# Some Variations in Morphological Characteristics and Palatability Among Geographic Strains of Indian Ricegrass[1]

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Indian ricegrass (*Oryzopsis hymenoides*) is a drought-resistant, cool-season bunchgrass common throughout the western United States, western Canada, and northern Mexico. It is particularly well adapted to sandy soils and is somewhat tolerant to alkali. In common with other native species which have occupied a wide area during a long period of time, natural selection has developed geographic strains or "ecotypes" showing wide variation in growth habit, size and shape of leaf, forage production, size and shape of seed, and other characters.

Variations in the palatibility of Indian ricegrass have been noted in different areas of Wyoming, and it was thought that these variations in palatability might be associated with geographic strains. Consequently, a study was undertaken with the following three principal objectives in mind: (1) to study the morphological variation in strains of Indian ricegrass from widely separated geographic locations, (2) to determine possible differences in palatability between these geographic strains and whether such differences are constant when the strains are grown on two different soil types, and, (3) to test the relationship between the chromogen content of plant material and its palatability to animals.

## Previous Studies

Because of its wide range of adaptability to dry habitats having low soil fertility, Indian ricegrass is an important species for revegetating depleted land in the semiarid West. However, Stoddart and Wilkinson (1938) state that it is essential to treat the seed chemically or mechanically before it can be used in a reseeding program because of its low germination.

Johnson (1945) conducted cytotaxonomic studies of Indian ricegrass and considered that the genera *Stipa* and *Oryzopsis* have arisen from a common basic stock. Stebbins and Love (1941) and Nielsen and Rogler (1952) state that many plants which appeared to be intermediate between various species of *Stipa* and Indian ricegrass have been found in nature. One of these has been increased and is known as Mandan ricegrass (*Stiporyzopsis*).

The literature reveals great diversity of opinion regarding the meaning of the term "palatability" as well as the causes of the variation in preference exhibited by grazing animals. Rogler (1944) lists the following factors which may affect palatability: (1) maturity of the forage, (2) intensity of grazing, (3) rate of recovery after grazing, (4) amount in mixture with associated species, (5) drought resistance, (6) previous feed or grazing activities, (7) individual differences in animals, (8) fertilizers, (9) kind of livestock, and (10) local conditions.

Archibald, *et al.* (1943) found a close relationship between vitamin A (carotene) and palatability. Ritchey (1936) using tame rabbits in a palatability and toxicity test found an apparent relationship between the palatability of nine species of rattlepod (*Crotalaria*) when tested with rabbits and when tested with cattle at the Florida Agricultural Experiment Station. Arnold (1942) conducted a palatability study on a wide variety of grass, weed, and browse species in Arizona. He used two species of wild rabbits in an attempt to determine their preferences in relation to those of cattle and found that they compared favorably on the more "highly preferred" grass species, but there was no close relationship between palatability to rabbits and cattle in the weeds and browse.

Research workers have devised several indirect methods for measuring the digestibility and consumption of forages by animals. No literature concerning indirect methods for determining palatability has been noted.

Reid, *et al.* (1950) reported a new indicator method for determining digestibility and consumption of forages by ruminants, involving the use of natural plant pigments or "chromogens" as reference substances. Smart, *et al.* (1953) have reported that these "chromogens" are composed of at least seven pigments: chlorophyll a, chlorophyll b, pheophytin a, pheophytin b, luteol, violaxanthol, and carotene.

Reid, *et al.* (1950) also stated that "In a few cases where animals refused a small quantity of the forage offered, the chromogen content of the orts was much less than that of the forage offered." From this statement, it was inferred that chromogen and palatability are closely related. It was thought to be conceivable that the chromogen technique could also be used as a simple laboratory method for determining the palatability of various forage plants by their chromogen content.

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## Methods and Materials

### Seed Sources

From 1953 to 1955, collections of Indian ricegrass seed were obtained from sources in most of the western states, and the present collection contains seed from 106 locations in 14 western states, Minnesota, and Canada.

### Establishment and Locations of Strain Nurseries

Seeds of 50 geographic strains of Indian ricegrass were planted in vermiculite and the seedlings individually transplanted into three-inch pots of soil. In the spring of 1954, plants of 24 of the strains were large enough to be transplanted to the field. Ten plants of each strain were transplanted at the Nebraska Agricultural Experiment Station and at the University of Wyoming Agronomy Farm. Those which winterkilled were replaced in the spring of 1955.

