ANNUAL VARIATION IN WILD RICE (*Zizania palustris* L.) GROWTH AND POTENTIAL YIELD IN SASKATCHEWAN

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Mature wild rice plants collected from 20 sites across northern Saskatchewan over the period 1984–1987 were measured for various morphological traits. Considerable regional variation was noted for factors such as stem length, degree of tillering and seed production with plants in the west being generally more robust. Differences also occurred between years. Much of this variation appeared to be related to environmental conditions with high water levels being particularly detrimental to the plants. Seeds collected at each site during the 1986 harvest were sown into growth tanks. Plant development under uniform growing conditions was compared to individuals collected from corresponding natural sites. Although intersite variability was considerably reduced indicating a high degree of environmental plasticity in the population, some regional variation in tillering and seed production was still detectable in the artificial populations and plants from eastern sites still tended to flower earlier. Such inherent genetic variability should be considered when seed is introduced into new sites as the industry expands in northern Saskatchewan.

Key words: Rice (wild), *Zizania palustris* L., Saskatchewan, environmental interaction, annual variation, regional plasticity

[Variation annuelle de la croissance et du rendement potentiel du riz sauvage (*Zizania palustris* L.) en Saskatchewan.]
Titre abrégé: Riz sauvage en Saskatchewan.
Nous avons mesuré diverses caractéristiques morphologiques de plants de riz sauvage matures recueillis en 25 endroits différents du nord de la Saskatchewan, entre 1984 et 1987. Nous avons constaté des variations régionales considérables pour des caractéristiques telles que la longueur de la tige, le degré de tallage et la production de graines, les plantes provenant de l'ouest étant généralement plus robustes. Des différences ont également été observées d'une année à l'autre. Ces variations paraissaient en grande partie liées aux conditions environnementales, les niveaux d'eau élevés étant particulièrement nuisibles aux plantes. Des graines prélevées à chaque endroit au cours de la récolte de 1986 ont été plantées dans des bassins de croissance. Le développement des plantes obtenues sous des conditions de croissance uniformes a été comparé à celui de plantes recueillies dans les emplacements naturels correspondants. Même si la variabilité inter-site a été considérablement réduite, indiquant ainsi un haut degré de plasticité environnementale au sein de la population, certaines variations régionales du degré de tallage et de la production de graines étaient toujours observables chez les populations cultivées en milieu artificiel et les plantes provenant de l'est avaient toujours tendance à fleurir plus tôt. Une telle variabilité génétique inhérente devrait être prise en compte

lorsque des semences sont introduites dans de nouveaux sites à mesure que cette culture s'étend dans le nord de la Saskatchewan.

Mots clés: Riz sauvage, *Zizania palustris* L., Saskatchewan, interaction environnementale, variation annuelle, plasticité régionale.

Wild rice (*Zizania palustris* L.) is an important new crop in northern Saskatchewan and it is widely distributed throughout the shallow lakes and slow moving rivers of the forested southern edge of the Canadian Shield (Archibold and Weichel 1986). Although it was introduced in the 1930s, commercial production did not begin until the mid 1960s. Aided by provincial seed grants and other incentives, interest in the crop has increased substantially with production in 1987 exceeding 550 000 kg. Production of lake-grown wild rice tends to fluctuate annually. In long-established stands in Manitoba and Ontario peaks in total provincial production occur in a 4- or 5-yr cycle (Fig. 1). This in part reflects annual variation in growing conditions and in part the accumulation of straw following good crop years. Because of the steady increase in acreage, similar trends in Saskatchewan have been obscured until recently, although local growers have reported varying production at specific sites.

The common contemporary name wild rice applies to the annual species of *Zizania*. Four forms have been recognized on the basis of morophology, range and habitat. Dore (1969) classified these plants as two species, *Z. palustris* L. and *Z. aquatica* L. each with two varieties, thereby disputing the nomenclature of Fassett (1924) who had proposed a single species, *Z. aquatica* L. with four varieties. According to Dore (1969) *Z. palustris* var. *palustris* (northern wild rice) and *Z. palustris* var *interior* (interior wild rice) are found in the upper Mississippi–Great Lakes region, ex-

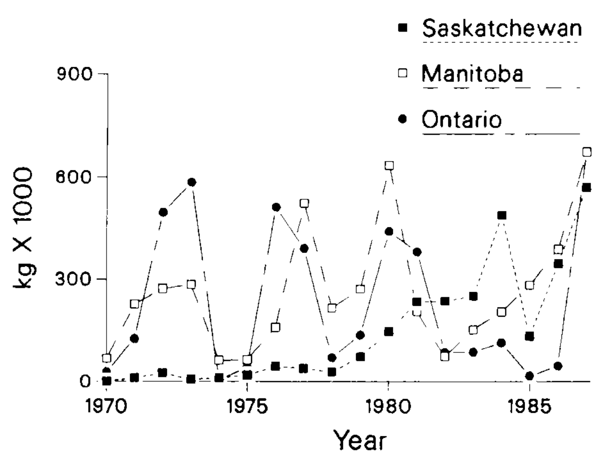

Fig. 1. Annual production of green wild rice for Saskatchewan, Manitoba and Ontario for the period 1970–1987.

