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Vernalization plays a fundamental role in the adaptation of winter cereals to their growing environment by controlling their growth habit, thereby allowing them to escape cold injury. Because of the climatic conditions of the region, dry summers and wet winters, growers sometimes cannot plant all of their winter wheat in fall and raise questions about late planting of winter varieties. This study was conducted to gain a better understanding of the vernalization requirement of winter wheat varieties currently grown in the Pacific Northwest. A greenhouse procedure was also developed to be used in determining the vernalization requirement of new wheat varieties.

Twenty varieties, representing a wide range of vernalization response, were tested in the field during the 1991 through 1993 cropping seasons. Varieties were sown from early October through late March at differing time intervals. Accumulated growing degree days from planting were calculated by averaging daily temperature.

CERES wheat model formulas were used to calculate vernalization days. Heading, plant height, number of heads/m row and yield parameters were measured. Relative vernalization index was created for grouping the varieties according to their vernalization response.

Results of the field studies indicated that Dusty, Eltan, Flora, Hill 81, Kmor and Yamhill have a strong vernalization requirement. They showed rapid deterioration in all parameters as a result of reduction in vernalization days due to late sowing. Weak vernalization requirement varieties - Hoff, Oveson, Treasure and Whitman were less affected by reduction in vernalization days. Other varieties were intermediate in response.

Similar variety response were observed during green house experiments where the same varieties were chilled for 5, 7, 10, 14, 21, 28 and 35 days at 6 - 7 °C constant temperature. Hoff, Hyak, Oveson, Treasure and Whitman headed after only 7 days of cold treatment. The varieties Eltan, Flora, Hill 81, Kmor, Rodhe and Yamhill showed marked response to vernalization. Heading of those varieties only occurred after four or five weeks of cold treatment.

This study suggests that (1) varieties vary widely in vernalization response (2) varieties can be grouped in strong, medium and weak vernalization response classes (3) strong vernalization requirement varieties can be planted until late February, but yield would be low, less than 50 % (4) weak vernalization requirement varieties can be planted until late March, but yield would be low, less than 50 % (5) a green house procedure can be used for the assessment of the vernalization requirement of new wheat varieties.

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CHAPTER 1

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important and widely adapted crops in the world. It is grown in low rainfall, high rainfall and irrigated areas. It is grown in mountain meadows, deserts, and flood plains. It is planted and harvested by hand and with some of the largest scale agricultural machinery in use by man. It can be grown as a winter or spring crop. Extensive breeding efforts and knowledge of how wheat grows have made it so widely adapted.

Wheat is also a major crop in the United States and Oregon. In 1993, cultivated United States acreage was 72 million acres with a production of 2.4 billion bushels (Miles, 1994). In Oregon, after grass seed, wheat is the most widely grown crop (Miles, 1994). It is cultivated in all parts of the state, but more than 90 percent of production comes from three areas - the Columbia Basin, the Willamette Valley and northeast Oregon. Wheat was grown on 950 thousand acres in Oregon in 1993 with a production of 65 million bushels. Oregon has one of the highest yield levels in the nation (Wheat Facts, 1994).

According to the Oregon State University Extension service reports, the average yield of the winter wheat grown in Oregon has increased from 28 to 60 bushels, about 120 percent, over past 30 years. One of the most important factors contributing to the increased in yield has been the development and use of improved varieties. Semidwarf varieties, improved resistance to disease, and greater stress tolerance have contributed to higher yield. A better understanding of how varieties will perform under specific conditions may lead to further yield increases.

One of the areas where we need better information is in determining the vernalization requirement of varieties. Vernalization, a necessary exposure of seeds or seedlings to low temperature, plays a key role in the adaptation of winter cereals to their growing environment by delaying the transition from the vegetative to reproductive phase of growth. It is a physiological process that controls flowering protecting winter cereals form freezing injury and disease by synchronizing growth with favorable climatic conditions.

Oregon has a Mediterranean type climate. Weather is moderated by the ocean and is largely influenced by the distance from the ocean. Winters are mild and most precipitation occurs during the winter and spring (Table 4.1.1). There is a narrow climatic variation in major wheat producing regions of Oregon. The Willamette Valley is relatively mild throughout the year with cool, wet winters and warm, dry summers. Extreme temperatures in the Valley are rare. Temperatures below freezing occur only about once every 25 years. The Columbia Basin is drier than the Valley but still is mild in temperature. Temperatures below freezing have also been rare over the past 30 years. Northeast Oregon is also relatively dry with annual precipitation below 20 inches. Winters are colder than in other major wheat producing areas in Oregon, but still mild in comparison to areas further inland. Because of these mild conditions, fall planted cereal varieties do not need to have a high level of winter hardiness in order to survive. In fact, in most years, there is an advantage to varieties that can "break" winter dormancy early and capitalize on favorable growing conditions in late winter and early spring (Karow, personal communication). Stephens, the most widely grown soft white wheat in Oregon for the past decade (Oregon Agricultural Statistical Service, 1984-94), has only a fair level of winter hardiness (Karow, et al., 1994) but has been successfully grown across a wide range of environments (Oregon Agricultural Statical Service Staff, 1984-94).