Of the strains established at both Lincoln, Nebraska, and Laramie, Wyoming, eleven fully established strains of Indian ricegrass and the hybrid Mandan ricegrass were selected for study. These strains showed wide differences in growth habit, leaf size and type, and seed size and shape.

### Palatability Studies

Two tame rabbits were used in the feeding trials. They were fed alfalfa hay and pellets for several days so that they would become accustomed to their surroundings before the feeding trials started. Forage from the 12 selected strains of Indian ricegrass grown at Lincoln, Nebraska, were fed in an air-dried condition while that from the same 12 strains grown at Laramie, Wyoming, was fed green. Alfalfa hay and pellets as well as water were available to the animals at all times, so as to be sure that the forage of the strains under test was consumed by choice rather than because of extreme hunger.

A portion of each of four strains was weighed and placed in separate pans located at intervals inside the cage. Each pan of material was weighed in grams at the time it was placed in the cage in the evening and removed and weighed again in the morning to determine the amount of forage eaten. When all 12 of the strains had been offered to the experimental animals, each strain of Indian ricegrass was again placed before them in different combinations of four until all 12 strains had been available to the experimental animals three successive times. The palatability ratings for each strain grown at both locations were then calculated on the basis of the percentage of the weight of each strain offered which was eaten.

### Chromogen Tests

The procedure used for determining chromogen content of the Indian ricegrass strains studied was that developed by Reid, *et al.* (1950). Chromogen determinations were made in duplicate from the 12 Indian ricegrass strains grown at the Lincoln, Nebraska, nursery.

## Results and Discussion

### Morphological Variations Among Geographic Strains of Indian Ricegrass

Many morphological variations were observed among the entire collection of geographic strains of Indian ricegrass. However, actual measurements and detailed notes were collected only for the 12 strains with which this study is principally concerned.

In comparing the seeds of the entire collection, it was noted that most of the geographic strains could be classified into two categories on a basis of either elon-