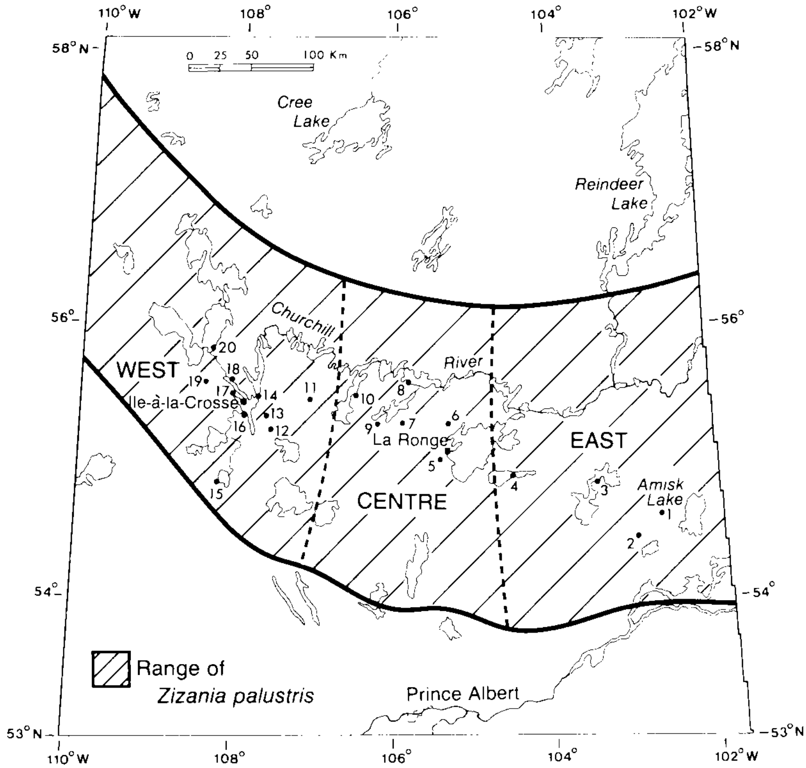

Fig. 2. The location of sample sites across northern Saskatchewan.

tending into the southern portion of the Boreal Forest. These varieties are sympatric over much of the species range, although a latitudinal gradient in dominance is acknowledged (Dore 1969; Lee 1979; Oelke et al. 1982). Recently, Warwick and Aiken (1986) demonstrated that there are two distinct species within the genus based on electrophoretic studies. *Zizania palustris* is considered the most widespread species in Saskatchewan. It is also the species of greatest commercial value owing to its large kernel size.

Significant morphological and phenological differences have been noted in the crop. For example, Lee (1979) reported 11–120 female florets per panicle on plants collected in northwestern Ontario and northeastern Minnesota. Similar data are reported by Garrod (1984). The northward decline in floret number was attributed to increased dominance of variety *palustris* possibly in response to variable climatic conditions (Counts 1983). Counts and Lee (1987) described several phenotypes based on commercially important characteristics such as seed size, seed number and tiller production. In Saskatchewan, Archibold and Weichel (1986) reported that plants were more robust, produced more tillers and yielded more seeds per panicle in the western part of the province, whereas plants in the east were characterized by earlier maturity.

Stands of wild rice growing in unmanaged habitats are sensitive to environmental perturbations which greatly affect annual productivity. In the early stages of growth water depth is critical; the plants can be drowned or uprooted by wave action (Rogosin 1951). Significant reproductive failure may result from very hot, dry weather or excessive rain during pollination (Moyle 1944), while harvest may be curtailed by early fall frosts (Brooks 1966). This research documents the annual variation in natural stands across Saskatchewan over four seasons. There was considerable variation in a number of morphological traits both between sites and from year to year. In order to determine to what extent differences might be either genetically or environmentally determined, a comparison was made between the field data and seed from different sites grown in tanks under uniform environmental conditions.

MATERIALS AND METHODS

Field studies were conducted at 20 sites (Fig. 2) just prior to harvest (August) from 1984 until 1987. At each site, stem density was measured in 25 0.5 × 0.5-m quadrats placed 10 m apart along two transects. Water depth, temperature, pH and conductivity were measured at every second quadrat. A sample of 30–50 wild rice plants was collected at random along the transects. The plants were air dried and the number of tillers, stem length, stem basal diameter and length of rachis were measured and number of female florets were counted. The number of female florets produced per panicle was used as the basis for estimating grain production at each site. Grain maturation progresses downwards from the top of the panicle over a period of about