Because of the dry summers and wet winters of the region, growers sometimes cannot plant all of their winter wheat in the fall. Fields sometimes become too wet to sow. Growers then have to determine which type of wheat they will plant, winter or spring. Grower experience in Oregon has shown that many Oregon-developed wheats have a low vernalization requirement and can be successfully planted in late-winter and early spring. March seedings of Stephens have been successful in some years. There are often warm, dry periods during January and February that allow fields to be worked and planted. Winter wheat seed is often more readily available and in some years less expensive then spring seed due to the nearly 9-to-1 ratio of winter versus spring wheat grown in the state (Oregon Agricultural Statistics Service Staff, 1994). Growers are anxious for specific information to use in making winter versus spring wheat seeding decisions; however, limited studies have been conducted to find out the vernalization requirement of the winter wheat varieties usually grown in the Pacific Northwest. A better understanding of vernalization requirement will allow reasonable latest sowing date recommendations to be made.

The objectives of this research were:

1 - To determine the relative vernalization requirement of winter wheat cultivars commonly grown in Pacific Northwest.

2 - To establish a greenhouse procedure for identifying the vernalization response of new Pacific Northwest cultivars.

3 - To develop latest planting date recommendations for winter wheat cultivars of the region.

CHAPTER 2

LITERATURE REVIEW

Level of winter hardiness and vernalization requirement are often correlated. Both are related to exposure to low temperature. Cold hardiness and days to head were significantly correlated during the development of winter wheat (Fowler and Carles, 1979). Winter hardy cultivars tend to have a strong vernalization requirement while less hardy cultivars have a lower vernalization requirement, but it is well documented that these two characteristics are not genetically linked. Cahalan and Law (1979) investigated the relationship between vernalization requirement and cold resistance to temperatures of - 6 °C and - 12 °C within a group of wheat genotypes and found no statistically significant relationship between them. They also did not find any evidence of genetic linkage between cold hardiness and vernalization requirement. There are cultivars which have a weak vernalization requirement, but have excellent winter hardiness. Celia triticale, for example, behaves like a spring cultivar, but has good cold hardiness potential.

Vernalization response is a physiological process which widely occurs in temperate plant species (Flood and Halloran, 1986). Delay of floral initiation is the most prominent feature of vernalization which permits plants to successfully pass through adverse climatic conditions. Low temperature induction is often a prerequisite for flower formation in long-day plants capable of responding to photoperiod (Ketellapper, 1966).

2.1 Adaptive Advantages of Vernalization

Wheat (*Triticum aestivum L.*) has been the main source of food for human beings since early ages. It also occupies the largest cultivated area among crop plants. The adaptability to wide range of soil and climatic conditions plays an important role in extensive use. Variation in vernalization response is the main part of this adaptability (Gotoh, 1983). Vernalization helps plants fit environmental niches by controlling their growth habit. Basically, vernalization reduces the risk of the damaging effects of winter freezing temperatures on the differentiated head by prolonging the vegetative developmental phase. Its action in delaying the initiation of reproductive development can ensure closer-to-optimum fitness (Flood and Halloran, 1986).

Vernalization may play a fundamental role for the adaptation of wheat cultivars to Southeastern U.S. environments. Frost may injure flowers and generate sterility if heading occurs too early (Qualset and Puri, 1975). On the other hand, heat, humidity, and disease effects may spoil grain filling if heading happens too late (Gardner and Barnett, 1990).

In the temperate climate vernalization is generally required for better adaptation of winter cereals and it is also a basic requirement for breeding and selection of new cultivars (Gardner et al., 1993). Vernalization requirement of winter wheat has been extensively evaluated by Razumov and his co-workers in USSR. They identify vernalization as an adaptive process which deters the transition of reproductive phase that decreases the risk of winter injury in temperate zones (Krekule, 1987).

