The Relationship Between Depth Of Planting And Maximum Foliage Height Of Seedlings Of Indian Ricegrass[1]

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Indian ricegrass *(Oryzopsis hymenoides* Roem. and Schult.) is a component of the deserts and plains flora. It is found throughout Nevada principally on well-drained soils at elevations from 4,000 to 7,000 feet but is most common on arid winter ranges in the southern part of the state. In some areas, it is an important constituent of the plant population and provides abundant nutritious forage when growing conditions are favorable (Figure 1).

Conservationists have recently shown an increasing interest in the use of Indian ricegrass in attempts at seeding arid ranges where crested wheatgrass is not well adapted. However, the literature reveals that little experimental seeding has been done with Indian ricegrass, perhaps because the hard, impermeable seed coat makes large-scale seedings with this species an uncertainty. Until a commercial seed source is available and the impermeable seed coat can be eliminated by the plant breeders or scarified in sufficient quantity, large scale seedings with this species will probably not be attempted.

Information concerning depth of planting as related to foliage height of Indian ricegrass seedlings seems particularly important before attempts are made to seed any sizeable acreage. During the spring of 1956, 1957, 1958, and 1960 excellent reproduction of Indian ricegrass occurred on deep sandy soil and provided an opportunity to study natural germination and growth of seedlings.

Procedure

The principal study location was 2 miles north of Fernley, Nevada, on a beach remnant of prehistoric Lake Lahonton. The soil is gravelly sand of very low fertility. Measurements of the depth of seed germination and maximum foliage height of the seedlings were recorded for approximately 250 seedlings each spring at the Fernley site. Another 250 seedlings growing on active sand dunes 25 miles east of Fallon, Nevada, were measured in 1958. The germinated seeds were exposed by careful excavation (Figure 2) and the depth of the seed below the soil surface and the maximum height of foliage was recorded for 1125 seedlings during 4 years of study.

One-hundred seedlings were located with small iron stakes and measured periodically to determine any changes occurring in the relationship of foliage height and depth of seed, and also, to determine longevity of seedlings.

In order to determine if increased soil moisture at deeper soil depths influenced quicker germination and more rapid elongation of the seedling, the following experiment was conducted. Seeds of Indian ricegrass were planted in the greenhouse at depths ranging to 80 mm. in a container 2 ft. by 10 ft. by 1 foot deep filled with sand from the Fernley site. The sand was kept moist throughout to determine if the same relationship between foliage height and depth of seed existed when moisture was not limiting.

Correlation and regression coeffecients and statistical significance for linearity of regression were determined for the meas-

FIGURE 1. Large areas of arid western grazing lands support an abundance of Indian ricegrass when conditions are favorable.

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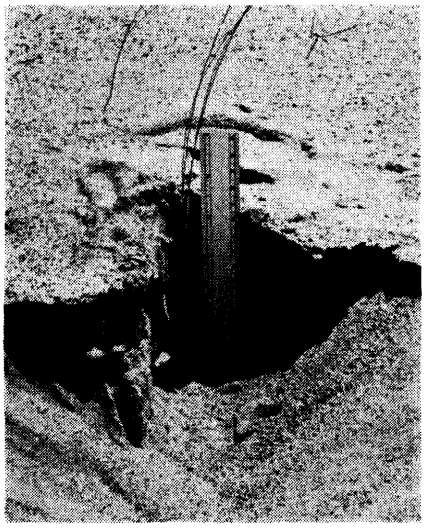

FIGURE 2. Seedlings were excavated to the depth of seed germination by carefully removing the sand or soil.

urements made each spring and for the total of all measurements.

Results and Discussion

Average depth at which seed germinated and height of foliage for all seedlings was 59.0 and 181.2 mm., respectively (Table 1). Height of foliage varied according to the particular growing conditions during early spring and the time of measurement and had no particular importance in the study reported here except as it related to the depth at which the seed germinated.

The correlation coefficient between depth of seed and height of foliage for the total of 1125 observations was r = 0.508 and was highly significant (Table 1, Figure 3). The positive correlation indicates that the most deeply planted seed produced foliage of greater maximum height and suggests that moisture in the deeper soil provides an advantage for deeper germinating seeds. However, a greenhouse experiment in which moisture was not a limiting factor at any depth showed also a significant and positive correlation between depth of seed and height of foliage. Moisture, therefore, apparently has little influence on the relationship between depth of seed and foliage height of seedlings but undoubtedly plays an important role in growth of Indian ricegrass after the seedling becomes established.