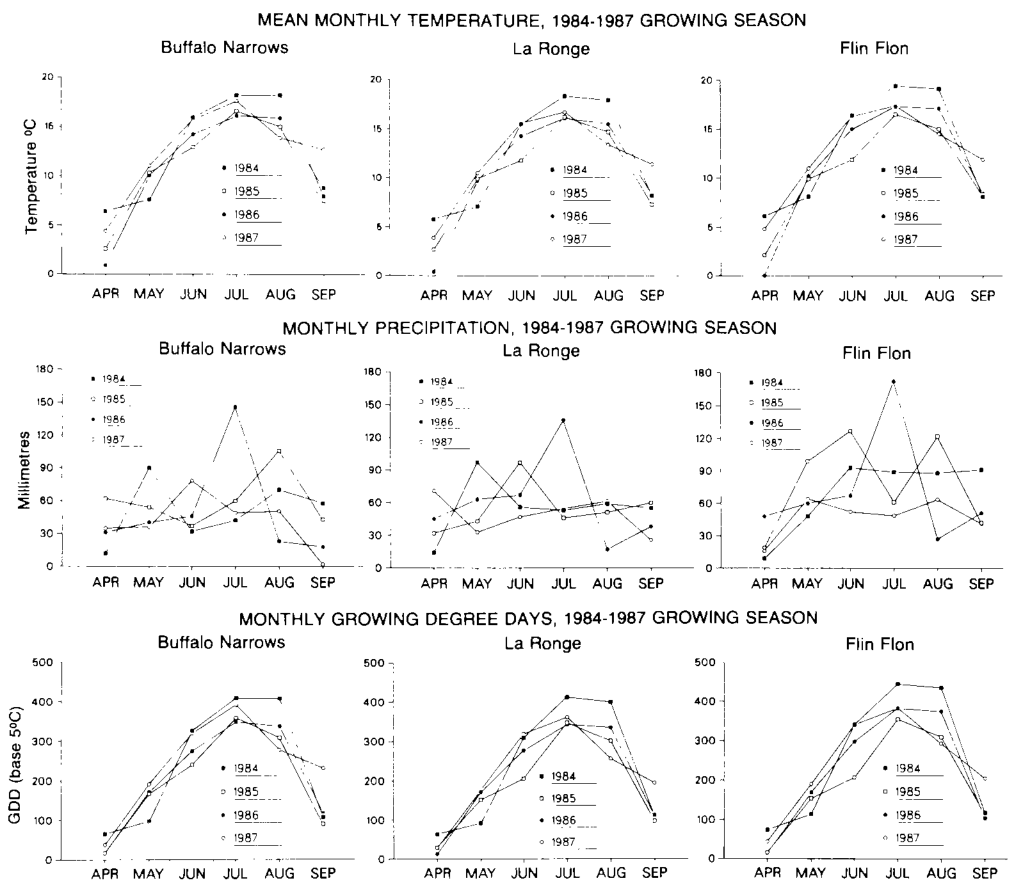

Fig. 3 Climate data for Buffalo Narrows, La Ronge and Flin Flon (Manitoba) over the 1984–1987 growing seasons.

2 wks. However, the mature grain shatters readily as a result of wind or bird activity. Also, many of the caryopses became detached during laboratory drying. Consequently, the pedicel scars were counted to determine floret numbers. Total sample size ranged from 1050 stems in 1984 to 1425 stems in 1987. Oven-dried material was weighed to determine shoot biomass. Mean seed weight was calculated by weighing composite samples of oven-dried grain still enclosed in the lemmas and paleas.

Samples of mature grain collected from each site during the 1986 harvest were stored over winter in Demchenko Lake near La Ronge to release dormancy. The seeds were retrieved in May 1987 and sown into open-air, plastic-lined tanks at the Crop Science Field Laboratory, University of Saskatchewan, Saskatoon. Each tank was partitioned into 60 × 60-cm sections containing 15 cm of loam and was flooded to a depth of 30 cm. The water in each tank was aerated to provide circulation and to reduce the growth of algae. Once established, the plants were thinned to a density of 50 m^{-2}. Four replicates for each site were randomly located in the tanks. Climate data for Saskatoon are given in Table 1. Representative data for the natural wild rice stands over the 4-yr survey period are shown in Fig. 3. Water level was maintained throughout the summer and the plants were harvested in late August and air-dried. The plants were processed in the manner described previously.

RESULTS

Regional and annual differences in stand density are shown in Fig. 4. In 1984 stem density ranged from 56.0 ± 4.6 (SE) stems m^{-2} at site 12 to 202.3 ± 25.7 stems m^{-2} at site 7. Apart from stands 14, 15 and 17, sites in the western part of the province were typically less dense than those in the east. Poor stand development occurred in 1985. The crop was completely drowned out at site 10 and the densest stand (site 2) averaged 111.3 ± 7.8 stems m^{-2} compared to 165.3 ± 13.2 stems m^{-2} the previous year. Stand reduction was most pronounced in the central and eastern parts of the province. Improved stand development occurred in 1986 particularly in the east where densities ranged from 55.4 ± 4.6 stems m^{-2} (site 4) to 104.2 ± 7.1 stems m^{-2} (site 2). However, some sites in the west were still affected by high water levels and did not recover well. This was most detrimental at sites 16 and 20 where stand densities were 14.9 ± 3.1 and 17.3 ± 3.8 stems m^{-2}, respectively. Stand density again increased in 1987 at most sites with a maximum of 116.5 ± 11.2 stems m^{-2} recorded at site 6.

Wild rice tillers readily both from the basal root plate and from nodes higher up the stem particularly in shallow water sites. The contribution of each stem type to the stands is shown in Fig. 5. In 1984 sites 2, 7 and 17 consisted primarily of single-stemmed plants with few tillers contributing to overall stand density. Tillering was most common in the western sites with the greatest numbers found at sites 19 and 20 where over 80% of the stems had arisen vegetatively. Several plants at site 19 had as many as 10 tillers arising form the basal plate and three more arising from nodes. Where present, the tillers most commonly arose from the basal plate, although at site 1 an unusually high percentage (35%) had arisen from nodes. There was a noticeable reduction in tillering in 1985. Sites 3, 16, 17 and 18 consisted entirely of single stemmed plants; only at sites 11, 13, 19 and 20 did tillering account for over 45% of the stand. Tillering was more conspicuous throughout the province in 1986 and 1987. However, during 1986 the majority arose from the basal plate whereas in 1987 nodal tillers were more common.