Adaptive advantages of vernalization has been controversial for spring wheat cultivars. Halloran (1967) did not find any adaptive purpose of vernalization requirement in some spring wheat cultivars during the study. Similar results were observed by Gardner et al. (1993), where they found that spring cultivars can be grown on wide range of climatic conditions and do not require vernalization. Kihara (1958) stated that vernalization response in spring may represent a phylogenetically older part of the what genome as ancestral forms of wheat are postulated to be winter type. In contrast, Jedel et al. (1986) reported that some spring cultivars do have a vernalization response and that their vernalization requirement should be examined prior to release.

2.2 History of Vernalization Research

Research on vernalization goes back to 1918, when German plant physiologist Klebs demonstrated that temperature and light are the decisive factors of the environment which control growth and development in plants. Earlier experiments on cold treatment had been made, but Klebs is regarded as the initiation of the modern extension of this branch of plant physiology (Murneek and Whyte, 1948).

Another earlier researcher in the field of vernalization was Gassner who found that the elongation and flowering of winter cereals depends on their passing through a period of low temperature. But he was primarily concerned about the low temperature response only in the early stage of plant growth, just after germination (Murneek and Whyte, 1948).

The greatest advancement in vernalization research was done by Lysenko and his co workers in Russia. Though there are some controversies about their hypotheses, many of their findings are still reliable. Many studies on vernalization in wheat were inspired by Lysenko's theory of phasic development, as winter cereals fit its postulates sensu stricto. Although this theory has failed to achieve general validity, it did help provide new information on the physiology and ecology of vernalization (Krekule,1987).

Purvis and Gregory (1937) were also among the early researchers who conducted a series of experiments on different aspects of cereal crop vernalization. Their famous works were on; localization of vernalization, reversal of vernalization (devernalization) by high temperature, vernalization of excised embryos, and comparative studies on relationship between vernalization and short/long day.

2.3 Vernalization in Wheat

Wheat varieties are distingished by outstanding variability in vernalization response. The growing environment and geographical origin of the cultivars influence on sensitivity to vernalization of wheat (Hunt, 1979; Hoogendoorn, 1985).

Many spring wheat cultivars also have weak vernalization requirement (Halse and Weir, 1970; Halloran, 1975). In a study, Levy and Peterson (1972) found that all 13 spring cultivars headed earlier when they were vernalized. Gries et al. (1956) reported that spring wheat are also sensitive to vernalization. Jedel et al. (1986) noticed that the duration of the cold treatment, the age of the plant during cold treatment and the temperature conditions for stabilization were the main factors which influenced the expression of vernalization response in spring wheat. They also suggest that vernalization requirement of spring wheat cultivarsbe examimend in controlled environment prior to release.

Vernalization response in wheat varies among genotypes (Flood and Halloran 1986; Martinic, 1973; Jedel et al., 1986). Sutton and Bacon (1988) investigated fifty wheat cultivars and lines grown in Arkansas for their vernalization response under controlled environment - 1 to 6 weeks of cold treatment - and found significant differences in heading among cultivars due to the cold treatments. Halse and Weir (1970) also found similar results when they evaluated sixteen Australian wheat cultivars by imbibed seed vernalization. They reported a wide range of vernalization response among cultivars. Gardner et al. (1993) reported that spring-type wheat cultivars require no vernalization and can be grown over a wide range of sowing dates in Southern USA, while winter-type cultivars require vernalization and should be planted in early winter at lower latitudes. Similar results were obtained by King and Bacon (1991) when they evaluated 25 winter and five spring oat cultivars by vernalizing germinated seeds at 5 °C and 12-h photoperiod for 0, 12, 24, and 48 d. They found that all winter oat genotypes responded to cold temperature with a decrease in days to heading, where as none of spring genotypes responded to vernalization.

Wheat cultivars can be classified into groups, according to their vernalization response. Gardner and Barnett (1990) studied five soft red winter wheat cultivars, two spring wheat cultivars, and one triticale with various duration of natural winter and refrigerator cold exposure. They found three types of vernalization response: (i) cold obligate, winter-hardy types (qualitative) : requiring 6 to 8 wk of cold for heading (ii) cold stimulated, mild-winter types (quantitative) : heading earlier then the control with 2 to 4 wk of cold exposure and (iii) cold neutral, spring types : not stimulated by cold exposure.

Vernalization can be saturated at any stage of plant life from imbibed seed to kernel formation. Purvis and Gregory (1937) found that the low temperature effect associated with vernalization can be obtained on ripening seeds while they are still attached to the mother plant. Vernalization can be satisfied during seed germination (Purvis, 1934). The vernalization requirement may be fulfilled in wheat and other cereals while the kernels are still developing in the ear (Krekule, 1986).