Seedlings from seed which germinated at lower depths in the sand had longer, more slender and delicate stems and leaves, such as etiolated seedlings might have, than the thick sturdy stems and more tillers of the seedlings from shallow planted seeds (Figure 4). The possibility that light or heat may inhibit the germination of seeds nearer the soil surface was not investigated. However, germination of seeds of some species is retarded or even prevented by light (Curtis and Clarke, 1950; Meyer and Anderson, 1952). Germination of lettuce seed is inhibited by light of certain wave lengths and is favored by light of other wave lengths (Flint and McAlister, 1935 and 1937). Germination of seeds of many members of the lily family is inhibited or retarded by exposure to light (Crocker, 1936). The possibility that germination of even the most shallow seeds (19 mm.) of Indian ricegrass was influenced by light appears doubtful. Perhaps some of the growth responses of Indian ricegrass were due to the phytochrome pigment which is known to influence photoperiodism and many other aspects of plant growth resulting in a general control of growth by light (Borthwick and Hendricks, 1960). These authors state that "in nature, the shoot from a deeply planted seed elongates until the food reserves are exhausted or until it reaches the surface and is exposed to light, which inhibits further lengthening."

In 1957, the depth of germinating seed and maximum foliage height of 100 seedlings were measured and marked with nearby iron stakes so that measurements might be taken periodically. Measurements made on April 26, 1957, of seed depth and foliage height were highly significantly correlated, r = 0.397 (Figure 5). Measurements were again made on May 27, 1957, but only 88 seedlings survived since the last measurement. Seed depth was assumed to be the same and foliage height increased from 171.8 mm. to 191.3 mm. The correlation coefficient for the May 27 measurements was r = 0.562 (Figure 5). Measurements of foliage height made a year later, April 30, 1958, of 71 surviving seedlings showed an even greater correlation, r = 0.736, with depth of germinating seed as measured earlier. In 1960, only 8 of the original plants remained alive. Increasing r valves with successive measurements suggest that those seedlings in which seed depth and foliage height are best correlated are the surviors. Sixteen, 32, and 54 percent of the variation in foliage height was due to variation in depth of seed of

TABLE 1. Average depth of seed and maximum height of foliage of Indian ricegrass when measured on dates indicated and correlation coefficients (r) between depth of seed and maximum height of foliage.

Date measured	Depth of seed, mm.	Height of foliage, mm.	Correlation coefficient
May 26, 1956	51.9 (22-79)[1]	144.1 (70-206)	0.431**
April 26 to May 10, 1957	53.1 (19-97)	187.1 (78-305)	0.588**
April 30, 1958	57.7 (25-92)	170.3 (74-252)	0.591**
May 10, 1958[2]	77.0 (28-141)	207.6 (95-361)	0.565**
May 12, 1960	62.3 (28-115)	150.8 (80-231)	0.478**
Average of all observations	59.0	181.2	.508**

**Indicates significance at the 1 per cent level of probability.

[1]Range of measurements in parenthesis.

[2]Measurements taken 25 miles east of Fallon, Nevada; all others at Fernley, Nevada.