In all years the tallest stems were found at site 7 averaging over 2 m in length (Fig. 6). In 1984 the shortest stems occurred at sites 6 (1.27 ± 0.26 m) and 11 (1.36 ± 0.29 m). Intersite variation in stem length was less pro-

Table 1. Climate data for April–September 1987 at Saskatoon

	April	May	June	July	August	September
Mean monthly temperature (°C)	8.5	14.1	18.9	18.3	14.8	14.4
Precipitation (mm)	13.7	33.6	22.0	26.3	44.3	14.5
Growing degree days (base 5°C)	128.5	285.0	419.5	416.5	305.5	284.5

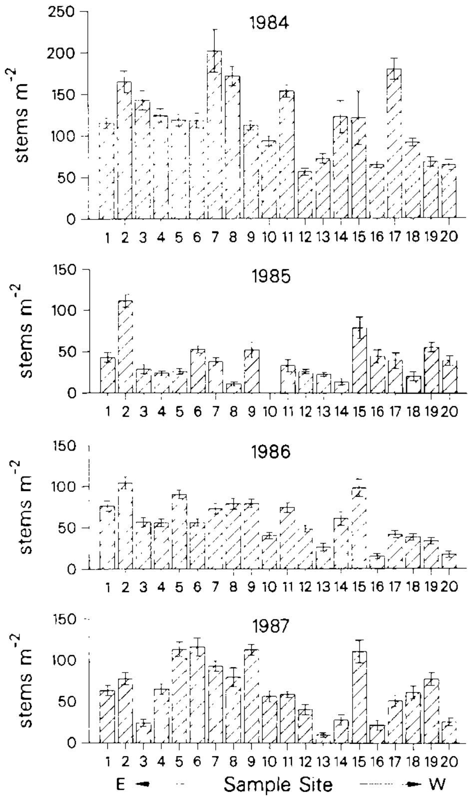

Fig. 4. Regional variation in stand density (mean ± SE) over the period 1984–1987.

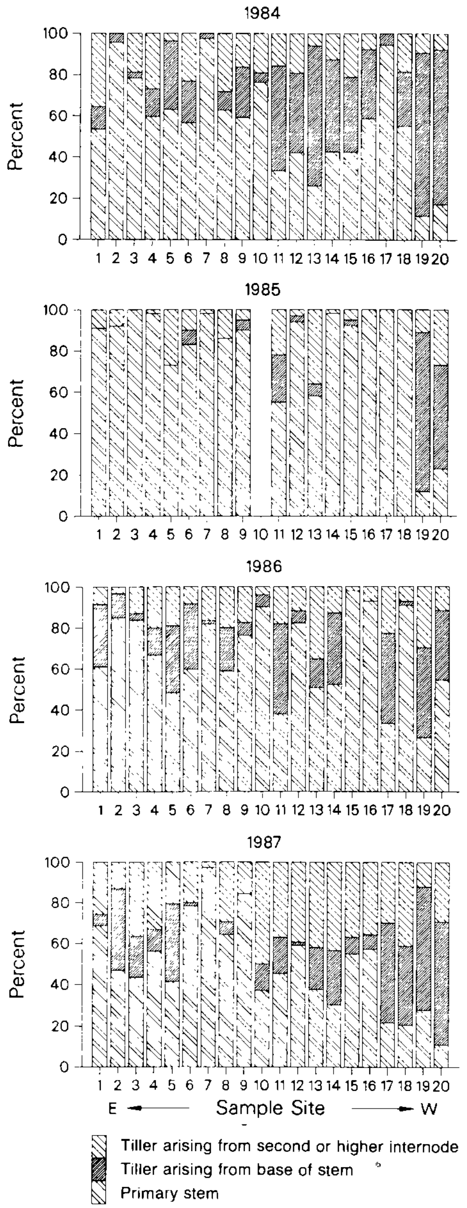

Fig. 5. Regional variation in tillering activity for the period 1984–1987.

nounced in 1985; the shortest stems were recorded at site 11 (1.05 ± 0.26 m) in that year. The reduction in stem length reflected poor tiller elongation under deeper water. Stem lengths tended to increase in 1986 and with the exception of sites 14, 19 and 20 exceeded 1.50 m. A general reduction in stem length was noted in 1987 with 11 sites averaging less than 1.50 m.

In 1984, basal stem diameter ranged from 2.2 ± 0.2 mm at site 7 to 7.4 ± 0.3 mm at site 19 (Fig. 7). In general plants were more robust in the western districts. Stems were typically thinner at all sites in 1985 and the longitudinal gradation characteristic of the previous season was obscured: only at sites 13, 18 and 19 did diameters exceed 4 mm. Stem diameter increased again in 1986. The thickest stems were recorded at site 19 (6.2 ± 0.2 mm), but sites 1, 6 and 4 also produced thick-stemmed plants resulting in little regional distinction in stem diameter. However, the trend to thicker stems in the western sites was again noted in

1987 with site 19 averaging 6.5 ± 0.2 mm compared to 1.9 ± 0.1 mm at site 7.

Oven-dry shoot weight is shown in Fig. 8. The largest individuals in 1984 were found at sites 19 and 20 where mean shoot weight was 42.2 ± 6.4 and 25.2 ± 5.1 g, respectively. The next highest value was recorded at site 13 (16.7 ± 3.7 g). Elsewhere shoot weight was less than 8 g. The plants in the east were generally lighter. Shoot weight typically reflected the tillering capacity of the plants. A reduction in plant biomass was noted at all sites in 1985, although a similar pattern of regional variation was detected. With the exception of sites 19 and 20 the bulk of the plants increased in the 1986 and 1987 seasons. No regional trends in shoot weight were detected in 1986 but in 1987 plants in the western sites were again considerably heavier than those in the east.