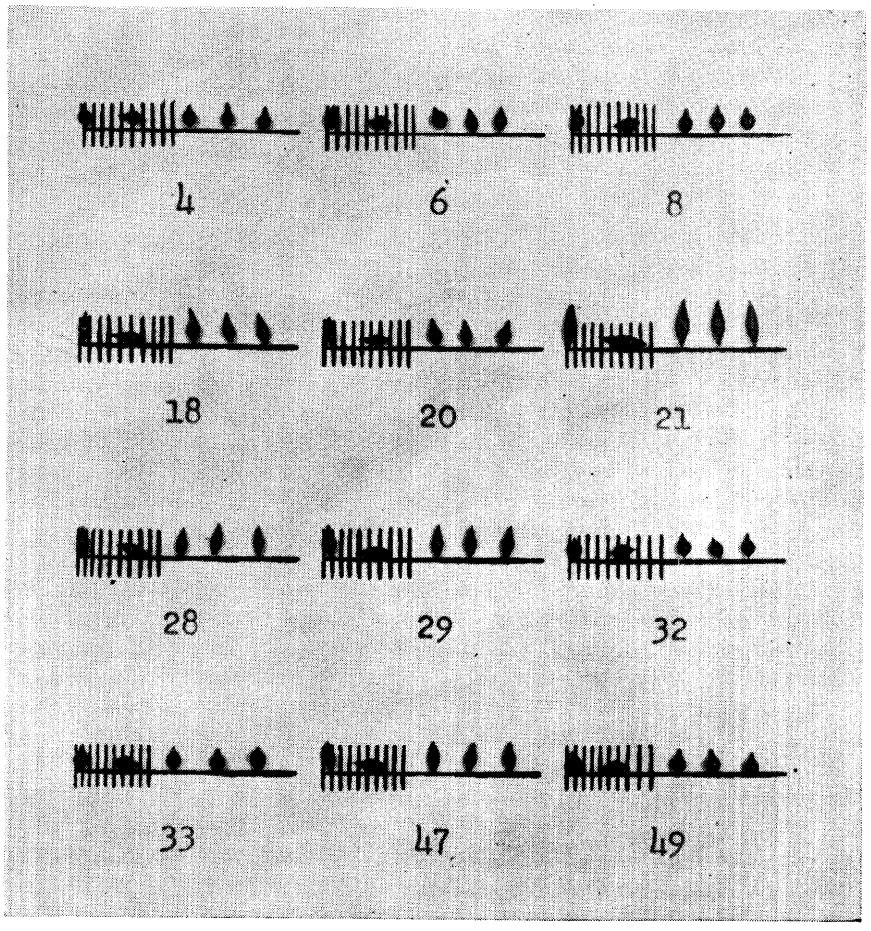


FIGURE 1. Seeds of the 12 strains of Indian ricegrass showing variations in size and shape. The pubescence has been removed from these seeds by mechanical means. Numbers refer to strains listed in Table 1. Scale at left of each line is in millimeters.

**Table 1. Some morphological variations among 12 geographic strains of Indian ricegrass.**

| Identification No. | Strain Origin | Growth habit | Height of mature plant | Leaf type | Width of widest leaf | Average length of seed | Average width of seed at widest point |
|---|---|---|---|---|---|---|---|
| | | | Inches | | mm. | mm. | mm. |
| 33 | Lethbridge, Alberta, Canada | Prostrate | 15 | Involute | 1.5 | 3.0 | 1.8 |
| 8 | Scottsbluff, Nebraska | Semi-erect | 18 | Semi-involute | 2.5 | 3.0 | 1.8 |
| 32 | Medicine Hat, Alberta, Canada | Erect | 24 | Semi-involute | 3.0 | 3.0 | 1.8 |
| 47 | Aberdeen, Idaho | Semi-erect | 24 | Involute | 3.5 | 3.8 | 1.3 |
| 29 | Antelope Valley, California | Semi-erect | 16 | Semi-involute | 3.0 | 4.0 | 1.5 |
| 6 | Cheyenne, Wyoming | Prostrate | 12 | Semi-involute | 3.0 | 3.0 | 1.8 |
| 4 | Hell's Half Acre, Wyoming | Erect | 17 | Involute | 3.5 | 2.9 | 1.7 |
| 49 | Swift Current, Saskatchewan, Canada | Erect | 17 | Involute | 2.0 | 3.0 | 1.8 |
| 21 | Mandan, North Dakota | Erect | 37 | Flat | 6.0 | 5.2 | 1.5 |
| 20 | Arizona | Erect | 20 | Involute | 4.0 | 3.6 | 1.4 |
| 28 | Whitebird, Idaho | Erect | 30 | Flat | 4.5 | 3.6 | 1.1 |
| 18 | Pullman, Washington | Semi-erect | 34 | Involute | 3.0 | 3.8 | 1.3 |

gated or globose shape. A few of the collection numbers were intermediate between these two categories. Seed from most of the strains were similar in size within either the elongated or globose category, but some notable size variations were observed. For example, the seed collected from near Melba, Idaho, was very small, whereas seed from a Pullman, Washington, strain was comparatively large in size. When planted in a common nursery, these strains reproduced seed of approximately the same size as the original, which would indicate that at least in these instances the size characteristic noted was inherent within the strain rather than environmentally induced.

Of the 12 strains studied most intensively, six were of the globose seed shape, five elongated, and one was intermediate between these two categories. Some differences in seed size were also noted. Table 1 shows that in a random sample of the seed of each of these strains, the average length varied from 2.9 to 5.2 millimeters, and the width at the widest point varied from 1.1 to 1.8 millimeters. These differences in seed size and shape are illustrated in Figure 1.

Considerable variation in the size and type of leaf was noted among the strains established in the nursery. Among the 12 strains studied, only two had flat leaves; the remaining eight were either of involute or semi-involute type. Table 1 shows differences in leaf width and plant height found among the 12 strains selected for study. Using growth habit and leaf width as criteria, the 12 strains of Indian ricegrass could be divided into three groups. Four strains were low-growing and narrow-leaved, four were intermediate in height and leaf width, and four were tall, erect, coarse-leaved plants.