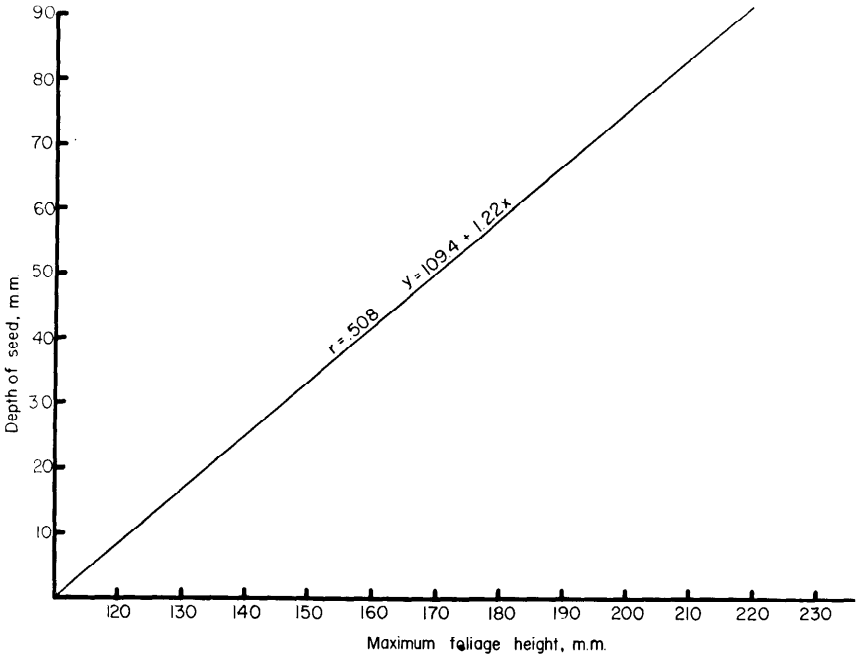

FIGURE 3. Regression line of maximum foliage height of Indian ricegrass seedlings as related to depth of germinating seed.

measurements made on April 26 and May 27, 1957, and April 30, 1958, respectively. The data suggest that depth of germinating seed has an increasing influence on foliage height as the seedlings become older.

Of the 1125 seedlings measured since 1956, 62.4 percent of the seed germinated at depths ranging from 41 to 70 mm. or from 1.6 to 2.8 inches (Table 2). Approximately 20 percent of the seed germinated in each of the ranges from 41 to 50, 51 to 60, and 61 to 70 mm. Below 41 mm. and above 70 mm. seed depth, germination and emergence were greatly reduced.

TABLE 2. Various depths and percent of total of germinating seed of Indian ricegrass under natural conditions on sandy soil.

Depth of germination, mm.	Percent of total germinating seeds
10 or less	0
11-20	0.4
21-30	3.2
31-40	11.2
41-50	20.0
51-60	22.0
61-70	20.5
71-80	11.0
81-90	6.3
91-100	2.4
100 or more	3.0

Summary and Conclusions

The depth of germinating seed and maximum foliage height of 1125 seedlings of Indian ricegrass has been measured since 1956. The seedlings were growing on sandy soils of low fertility under natural climatic conditions at Fernley and Fallon, Nevada. Correlation and regression coefficients and statistical significance for linearity of regression were determined to learn the influence of depth of germinating seed on maximum foliage growth.

A positive and highly significant correlation was found to exist between depth of seed and maximum foliage height. Results indicate that deeper seeds have an advantage, perhaps better moisture, for germination and growth over seeds planted shallow. However, greenhouse studies indicate the same relationship exists when moisture is ample at all soil depths. The presence or absence of soil moisture undoubtedly plays a prominent role in growth after the seedling becomes established.

The long, slender, delicate seedlings from seed at deeper depths suggested that light or

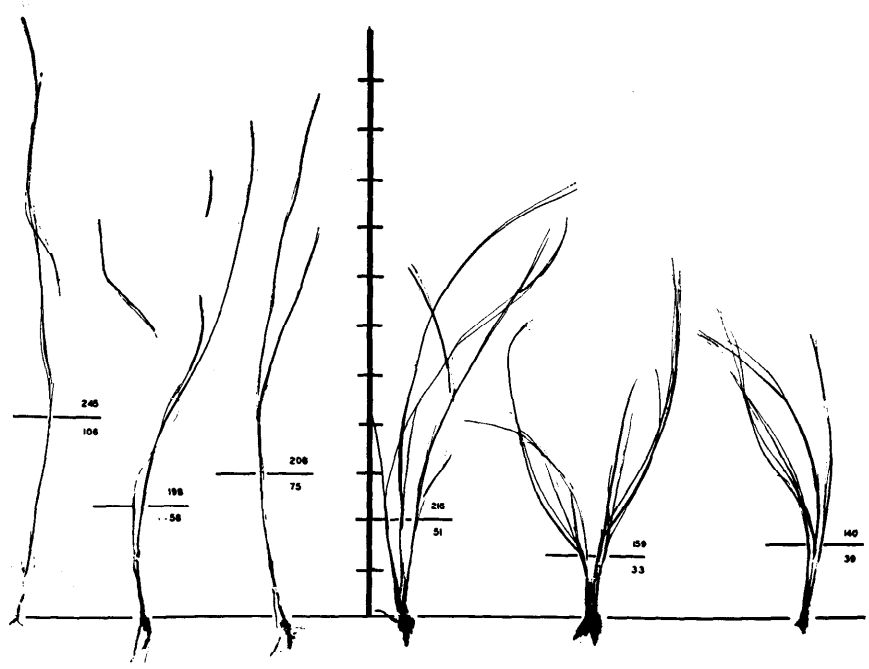

FIGURE 4. Three seedlings on the left illustrate the growth response to deeply planted seeds; seedlings on the right developed from seed planted shallow. Short horizontal lines indicate the soil surface. Average depth of seedlings on the right was 41 mm. and average maximum height of foliage was 172 mm.; on the left, average depth was 80 mm. and average height 217 mm. Scale in the center in inches.