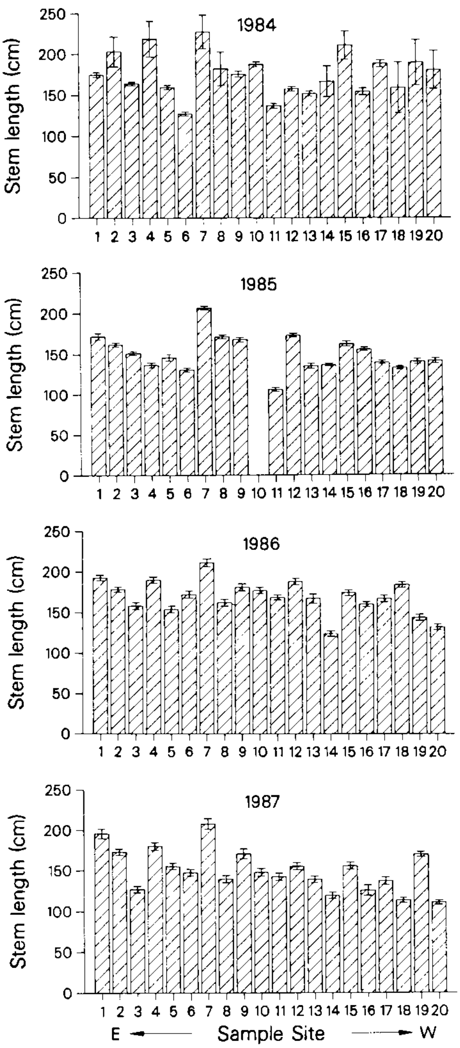

Fig. 6. Regional variation in stem length (mean ± SE) for the period 1984–1987.

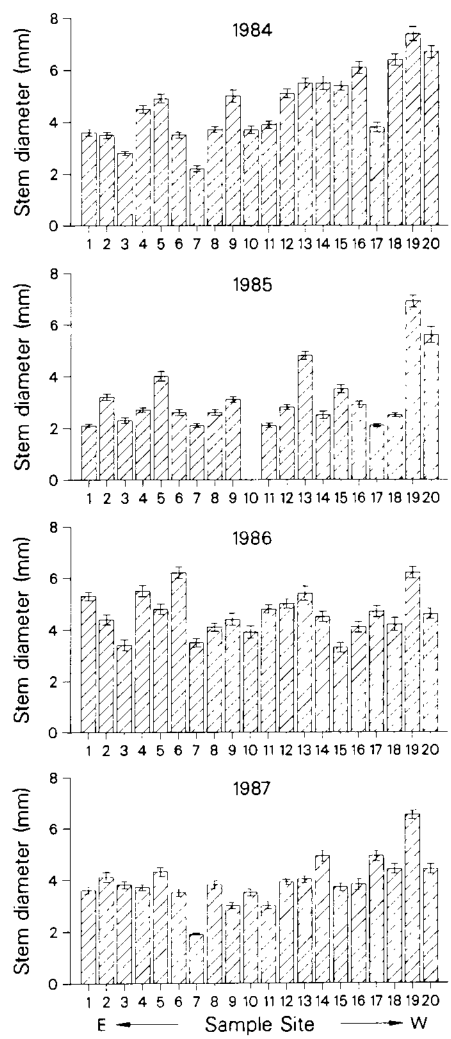

Fig. 7. Regional variation in stem diameter (mean ± SE) for the period 1984–1987.

Floret numbers ranged from 16.7 ± 1.4 per panicle at site 7 to 100.3 ± 5.4 per panicle at site 19 in 1984 (Fig. 9). The western sites generally produced the largest seed heads and only at sites 11 and 17 were counts below 50 florets per panicle in this region. This compares to a range of 19.0 ± 0.9 to 51.2 ± 3.7 in the east and 18.8 ± 1.1 to 53.9 ± 2.8 in the central district. 1985 counts were much reduced ranging from 15.7 ± 1.0 at site 1 to a maximum of 72.6 ± 2.5 at site 19. At several sites the panicles bore less than 30 florets while at site 10 deep water prevented the growth of any plants. However, the trends were similar to the previous year with site 5 being the most prolific in the east, sites 6 and 9 having above average floret production in the central district and sites 19 and 20 bearing the highest number of florets in the west. Floret numbers increased in 1986 but were generally below 1984 production. Plants at site 19 were the most productive with an average of 67.1 ± 3.6 florets per panicle compared to 18.9 ± 1.0 florets per panicle at site 15. Regional variability in seed production was less apparent this year with good seed counts noted at several sites in the east and central districts. However, by 1987 the production patterm had reverted to that noted in 1984 with the western sites generally producing in excess of 50 florets per panicle compared to a range of 27.5 ± 1.4 to 43.4 ± 2.1 florets per panicle in the east

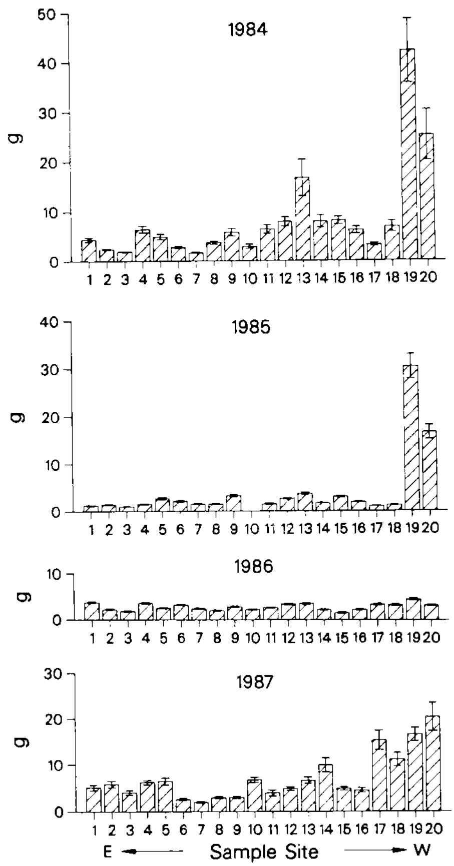

Fig. 8. Regional variation in shoot weight (mean ± SE) for the period 1984–1987.