From their widespread distribution it appears that there was little or no correlation between

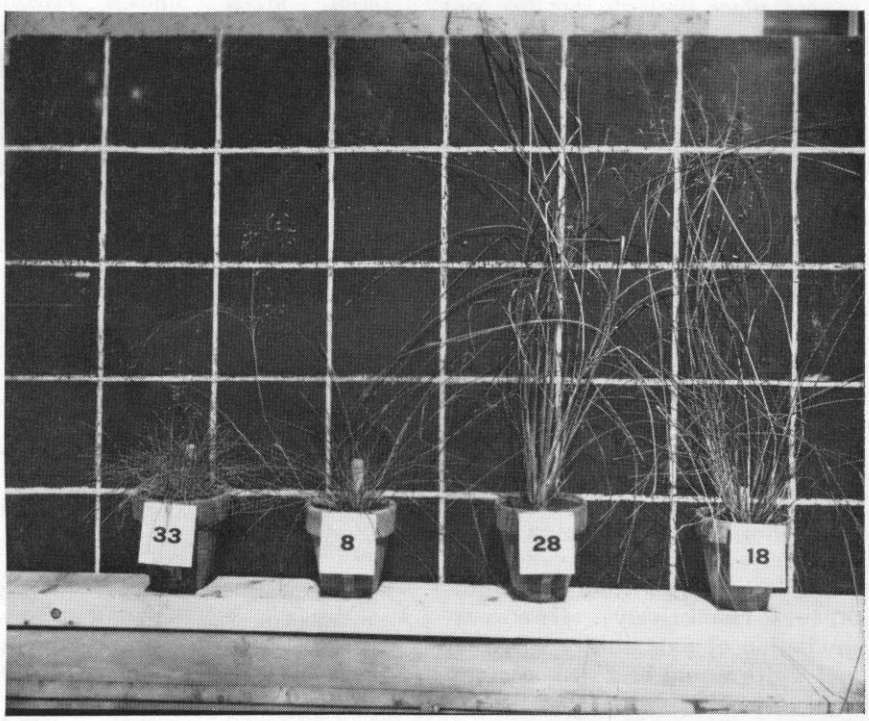


FIGURE 2. Individual plants of the two most palatable (*left*) and the two least palatable strains (*right*) among the 12 strains of Indian ricegrass. Scale unit = 6 inches.

growth habit and geographic location for any of the groups.

### Palatability Differences Among Geographic Strains of Indian Ricegrass

Separate palatability trials were conducted using the dry forage from the selected strains grown at Lincoln, Nebraska, and the green forage from the same strains grown at Laramie, Wyoming. The trials were carried out consecutively with two tame rabbits used as experimental animals, and the resulting palatability ratings were based on the percentage of the weight of the material offered which was consumed by the experimental animals during an approximately 15-hour period of time.

Strain No. 33, from Lethbridge, Canada, was the most highly preferred strain in both the dry and green forage palatability tests. It averaged 91.67 percent palatability in four tests using dry forage and 93.83 percent palatability in four tests using the green forage. This strain has a low and prostrate growth habit and narrow, involute leaves. Strain No. 8 from near Scottsbluff, Nebraska, ranked in second place in both the dry and green forage tests.

The least palatable strain, No. 18, collected near Pullman, Washington, averaged 56.89 percent palatability in the dry-forage trials and 75.43 percent palatability in the green-forage trials. This strain, one of the tallest of those tested, was semi-erect and its widest leaf measured three millimeters. Strain No. 28, from Whitebird, Idaho, ranked in eleventh place in average palatability but differed only slightly from No. 18.

As noted in Tables 1 and 2, the two most highly palatable strains had narrow leaves (1.5 and 2.5 millimeters, respectively) and the two least palatable species had wide leaves (3.0 and 4.5 millimeters, respectively). However, prediction of palatability based on leaf width would be a rash assumption, for even with the limited number of strains tested in this study, several exceptions were found. Figure 2 shows the general growth habit of the two most highly palatable and the two least palatable strains tested.

The experimental animals consumed a greater percentage of the fresh green forage offered than they did of the dry forage. Regardless of this difference in preference, it should be noted that the rank in palatability for the three most highly palatable and the three least palatable strains was identical based on both dry and green forage tests.

These results are based on preference exhibited by experimental rabbits and do not necessarily apply directly to domestic livestock. The differences in palatability among strains of Indian ricegrass shown for rabbits are apparently inherent among the geographic strains of this species.

