Late Fall vs Spring Seeding in the Establishment of Crested Wheatgrass in the Zarand Saveh Region of Iran

MOHAMMAD REZA MOGHADDAM

Highlight: Seeding to adopted forage species is one of the most effective means for restoring Iranian rangelands to full forage production. Observation and study of native vegetation response to reduced grazing has indicated an unexpected potential for forage production. The severely deteriorated condition of much of the native rangeland, however, does not leave an alternative to reseeding. Fall seeding of crested wheatgrass is favored over spring seeding because (1) a higher percentage of seedling establishment is realized, (2) more vigorous seedlings are obtained, and (3) seeded stands can be utilized from the end of the second year.

The success of range seeding in Iran is extremely variable. Time of seeding is one of the most important of the many factors involved.

Climatic regimes in Iran are somewhat similar to those found in the Intermountain and Southwest regions of the United States. Here the proper time to seed has received considerable research effort (Hull, 1948; Hull and Doran, 1950; Doran et al., 1952; Plummer et al., 1955). For southwestern Colorado, August plantings have been suggested (Hull and Johnson, 1955). According to McGinnies (1960), the only planting date that consistently gave satisfactory stands of crested wheatgrass in western Colorado was April 1.

It does not appear that spring seeding can be acceptable for planting Iranian ranges under arid and semiarid conditions because of draught. With spring seeding, seedlings will not become sufficiently established to survive the summer drought period. According to our experiments and Pabot's works (1967) at Noudehak, 100 km west of our study area, fall seeding was found to be far superior to early spring seeding. Exceptions may be areas with good spring soil moisture and at high elevations (in semiarid and subhumid zones). Here spring plantings can be successful. A similar observation has been reported from the U.S. by McGinnies (1960).

Fall seeding can be made either in early or late fall. However, in early fall failures are common. The seed may germinate with early fall precipitation but have a high mortality due to subsequent arid conditions and cold temperatures (McGinnies, 1960; Kilcher, 1961). In late fall plantings the seed does not germinate until the following spring when conditions are more conducive to successful plant

establishment (Frischknecht, 1959; Wilson, 1973).

Data from our experiment and from longer-term studies by Pabot (1967) at Noudehak and Rudeshur indicate that under arid conditions of the Zarand Saveh area, as in similar areas of the U.S., date of seeding is a crucial factor in establishing crested wheatgrass (*Agropyron desertorum* Fisch. ex Link Schult.) and that seeding is likely to fail unless done in fall.

General Climate and Site Description

Zarand Saveh is located approximately 41 km south of Karadj (76 km southwest of Tehran). There is no climatic station in the Zarand area, but according to the climatic data obtained from the nearest stations (Saveh 70 km to the south and Buinzahra 53 km northwest) and considering type of vegetation, the climate is arid with an annual precipitation of about 150–200 mm (6–8 inches), mostly received during the cold season of the year. Winters are cold, and the freezing period is from mid-November to mid-March. Summers are hot and dry. Table 1 and Figure 1 illustrate the distribution and amount of precipitation and the temperature regime during the year.

Fig. 1. Pluviothermic diagrams for two stations representative of the Zarand Saveh region, Iran. (A) Saveh station, (B) Buinzahra station.

The author is head, Department of Range and Watershed Management, College of Natural Resources, University of Tehran, Karadj, Iran.

Manuscript received January 4, 1975.

Table 1. Precipitation (mm) and temperatures (°C) of two weather stations representative of the Zarand Saveh region of Iran.

Month	Saveh			Buinzahra		
	Precipitation	Temperature		Precipitation	Temperature	
		Minimum	Maximum		Minimum	Maximum
January	15.5	-1.5	10.4	20.5	-7.0	5.2
February	19.0	-0.1	12.0	12.7	-3.8	8.4
March	27.4	5.2	18.5	31.1	1.1	16.2
April	17.3	9.3	23.3	38.3	6.0	19.3
May	14.5	16.8	30.2	16.6	11.5	27.5
June	1.2	19.0	35.6	3.0	14.8	32.4
July	0.0	21.6	38.2	1.6	17.3	34.9
August	0.0	21.1	37.5	0.0	16.7	34.5
September	0.0	16.1	32.9	1.4	12.2	29.9
October	0.6	11.3	26.6	11.0	7.2	22.6
November	20.9	5.6	19.3	25.1	1.9	15.9
December	30.0	0.5	13.6	11.2	-2.7	9.1
Total	146.7			142.5		

The pluviothermic quotient of Emberger has been calculated for both stations of Saveh and Buinzahra, according to the formula:

$$Q_2 = \frac{2000 p}{M^2 - m^2}$$

in which p = precipitation in millimeters, M = mean maximum temperature during warmest month of the year, m = mean minimum temperature during coldest month of the year, and M and m are converted to absolute degree in which $0^\circ\text{C} = 273$ K. The Q_2 demonstrates the aridity of the climate. Q_2 for Saveh is 12.6 and for Buinzahra is 11.8.