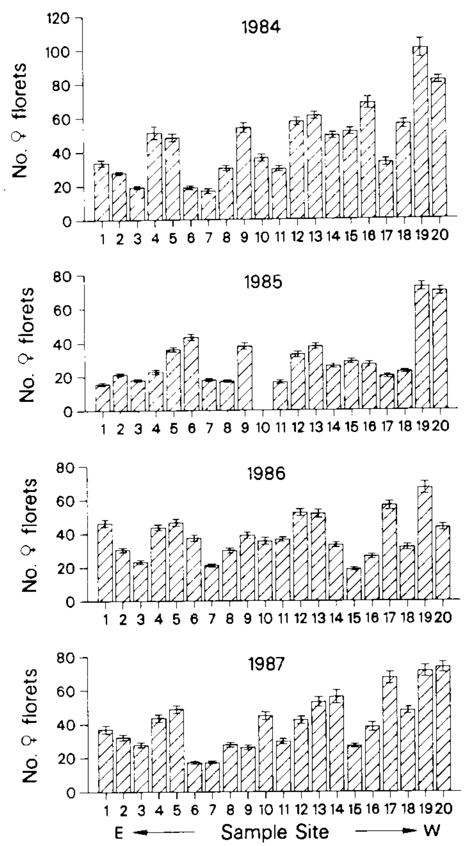

Fig. 9. Regional variation in the number of female florets per panicle (mean ± SE) for the period 1984 –1987.

and 17.0 ± 0.9 to 48.7 ± 2.3 florets per panicle in the center of the province.

The general range in seed weight in 1984 was between 40 and 50 mg. The heaviest seeds were noted at site 11 (52 ± 1 mg) and unusually light seeds averaging only 25 ± mg were recorded at site 2. Because of the very poor growth and the late harvest it was not possible to collect any seed in 1985. There was good grain development at most sites in 1986. The heaviest seed was again collected from site 11 with high seed weights noted at sites 1 and 3. As in 1984, site 2 was characterized by light seed weight (30 mg) at maturity; similar seed weights were recorded for sites 12 and 20, but this reflected the lateness of the crop at the time of sampling and the immaturity of the grain. Plant development in western districts is invariably 10–12 d later than elsewhere and unfilled grain accounted for low seed weights at many of these sites in 1987. Because of the remoteness of the sites, it was difficult to sample the stands at identical stages of development each year. In the west, the crop was rather late, but elsewhere some early harvesting had been carried out prior to sampling and the mature, heavy grain would have been removed. This could also account for the somewhat reduced seed weights noted across the province in 1987 compared to previous years.

Of the environmental parameters measured, water temperature and water depth showed the most regional and temporal variation. Water temperatures at the end of the 1984 growing season ranged from 17°C at site 13 to 23°C at site 6. Temperatures in 1985 were 2–5°C cooler. Cool water temperatures were characteristic of the 1986 and 1987 seasons. The deepest water at harvest time in 1984 was recorded at site 7 (1.48 m). At sites 4 and 10, water depths were 1.04 and 1.08 m, but elsewhere the water ranged from 0.50 to 0.98 m. This was considerably shallower than 1985 levels which varied from 0.65 m (site 11) to 1.85 m (site 10). In 1986 and 1987 water levels were comparatively high in the central district, but generally, levels declined throughout the province during this period approaching those recorded in 1984. Water pH values over the 4-yr period ranged from 6.8 to 8.5, but most sites were between 7 and 7.5: sites in the central district tended to be the most acidic. Conductivity, a measure of the ionized salt content of the water, similarly exhibited significant trends, but little annual variation was detected. Conductivity values ranged from 3.5 mS cm^{-2} to 27.5 mS cm^{-2}. Values were lowest in the central district averaging about 8.0 mS cm^{-2} compared to average conductivities of 11.0 mS cm^{-2} in the east and 16.5 mS cm^{-2} in the west. Subsequent analysis indicated that calcium, magnesium and sodium bicarbonates were predominant in the water.

The relationship between environmental parameters and plant performance is shown in Table 2. In all years water depth was positively correlated with stem length and negatively correlated with stem basal diameter and tiller production. Shoot biomass, length of female rachis and the number of florets produced were also negatively related to water depth in most years. The effects of other parameters were less consistent. Tillering was generally reduced in warmer sites. In 1984 higher pH levels were positively correlated with all of the measured parameters with the exception of stem length, but this was not consistent in later years. High conductivity was related to increased length of the female rachis and increased seed production in 1984 and 1987. All of these relationships must be viewed cautiously. The data were collected only at harvest time and may not accurately reflect growing conditions at critical stages in the development of the plants.

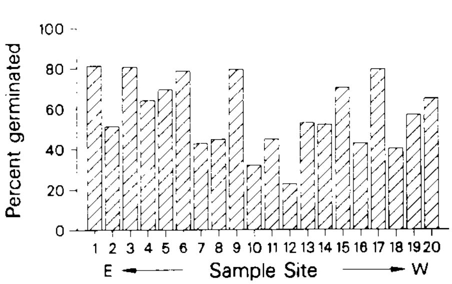

Fig. 10. Regional variation in viability of seed collected during the 1986 harvest period.