### Relationship Between Chromogen and Palatability

The results of chromogen determinations made from a sample of the forage of each of the 12 geographic strains of Indian ricegrass grown at the Lincoln, Nebraska, nursery are presented in Table 2. Strain No. 8 from Scottsbluff, Nebraska, had 19 chromogen units per gram of dry matter, the lowest value found among the 12 strains tested. The highest chromogen reading, 38.5 units per gram of dry matter, was observed in Strain No. 21 from Mandan, North Dakota, and Strain No. 29 from Antelope Valley, California.

Chromogen content shows an inverse relationship to palatability in a comparison of the three most palatable and three least palatable strains. The top three strains in palatability rating had an average of 21.1 chromogen units, whereas the lowest three had an average of 27.0 units of chromogen. However, a linear correlation analysis of all strains gave a coefficient of correlation of —.32, indicating only a

**Table 2. Palatability percentage and rank and units of chromogen for the 12 strains of Indian ricegrass grown at Lincoln, Nebraska, and Laramie, Wyoming.**

| Identification No. | Strain Origin | Grown at Lincoln, Nebraska | | | Grown at Laramie, Wyoming | | |
|---|---|---|---|---|---|---|---|
| | | Units of chromogen per gram of dry matter | Percentage of dry forage which was eaten | Rank in dry forage tests | Percentage of green forage which was eaten | Rank in green forage tests | Rank in both tests (av.) |
| 33 | Lethbridge, Alberta, Canada | 24.0 | 91.7 | 1 | 93.8 | 1 | 1 |
| 8 | Scottsbluff, Nebraska | 19.0 | 87.6 | 2 | 93.8 | 2 | 2 |
| 32 | Medicine Hat, Alberta, Canada | 20.5 | 86.5 | 3 | 87.8 | 3 | 3 |
| 47 | Aberdeen, Idaho | 33.5 | 82.3 | 4 | 82.8 | 7 | 4 |
| 29 | Antelope Valley, California | 38.5 | 79.7 | 5 | 80.0 | 9 | 7 |
| 6 | Cheyenne, Wyoming | 20.5 | 76.7 | 6 | 84.2 | 6 | 5 |
| 4 | Hell's Half Acre, Wyoming | 26.5 | 75.3 | 7 | 84.9 | 4 | 6 |
| 49 | Swift Current, Saskatchewan, Canada | 23.5 | 74.6 | 8 | 84.5 | 5 | 8 |
| 21 | Mandan, North Dakota | 38.5 | 68.4 | 9 | 82.5 | 8 | 9 |
| 20 | Arizona | 25.5 | 65.0 | 10 | 77.0 | 10 | 10 |
| 28 | Whitebird, Idaho | 29.0 | 57.8 | 11 | 76.8 | 11 | 11 |
| 18 | Pullman, Washington | 29.0 | 56.9 | 12 | 75.4 | 12 | 12 |

weak relationship between these two factors.

From this study it would appear that units of chromogen in plant material would not be a reliable method of predicting the probable palatability. However, the number of strains tested was small and a larger number of strains might conceivably show a closer correlation than found here. Further refinement of the chromogen testing method might lead to a quick test of palatability.

## Summary and Conclusions

A study of variations in morphological characteristics and palatability of 12 geographic strains of Indian ricegrass was made.

The principal objectives were: (1) to determine morphological differences exhibited by geographic strains of Indian ricegrass; (2) to determine possible differences in palatability between the geographic strains and the constancy of such differences in strains grown on two soil types; and (3) to test the relationship between the chromogen content of plant material and palatability as a possible laboratory method for determining animal preference.

Indian ricegrass was found to have wide variation in growth habit, leaf type, and size and shape of seed. These differences are probably due to natural selection, and when the geographic strains were grown in a common nursery, the differences noted appeared to be inherent within the geographic strain.

In general, the seed of strains could be classified into two categories on the basis of shape: elongated and globose. A few of the collections showed intermediate characters.

Palatability ratings for the 12 strains of Indian ricegrass studied were determined by the percentages of forage of the different strains consumed by rabbits.

Strains from near Lethbridge, Alberta, Canada; Scottsbluff, Nebraska; and Medicine Hat, Alberta, Canada, were the most preferred strains of those tested. Strains from near Pullman, Washington, Whitebird, Idaho, and Arizona, were the least preferred.

There appeared to be little correlation between palatability and the amount of chromogen in each strain. Linear correlation analysis gave a coefficient of correlation of —.32, indicating only weak relationship between palatability and the amount of chromogen present in the plant material.

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