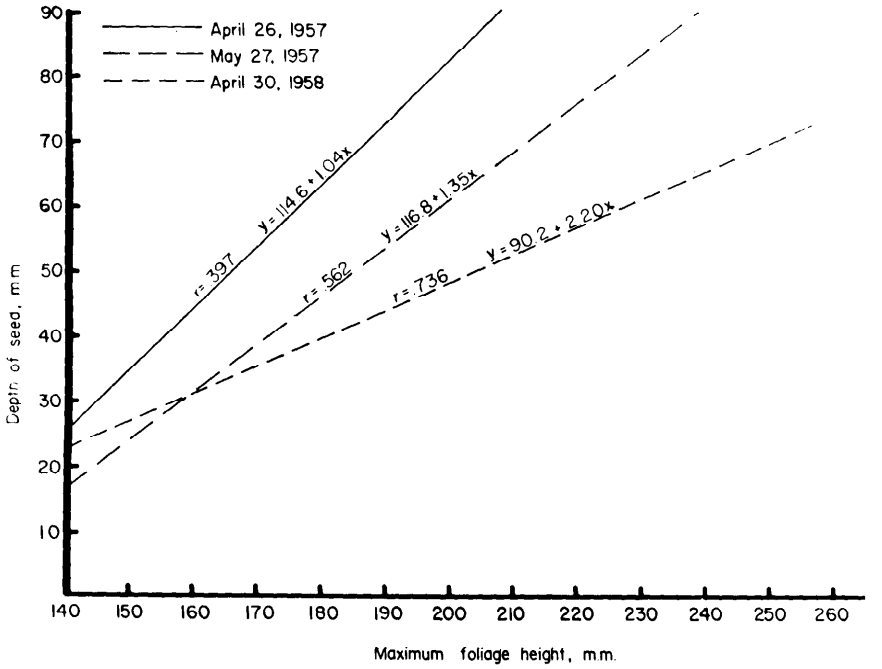

FIGURE 5. Regression lines of maximum foliage height of 100 marked Indian ricegrass seedlings as related to depth of germinating seed when measured on April 26 and May 27, 1957, and April 30, 1958.

heat may inhibit germination at shallow depths. However, this assumption was not investigated.

Correlation coefficients of depth of seed and height of foliage of 100 marked seedlings measured on April 26 and May 27, 1957, and again on April 30, 1958, were r=0.397, 0.562, and 0.736, respectively. Of the 100 original seedlings, 88 percent survived on May 27 and 71 percent on April 30.

As the seedlings became older, depth of seed had more influence on maximum foliage height. For instance, when the seedlings were first measured on April 26, 16 percent of the variation in foliage height was due to variation in depth of seed. On May 27, 1957, and April 30, 1958, the values were 32 and 54 percent, respectively. Seedlings in which depth of seed and foliage height were best correlated were the survivors of the original 100 seedlings.

Average depth of seed of all seedlings measured was 59.0 mm. or 2.3 inches. Sixty two percent of the seed germinated between depths ranging from 1.6 to 2.8 inches. When seeding Nevada's arid southern rangelands to Indian rice grass, planting the seed at this range of depths has distinct advantages: (1) the seed is placed nearer the limited soil moisture and (2) away from high soil surface temperatures common on southern desert ranges. However, seedlings from seed planted deep are slender and delicate compared to more tillers and thick, sturdy stems of seedlings of shallow planted seed.

Recommendations for most grass species state the seed should be planted at depths of one-fourth to one-half inch. Few grass species can be planted deeper than 1 inch and produce a crop. Indian ricegrass seed is unique in that the majority of seed will germinate and emerge from depths up to 3 inches in a sandy soil providing distinct advantages in seeding arid ranges which have loose, sandy, well-aerated soils.

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