2.4 Vernaliation and Photoperiodism

It has long been known that photoperiod and vernalization temperatures are important environmental factors controlling ear emergence in wheat. There are studies which have shown that the two process interact physiologically to control flowering in wheat (Masle et al., 1989). In wheat, vernalization and photoperiodism are controlled by different genes. Hoogendoorn (1985) found genetic differences in sensitivity to photoperiod and vernalization in wheat controlled by a relatively small number of loci. There has been speculations that vernalization and photoperiodism are physiologically interactive, though the genetic control of these two processes appears to be largely independent (Flood and Halloran, 1986). Terzioglu (1988) studied the photoperiod and vernalization of six Turkish wheat cultivars by chilling imbibed seeds at 2 ± 1 °C for 0, 15, 45 days. He reported that long days hastened development of flower when the vernalization requirement was met, while in the absence of vernalization, the apex remained vegetative. After vernalization, long days also reduced the time to anthesis. Short days after vernalization accelerated development in all cultivars to a greater or lesser extent. Levy and Peterson (1972) indicated that increasing the photoperiod from 9 to 17 h for vernalized spring and winter wheat cultivars significantly decreased the days to heading. Joubert (1985) tested 24 south African wheat cultivars under control conditions and found different cold and day-length reactions.

Whether short-day replaces the vernalization requirement or enhances its effects in wheat has also been the aim of several studies. Terzioglu (1988) reported that development in wheat cultivars could occur in the absence of chilling as a result of short day exposure of wheat seedlings. Gott et al., (1955) found that short-day exposure of seedlings caused more rapid floral initiation in unvernalized rye plants than normal days. Evans (1987) found that short days followed by long ones resulted in the earliest anthesis of any treatment. He also found that treatment with low temperatures for 8 weeks and short days showed similar response to day length after inflorescence initiation. He concluded that short day induction can replace low temperature vernalization in these winter wheats. Under field conditions, if short day applied during vernalization it enhances development in winter wheat. Short day applied after vernalization prolonged development (Krekule, 1961).

There are also studies which indicated that short-days do not affect vernalization response and that there is no interaction between vernalization and photoperiod. Hartmann (1968) suggested that there was no response of winter wheat to long days and short days when they were vernalized for optimal times. Similar findings were observed by Flood and Halloran (1986) when they found no interaction between photoperiod and vernalization. Gott (1961) and Krekule (1964) also produced evidence that short-day vernalization does not exist in wheat.

2.5 Vernalization and Winter hardiness

The ability to survive cold is another important physiological response in wheat. Cold hardening is a physiological adaptation to cold exposure while vernalization involves changes leading to the onset of reproductive growth. Fowler and Carles (1979) observed significant developmental correlations between cold hardiness and days to heading in wheat. Though winter hardiness and vernalization requirement of wheat are often correlated, no genetic linkage yet has been found between them. Cahalan and Law (1979) investigated the relationship between vernalization requirement and cold resistance to temperatures of - 6 °C and - 12 °C within a group of winter wheat genotypes and found no statistically significant relationship between them. They also maintained that, though chromosomes in homoeologous Group 5 were implicated in the control of both vernalization and cold hardiness there is no evidence that the characteristics are determined by same genes. It is generally postulated that winter hardy cultivars tend to have a strong vernalization requirement, while less hardy cultivars have a lower vernalization, but recent research has shown that spring cultivars may also be winter hardy. In general, however, it appears that winter wheats are more tolerant of cold and frost than spring cultivars which may be a consequence of vernalization (Cahalan and Law, 1979). Brule-Babel and Fowler (1988) investigated the relationship between vernalization and winter hardiness using parents differing widely in vernalization response and reported that lack of vernalization did not hinder the development of cold hardiness and that some spring cultivars also had cold hardiness.

2.6 Effect of Temperature on Vernalization

Temperature is the environmental factor which drives vernalization in wheat. Establishment of the optimal temperature range for vernalization has always been of great concern to many researchers. For winter wheat cultivars, either the satisfactory vernalization saturation duration or the exact temperature limits for vernalization are understood (Krekule, 1987). "Because low temperature influences both rate of growth and rate of development, the most effective vernalizing temperature for early induction of cereals is not yet resolved. It is generally considered, however, that the weaker the vernalization response, the higher the vernalizing temperature can be for maximum rate of vernalization" (Flood and Halloran, 1986).

