizosphere (David *et al*., 2004), secretion of organic acids from the roots and amounts of CO_2 released from roots and micro-organisms (Hinsinger *et al*., 2003), increased leaching and decreases in carbonate calcium equivalent (CCE) percent. With increasing organic matter, mineral and organic acids are produced with carbonic acid the most abundant. Although this is a weak acid, its continuous production in soil with high root density causes lime dissolution and leaching from soil. Dissolving the $CaCO_3$ causes pH reduction (Al-Seekh, *et al* 2009). Pit seeding increased soil electrical conductivity compared to control. EC increasing in the grazing exclusion sites could be due to increasing soil cation exchange capability (Abdallah *et al*., 2008).

Pit seeding caused decreasing in CCE in first depth compared to control. Mean value of CCE in second depth increased in pit seeding treatment. CCE increased in soil as soil depth increased. . The increased CCE in deeper soil layers could be attributed to its dissolving from upper soil layers and accumulation deeper in the soil profile, with high amounts of $CaCO_3$ in the parent material. Due to increasing vegetation canopy cover percentage and denser vegetation cover in improved sites, organic matter is enhanced and pH is lowered. Improvement in soil structure, a decrease in runoff and increased water infiltration could cause a reduction in CCE in the surface soil depths due to dissolving by pH reduction. These results are in agreement with Pie et al. (2008) and Jeddi and Chaieb (2010).

Organic matter at both soil depths increased in pit seeding treatment compared with the control. Pit seeding treatments high vegetation cover as well as high volume of roots in soil increased soil organic matter compared to control which is in agreement with Durmar (1989), Frank et al. (1995). Mean values of nitrogen in both depths due to conducting reclamation operations increased compared to control. Vegetation cover in terms of type and density has an important role in soil nitrogen content. Soils having plants with abundant roots usually have more organic matter and nitrogen (Foth *et a*l., 1997). Therefore in pit seeding treatments with Agropyrone species, amount of vegetation cover and also high root volume increased soil nitrogen compared to control which is in consistent with Jafari et al. (2009) and Steffens *et al*. (2008). Cultivation of new species and increasing vegetation cover resulted in improving in soil physico-chemical properties and water infiltration increased, thus more dense vegetation and appropriate aeration, litter enhancement and its decomposing increased soil organic matter in pit seeding treatment and also increased phosphorous and potassium contents (jafari et al., 2009). This is likely due to the increase in potassium and phosphorous transferring by plants to the upper soil layers compared to the control as discussed above for phosphorous. Due to improving soil properties by exclusion treatment resulted from increasing the vegetation cover, litter percentage and soil organic matter, increase in potassium amount is expected. Since lower pH results in high potassium levels (Foth *et al*., 1997) and an increase in pH has been shown to cause potassium deficiency (Somda *et al*., 1997), could be concluded that lower pH in exclusion treatments increased potassium and phosphorous content.

Effect of pit seeding on vegetation properties

Pit seeding significantly increased the canopy cover percent, yield of forage, density and percent cover of litter compared with the control site. All growth forms of pit seeding treatments has significant difference with control, so pit seeding with *Agropyron elongatum* species, canopy cover percentage (1.26-fold), and yield of perennial grasses (3.01-fold), perennial forbs significantly increased. Considering that *Agropyron* is the resistant species (Moghimi, 2005), pit seeding of *Agropyron* caused increasing in canopy cover percentage and therefore vegetation cover percentage, more water infiltration and improving soil status for developing vegetation to climax stage and spreading grasses a perennial forbs. Cultivation of native plants seeds or exogenous plants in virgin lands and making covers is for soil and water conservation, increase in forage yield and eventually its promenade value which successful if correct place and species were selected (mesdaghi, 2007).

Pit seeding significantly increased canopy cover percentage (28.45%), yield (1.13-fold), density (1.02-fold) and litter percent (44.2 percent) of vegetation compared to control, which in good agreement with Robertson et al. (1970), Razi (1968), Ahamadi and Sanad Gol (2005) and Jafari et al. (2009). Due to pitting, canopy cover percentage, yield and density of some species like *Bromus tomentellus* ، *Hordeum fragile* ، *Festuca ovina* and *Dactylis glomerata* increased and for some such as *Cousinia atropatana* و *Noea mucronata* decreased. Since *Agropyron elongatum* salt and drought-resistant species and have rhizomes (Moghimi, 2005), thus its density reported as pit number per m^2.

Conclusion

For pasture planting in steep mountainous regions which machinery operations is impossible, pit seeding were used. Using desirable species in poor rangelands seeding very effective in improving rangeland status and increasing forage yield and provide better establishment of new plants, because shallow holes as cultivation bed in pit seeding caused more water reserving in seeds cultivation place and thus helps to plants establishment. Better and more established plants increased canopy cover percentage and caused more yield and improved rangeland status.

By conducting pit seeding in Imam Kandi rangelands, improving vegetation cover and increasing litter resulted in increasing in water infiltration, preventing soil erosion, appropriate soil porosity and aeration, extending biological activity of microorganisms, increasing organic matter and improving soil aggregation; therefore improved soil and vegetation properties compared to control. Could be concluded that conducting reclamation operations in the rangelands were successful and has positive effect on soil and vegetation properties.

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