The drought period is demonstrated by the curve adapted from the Gaussen and Bagnouls method. It is not from the Zarand Saveh area, but rather is typical of the climate of Iran and may be considered representative of nearly all of the arid and semiarid regions of that country.

The research area is on a 1 to 2% northwest slope at an elevation of 1,250 m. The soil is an alluvial, brown steppic, textured lime.

Vegetation of the area is classified as a steppic vegetation type (Pabot, 1967) with *Artemisia herba-alba*, *Salsola rigida*, *Stipa barbata* as the most important species. The vegetation is seriously deteriorated due to continuous misuse during past years.

Methods and Procedure

To compare results of seeding at different periods, and to avoid influences of seedbed preparation on seedling establishment (Douglas et al., 1960), we chose an area with a homogenous soil and slope. The seedbed preparation was the same for both seedlings and consisted of plowing, discing, and rolling. Seeding was done with a rangeland drill. The seeding depth was 2.54 cm, seeding rate 5.75 kg/ha, and row spacing 0.5 m. The time of late fall seeding was November 17, 1972,

Table 2. Seedling emergence and plant establishment during the first year of seeding.

Seeding date	Number of seeds germinated (per m ²)	Number of seedlings established (per m ²)	Number of plants with reproductive shoots (per m ²)	Number of shoots per plant
Autumn	37.5	27.8	2	1.91
Spring	31.1	13.1	0	0

Fig. 2. Three-year old crested wheatgrass, established by late fall seeding in Zarand Saveh region, Iran.

and for early spring seeding was March 24, 1973.

Observations were made using 20 randomly located 1-meter-square plots. Seedlings were counted on each plot after seedling emergence, with a second count at the time of optimum plant growth in mid-summer. The second count showed the establishment success of individual crested wheatgrass plants. All emerged plants and the seed stalks for each plant were counted. Records were taken for 2 years.

Results and Discussion

Best seedling establishment and the most vigorous crested wheatgrass seedlings were obtained from fall plantings (Tables 2 and 3, and Fig. 2). Poor emergence and seedling stands were obtained from spring planting (Fig. 3). These results indicate that the most reliable seeding time for obtaining satisfactory stands in arid and semiarid sites of Iran is late fall. Crested wheatgrass gives good establishment over a wide range of seeding dates, but in the case of Iranian arid and semiarid conditions, the limitation in amount and distribution of precipitation is the major factor influencing the seeding date.

The germination of crested wheatgrass seed from both spring and fall trials was approximately the same. However fall seeding had the advantage of germinating in the early spring giving a longer period of access to soil moisture than spring seeded plants before soil water depletion and high temperature prevailed.

Seedlings which have not developed root systems in the deeper soil layers by the time of water depletion and high temperatures are subject to high mortality, and the difference between the results of spring and fall trials became much more distinct in late spring and summer. Late fall seedings gave more successful establishment and seedlings produced seed stalks.

The second year data showed much greater differences in stand establishment. The number of seed stalks per plant was distinctly higher on late fall seeded plants.

Table 3. Plant establishment the second year of seeding.

Seeding date	Number of plants established (per m ²)	Number of plants with reproductive shoots (per m ²)	Number of shoots per plant
Autumn	25.2	14.5	3.37
Spring	10.9	1.8	1.3

Fig. 3. *Three-year old crested wheatgrass, established by spring seeding at the Zarand Saveh region.*

Conclusions

The major findings were as follows in favor of fall seedings:

- 1) A high number of seeds germinated and a high percentage of seedling establishment was realized.
- 2) Seedlings became established prior to summer drought resulting in less competition and more vigorous seedlings.
- 3) Good establishment and high vigor of stands enable utilization of seeded sites from the end of the second year, which is an important factor for forage production in the area.

Because of the homogeneity of the conditions in arid and semiarid Iranian ranges, the results obtained on seeding dates in Zarand Saveh are valuable and may be applied to most Iranian ranges.

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