However, it is generally excepted that temperature between 2 °C and 10 °C is effective for vernalization in wheat. Purvis (1948) reported that in Petkus rye vernalization occurred up to 10 °C, but the most effective temperature range was 0 °C to 7 °C. McKinney and Sando (1935) found that 2.8 to 6.6 °C hastened initiation of flowering in winter wheat more than did -1.1 to 1.7 °C. Ahrens and Loomis (1963) vernalized soaked winter wheat seeds at - 2 °C, 1 °C, and 3 °C for periods up to 19 weeks and planted them in a greenhouse at 24 °C, with 18-hour days. They found that vernalization at 1 °C for a period of 6 weeks resulted in the most rapid heading, while exposure to - 2 °C had no effect on flowering of these plants. The range of optimum vernalization temperature mainly depends on variety response. Vavilov (1951) conducted a series of experiments on different wheat cultivars in order to find the most effective range and duration of temperature for vernalization requirement. He concluded the following ranges :

Soft-grained spring cultivars	10 - 12 °C	for	5 to 10 days
Hard-grained spring cultivars	2 - 5 °C	for	10 to 14 days
Semi-winter cultivars	5 - 10 °C	for	25 to 30 days
Winter cultivars	0 - 5 °C	for	35 to 60 days

The time at the low temperature required for the saturation of vernalization in wheat depends on genotype and the temperature during the cold treatment. That time is genetically controlled; thus it varies among cultivars. A comprehensive study to find out the effective temperature limits of vernalization for winter wheat was carried out by Trione and Metzger (1970). They found that the effectiveness of the cold treatment in wheat seedlings was maximum at 7 °C but effectiveness was much less when temperature was raised to 9 °C or lowered to 3 °C .

Reversal of vernalization (devernalization) was also observed in vernalized plants when they were exposed to relatively high temperature after cold treatment. Devernalization may occur if the seedlings are transferred in a warm environment immediately after cold treatment (Lang, 1965). In nature, where environmental conditions are not controlled, the actual physiological response is probably a summation of the individual fast, slow, and devernalization reactions that may occur (Trione and Metzger, 1970). Purvis and Gregory (1945) first observed devernalization in winter rye when plants were exposed to 25 °C, 30 °C, and 40 °C immediately after cold treatment of 1°C for 45 days. Similar results were obtained by Chujo (1970) for wheat. He vernalized the winter wheat cultivar at 1, 4, 8, 11, and 15 °C for 40 days. Immediately after cold treatment, he exposed the plants to relatively high temperatures of 12 °C, 18 °C, and 24 °C for 10 days. He reported significant reversal effect of vernalization by exposure to the 18 °C and 24 °C.

2.7 Genetic Control of Vernalization Response

Genetic control of vernalization response in wheat has also been explored by several workers. These genetic studies have helped us understand vernalization in wheat (Krekule, 1987). It is now better known that qualitative and quantitative vernalization responses in wheat are controlled by many genes. The apparent continuous variation in the time of ear emergence in wheat from spring to strong winter habit suggests the action of many genes rather than a small number of genes for vernalization response.

Klaimi and Qualset (1974) reported that, apart from major genes, some minor genes and multiple alleles were also involved in controlling vernalization response. Flood and Halloran (1986) found some evidence for multiple allelism of genes for vernalization response in wheat. Cahalan and Law (1979) stated that chromosomes 5A and 5D have genes which are responsible for controlling the vernalization response in wheat. Two genes, *Vrn* 1 and *Vrn* 3, have been located on chromosomes 5A and 5D, respectively. Another gene, designated *Vrn* 5, has been assigned to chromosome 7B (Law, 1966). Flood and Halloran (1986) argue that the combination of *Vrn* 1, *Vrn* 2 and *Vrn* 3 genes confers winter habit, but the presence of even one dominant allele gives spring habit.

CHAPTER 3

MATERIAL AND METHODS

3.1 Field Experiment

Trials were conducted on the Hyslop Field Experimental Station of the Department of Crop and Soil Science, Oregon State University, Corvallis, OR, during the 1991 through 1993 crop seasons. During the 1990-91 growing season, 20 winter wheat cultivars were tested. In 1991-92 and 192-93, 24 and 27 cultivars were evaluated, respectively. A set of twenty cultivars common to all trials was selected for detailed statistical study - - 16 soft white winter and club cultivars, one hard red winter, one soft spring wheat and two winter triticale. These cultivars were selected because they are adapted to Pacific Northwest but they also represent a wide range of vernalization requirements and differences in winter hardiness. Cultivars and basic information about them are presented in Table 3.1.1.

In 1990-91, an attempt was made to seed every other week in October through mid-January, then weekly until late March. As fall seedings were seen to be similar in 1990-91, monthly seedings were used in October, November and December 1991-92 and 1992-93 with weekly seeding from mid-January to late March. January weather interfered with some planting. Sowing dates for each year are shown in Table 3.1.2. Each cultivar was sown in a single 2.4 m row on each planting date. Spacing between rows was 60 cm. Sowing was done manually. A seeding depth of 2.5 - 3.8 cm and seeding rate of 66 seeds/ m of row were used.