Table 2. Correlation coefficients between water conditions and morphological characteristics of lake grown wild rice (n = 20)

Depth	1984	1985	1986	1987
Stem length	0.76**	0.77**	0.55**	0.77**
Stem basal diameter	−0.75**	−0.51**	−0.51**	−0.73**
No. of tillers	−0.59**	−0.43*	−0.46*	−0.69**
Shoot biomass	−0.55**	−0.45*	−0.18	−0.68**
Length of rachis	−0.49*	−0.51**	−0.24	−0.60**
No. of seeds	−0.63**	−0.46*	−0.24	−0.67**
pH				
Stem length	−0.18	−0.44*	0.53**	0.19
Stem basal diameter	0.53**	0.02	0.16	0.34
No. of tillers	0.58**	−0.26	0.37*	0.20
Shoot biomass	0.60**	−0.10	0.03	0.27
Length of rachis	0.54**	−0.07	0.22	0.47*
No. of seeds	0.61**	0.02	0.28	0.34
Conductivity				
Stem length	−0.15	−0.19	−0.41*	−0.30
Stem basal diameter	0.47*	0.52**	−0.09	0.49*
No. of tillers	0.58**	−0.21	0.13	0.31
Shoot biomass	0.41*	−0.10	−0.09	0.34
Length of rachis	0.58**	0.46*	−0.18	0.40*
No. of seeds	0.46*	0.49*	0.10	0.45*
Temperature				
Stem length	−0.06	0.23	0.36	0.49*
Stem basal diameter	−0.20	−0.49*	0.05	−0.19
No. of tillers	0.17	−0.69**	−0.40*	−0.47*
Shoot biomass	0.16	−0.62**	−0.09	−0.27
Length of rachis	−0.05	−0.07	0.02	−0.17
No. of seeds	−0.15	−0.60**	−0.26	−0.25

*,**$P \leq 0.05$ and $P \leq 0.01$, respectively.

Stored seed was tested for viability prior to planting out in growth tanks. Viability ranged from 23% for site 12 to 81% at sites 1, 3 and 17 (Fig. 10). Viability was generally higher for seed collected from the east side of the province. The number of tillers produced by plants under uniform conditions averaged from 0.91 ± 0.15 (site 9) to 2.71 ± 0.27 (site 7) (Fig. 11). Under natural conditions the stand at site 9 was characterized by a high percentage of single stemmed plants and site 7 was almost entirely single stemmed plants suggesting that the capacity to tiller is environmentally controlled. Conversely, sites like 19 and 20 which naturally produce large numbers of tillers, averaged less than 1.5 tillers per plant in the growth tanks.

Greater uniformity in stem characteristics was also noted for plants grown in the tanks (Fig. 11). Maximum stem length was 1.24 ± 0.02 m (site 6) with the shortest plants, 1.00 ± 0.04 m in length, being found at site 12. In the lakes, site 6 produced some of the shortest plants while at site 12 plants were longer than average in 1984, 1986 and 1987. Similarly, variation in stem diameter was reduced, ranging from 3 mm to 4.5 mm. In 1984, average stem diameter at many sites was about 2 mm, while in other years stem diameters exceeding 5 mm were not uncommon. The greater consistency in tiller production and stem form is reflected in a more even distribution in shoot weight. Most plants averaged 6–8 g compared to a range of 1–42 g recorded during field observations. The greatest difference between lake-grown and tank-grown plants was noted in the western sites. Floret counts for the tank grown plants (Fig. 12) ranged from 45.4

± 1.8 (site 2) to 82.3 ± 2.5 (site 13); this represents much less variation than in natural stands.

DISCUSSION

Wild rice is grown in unmanaged lakes and rivers in Saskatchewan. Unlike the wild rice cultivated in paddies in Minnesota and California, the use of fertilizer and pesticides is expressly forbidden by provincial law. This policy is accepted by the growers who enthusiastically promote the health food qualities of their product. Regulations also prevent the use of water control structures. Production is therefore largely controlled by the vagaries of the environment and the plant's variable response to growing conditions.

Potential yield of grain from the sites was calculated by multiplying mean seed weight by mean floret number and mean stem density (Fig. 13). In 1984, site 15 was the most productive with a potential yield of 3342 kg ha^{-1}. Potential yields were generally higher in the west, but high yields were also recorded for sites 4, 5, 8 and 9. The data presented here greatly overestimate actual yield. Often pollination failure occurs; ripening may be prevented by climatic conditions, and natural shattering and inefficient harvesting will typically reduce actual yields to less than 20% of these values. The data do, however, provide a basis of interregional and interannual comparison. A dramatic decrease in potential yield occured in 1985. Values in excess of 1000 kg ha^{-1} were reported at only three sites. The majority were less than 500 kg ha^{-1} and at site 10 there was a complete absence of plants. Some increase in production was noted in 1986 with potential yields in excess of 2000 kg ha^{-1} reported at some sites in the east and central districts. However, sites 19 and 20 continued to decline. By 1987 potential production at the majority of sites ranged between 600 and 1000 kg ha^{-1}. Sites 3, 13 and 16 were well below average production.

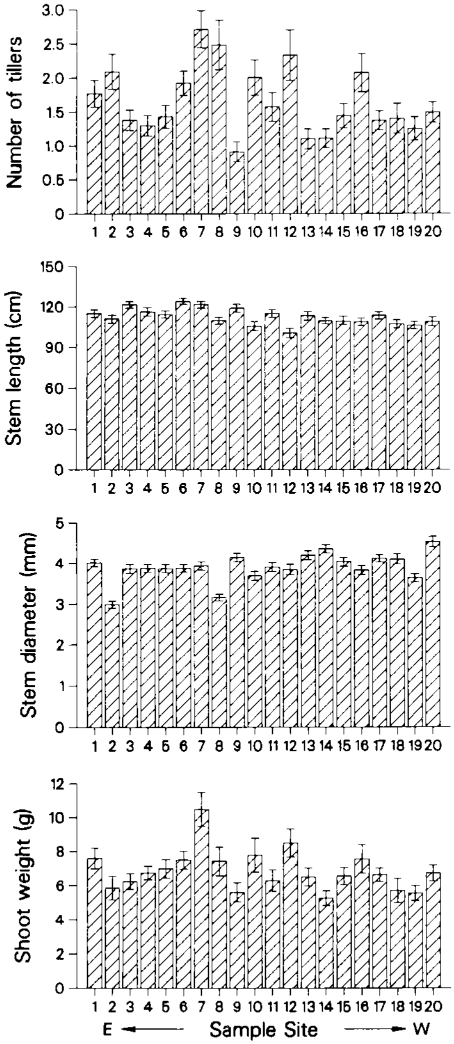

Fig. 11. Intersite variation in stem morphology (mean ± SE) for plants grown from seed in tanks under uniform conditions.