Table 3.1.1. Agronomic characteristics of cultivars.

Variety	Released Year	Released State[1]	Winter-hardiness[2]	Maturity	Height[3]	Lodging[4] resistance
Varieties of the study						
Daws	1976	WA	8	midseason	SD-M	R
Dusty	1985	WA	7	late	SD-M	MR
Eltan	1990	WA	9	mid-late	SD-M	MS
Flora	1986	OR	9	early-mid	SD-SM	R
Hill 81	1981	OR	5	midseason	SD-MT	R
Hyak	1988	WA	8	early-mid	SD-MT	MR
Kmor	1990	WA	7	mid-late	SD-MT	MR
Madsen	1988	WA	5	midseason	SD-MT	R
Malcolm	1987	OR	4	early-mid	SD-M	R
Gene	1991	OR	3	early	SD-SM	R
Hoff	1991	OR	4	early-mid	SD-MT	MR
Rohde	1992	OR	6	early-mid	SD-MT	R
W 301	1992	OR	8	early-mid	SD-M	R
MacVicar	1992	OR	5	midseason	SD-MT	R
Oveson	1987	OR	4	mid-late	SD-MT	MR
Stephens	1977	OR	4	early-mid	SD-M	R
Treasure	1984	WA	spring	midseason	SD-M	R
Rod	1992	WA	5	mid-late	SD-M	MR
Whitman	1988	WA	3	midseason	MT	MR
Yamhill	1969	OR	8	midseason	MT-T	R
Additional cultivars in 1991-92						
Lewjain	1982	WA	6	late	SD-M	MR
Owens	1981	ID	spring	early	M	MR
Rely	1990	WA	5	midseason	SD-M	MR
Wadual	1988	WA	spring	early	M	R
Additional cultivars in 1992-93						
Juan		CA	spring	mid-late	T	R
Penawawa	1985	WA	spring	midseason	M	R
Celia	1993	OR	9	early-mid	SD-SM	R

Source: Russell S. Karow, Special Report 775, Oregon State University Extension Service
[1]WA = Washington, OR = Oregon, CA = California, ID = Idaho
[2]Scale of 1 to 10, poor to excellent
[3]SD = semidwarf, SM, short-medium, M = medium, MT = medium-tall, T = tall
[4]R = resistant, MR = moderately resistant, MS = moderately susceptible

Replication of treatment plot was not used in the study. Plots were sown on ground that had been followed the previous year. Neither fall fertilizer nor herbicides were used. Plots were hand weeded. Soil type at the site is a Woodburn silt loam (Fine-silty, mixed, mesic, Aqualtic Argixerolls). This soil is deep and moderately well drained and also has high mineralization capacity (Soil Survey of Linn county area). Plots were topdressed with 56 N kg/ha as urea when they reached the tillering stage.

Table 3.1.2. Sowing dates of wheat cultivars for three consecutive years.

	Cropping Season		
No	1990-91	1991-92	1992-93
1	04 October	18 October	13 October
2	17 October	15 November	13 November
3	01 November	20 December	11 December
4	15 November	15 January	21 January
5	28 November	22 January	4 February
6	13 December	29 January	11 February
7	26 December	05 February	18 February
8	11 January	12 February	4 March
9	24 January	19 February	11 March
10	07 February	26 February	19 March
11	22 February	04 March	25 March
12	28 February	11 March	8 April
13	07 March	18 March	
14	14 March	25 March	
15	21 March		
16	28 March		

Multiple applications of Tilt (propiconazal) were applied at 0.29 l/ha in an attempt to control leaf diseases (*Puccinia striiformis, Puccinia recondita, Septoria tritici*).

No insecticide was used. Aphids and other insects were not a problem.

Measurements of the following agronomic characteristics were taken from all plots:

1. Heading date was recorded when 50 % of the spikes were emerged from the boot.

2. At maturity, plant height was measured randomly at two locations in each plot. Height was measured from ground level to the apex of grain heads. If no heads were present, height was recorded as zero.

3. At maturity, number of heads per 60 cm were counted.

4. Five spikes were taken randomly from each treatment for ear data. Heads were individually hand threshed. Head data includes number of spikelets, number of seeds per head and seed weight.

5. Grain yield was calculated on a grams per meter of row basis. In 1990-91, 30 cm of row was harvested from each treatment and threshed in a Vogel Thresher to determine yields. In subsequent years, row lengths were measured and entire rows were combined with a Wintersteiger plot combine.

3.2 Vernalization Day Calculations

Vernalization days (VD) are used as the unit against which cultivar performance is measured. Use of VD allowed standardization of planting date data over years. VD are an estimate of accumulated cold. To calculate VD, an average daily temperature is calculated ($[T_{max} + T_{min}]/2$). Then a vernalization effectiveness is determined using some function. In this study, CERES wheat model functions

(Ritchie, J.T, D.C. Godwin, and S. Otter-Nacke. CERES- a simulation model of wheat growth and development. An unpublished, users guide. Personal communication, Dr Dale Mos, Oregon State University) were used to estimate VD for each planting date. VD were accumulated from each sowing date through May 30th of each harvest year, the last day in any year when VD were accumulated. If mean temperature was less than 0 ^{0}C or higher than 15^{0}C, a value of 0 was assigned. The following CERES vernalization effectiveness functions were used.

Equations	Temperature Range	
$Y1 = .432432 * X1$	0	1.85
$Y2 = .4082352 + .2117647 * X2$	1.85	2.7
$Y3 = .83 + .0515151 * X3$	2.7	3.3
$Y4 = 1.0388235 - .0117647 * X4$	3.3	6.7
$Y5 = 1.4548 - .074 * X5$	6.7	9.2
$Y6 = 2.0043103 - .1336206 * X6$	9.2	15

Where,

X = Average temperature (GDD) and Y= Vernalization Days (VD)

The functions are shown in graph form in figure 3.2.1.

3.3 Estimation of Growing Degree Days

Daily weather data for all three years was obtained to calculate the growing degree days (GDD) accumulated from sowing through heading for each treatment.

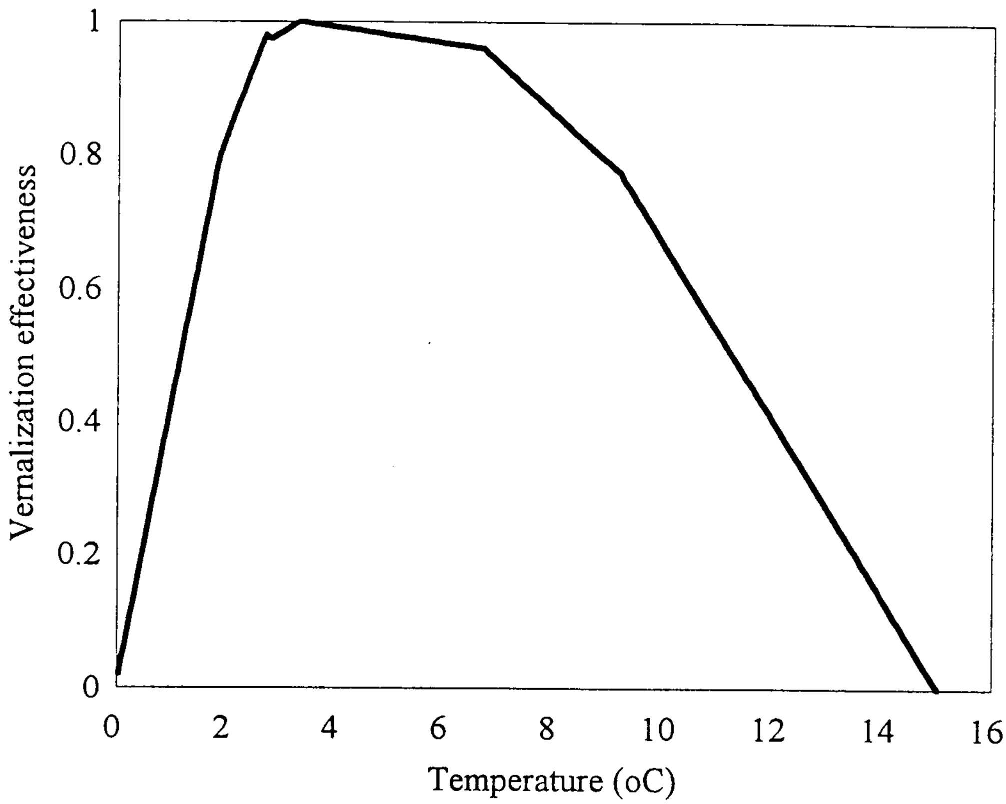

Figure 3.2.1 Relationship between vernalization effectiveness and temperature by using CERES wheat model functions.

GDD were calculated by using following formula:

$$GDD = [(T_{max} + T_{min})/2] - T_x$$

where,

T_{max} is maximum air temperature, T_{min} is minimum air temperature and T_x is a base temperature. For wheat 0 ^{0}C is used as base temperature. When the mean daily vernalization temperature was less than zero, a GDD value of zero was assigned.