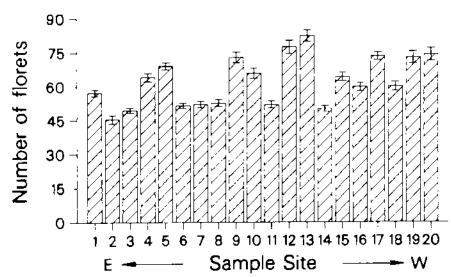

Fig. 12. Intersite variation in the number of female florets per panicle (mean ± SE) for plants grown from seed in tanks under uniform conditions.

The extent to which observed differences within the population reflect varietal differences or environmental control is unclear. Recent taxonomic studies (Warwick and Aiken 1986) suggested that the genus be separated into two species, *Z. palustris* consisting of two varieties and *Z. aquatica* comprising three varieties. Dore (1969) reported that both varieties of *Z. palustris* have been introduced to Saskatchewan. The variety *interior* prefers shallower water and stream banks, it is taller, flowers earlier and produces more grains than variety *palustris*. There are no records of seed sources for lakes in Saskatchewan. Growers invariably obtained seed from any available source with little thought given to selecting seed from adjacent lakes or from lakes with similar site conditions. Because wild rice is cross pollinated, each lake could comprise a very large gene pool of intermixed populations and intervarietal hybrids. Preliminary studies by Good et al. (unpublished) have shown that there is discernible genetic variation in Saskatchewan wild rice as measured by gel electrophoresis. They found that while a number of genotypes are common to many sites, at some locations very distinctive populations are present.

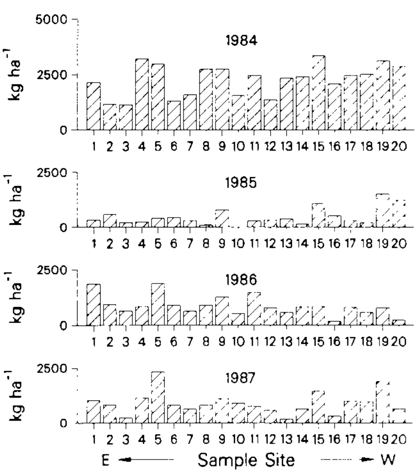

Fig. 13. Annual variation in potential yield of wild rice for 20 sites across northern Saskatchewan.

Results of the growth tank experiments suggest that much of the variability noted in the field reflects the highly plastic response of the plants to growing conditions. Water depth, in particular, elicits a significant response on plant morphology: in deeper water stem length increases and the number of tillers is reduced. It is doubtful if the industry has been established for sufficient time for geographic differences to have been developed in response to regional selection pressures. The continued exchange of seed across the province will further obscure such trends. But as each district becomes more autonomous in its seeding programmes, local patterns should become established. Counts and Lee (1987) reported on patterns of variation in Ontario wild rice stands which appear to be related to climatic gradients. In Saskatchewan an increasingly unfavorable growing season can be discerned as one progresses from southwest to northeast across the province (Weichel 1985). The length of the frost-free period can be as much as 20 d shorter in the northern part of the wild rice-growing district resulting in a reduction of accumulated heat by as much as 300 growing degree days (base 5°). Growers in the east usually commence harvesting a week or so earlier than their western counterparts. The date at which 80% of the stems in the growth tanks came into flower is shown in Fig. 14. These data offer some supporting

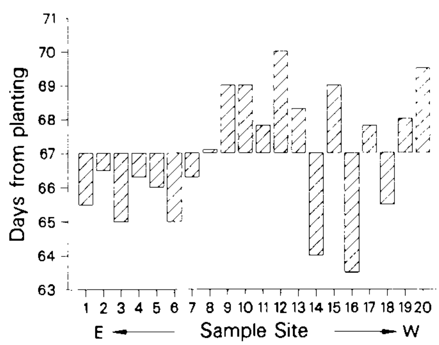

Fig. 14. Variation in time for 80% of the stems to come into flower for plants grown from seed in tanks under uniform conditions.

evidence of genetic diversity within the population.

CONCLUSION

The geographic range of wild rice covers some 200 000 km^2 in northern Saskatchewan. Within this area there is considerable variation in climate, lake physiography, sediment and water chemistry (Weichel 1985). Lake accessibility might also restrict development. At present only approximately 5500 ha are producing wild rice and a fivefold expansion of industry has been predicted. In 1987, an area of muskeg was artificially flooded and seeded to wild rice. Production at this site is promising. If successful, extensive areas of new habitat may become available in which optimum water depths can be maintained. Most growers consider fluctuating water levels to be the principal cause of annual variations in production, and without a reliable supply of wild rice market opportunities are limited.

In this paper we have demonstrated that the wild rice population in Saskatchewan exhibits considerable variation in various morphological and phenological traits. Some of this variation is correlated to environmental conditions. Changes in growing conditions from year to year have a noticeable effect on plant performance. However, the results of the growth tank trials indicate that inherent genetic variation might control some of the intersite variability noted in the population. This provides the basis of breeding programs to select superior strains for the great variety of potential sites which exist in northern Saskatchewan.

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