3.4 Statistical Analyses

In most agronomic studies, replicated, small-scale plots or repeated sampling are used to obtain experimental data. With such data, routine analysis procedures can be used to determine the statistical significance of findings. Due to the difficulty of planting in mid-winter and the large number of cultivars tested, single-row, non-replicated plots were used in this study. In some instances, single plots were adversely affected by field conditions - mice, low areas with standing water, weeds, disease, etc. These conditions sometimes caused significant deviations in data, especially yield data, as evidenced by extremely high or low values in comparison to adjoining plots of the same cultivar. This variation caused problems as we tried to analyze data; however, there were similar trends in cultivar response over years.

Each trait for each cultivar is represented by a curve. Curves, using 1992 as the example, are shown in Figures 4.2.1 to 4.5.4. Observation showed, as expected, that curves were different for different cultivars. The point at which cultivars started to show change in performance, the rate of deterioration in cultivar performance and the point at which cultivars did not vernalize differed. We thought that we should be able to determine regression equations for each curve and use differences among equations as a means to group cultivars. An attempt was made to use PC Nonlin (version 4) to analyze data. We quickly discovered that most data did not fit standard functions and that different functions had to be used to get adequate fits for the same type of data (yield, heading date, etc.). We decided that regression analysis would not be a useful analysis procedure.

We next tried a Cate-Nelson analysis procedure (Cate and Nelson, 1971). Cate-Nelson analysis is routinely used to determine critical levels of plant nutrients. We reasoned that a vernalization threshold should be like a nutrient threshold - poor performance when inadequate, consistent performance when adequate, rapid change in performance from inadequate to adequate. Vernalization threshold levels were determined, but visual analysis of data curves showed that results were not right. Cate-Nelson is a least squares procedure. Each of our data sets contained a large number of very high or low (zero) data values. These extreme values apparently biased the analysis and resulted in skewed threshold numbers. Therefore, Cate-Nelson analysis was abandoned.

We finally decided to dissect the curves for each cultivar and to analyze for differences in curve characteristics. We could visually see that the curves differed in the point at which cultivar performance started to deteriorate. We called this point the "break point." The break point for each cultivar and each measured trait (height, heading, yield and heads per meter of row) was visually assessed for each year. Break points for each data set were evaluated using a standard randomized complete block analysis procedure (MSUSTAT Version 3.0, Montana State Univ., 1985) with years as replications. Before we attempt to publish this data in a referred journal, a linear-plus-plateau analysis procedure will be used to determine break points. This procedure has been used in critical level nutrient analyses (Cerrato and Blackmer, 1990). Time constraints in thesis writing and unfamiliarity with statistical analysis packages containing linear-plus-plateau procedures did not allow such analysis at this time.

Two other curve characteristics were analyzed - the end point and the rate of decay or slope. The end point was that planting date at which a cultivar no longer headed and heading date, height and yield data "vanished." Rate of decay was measured as the slope of the line from the break point and end point. All data points between these end points were used in a linear regression analysis to determine the slope value. Years were again used as replications and a randomized complete block analysis was performed on data for each measured characteristic.

Data for each measured parameter was also ranked. The ranking procedure used was to order data from lowest to highest and then to assign rank numbers starting with one. If values for two or more cultivars were the same, an identical rank number was used. A value termed relative vernalization index (RVI) was generated by multiplying slope by end point values for each year and averaging and analyzing over years. RVI values were also ranked as described above. A grand index value was generated by averaging and analyzing RVI rank values for each parameter.

3.5 Growth Chamber Experiment

As field determination of vernalization response is both difficult and time consuming, an attempt was made to develop a growth chamber/greenhouse procedure that could be used to classify cultivars as having a strong, moderate or weak vernalization requirement. A subgroup of the cultivars used in the field studies as used in the growth chamber/greenhouse tests.

The experiment was carried out in two phases. In the first phase, five cold treatments periods were used - 1, 2, 3, 4, 5 weeks. All cultivars were fully vernalized (headed) after only four weeks of cold treatment, therefore, treatments were narrowed to 5, 15, and 20 days in the second phase. In both phases, seeds were soaked for 24 h at room temperature prior to sowing so that seedling emergence would be as uniform as possible for all treatments. Seeds were sown in 45 cm by 35 cm pressed peat trays. Vermiculite was used as the sowing media. Twenty seeds of each cultivar were placed in 35 cm rows, nine rows per tray. Plants were placed in a cold chamber at 6 to 7 ^{0}C constant temperature for vernalization treatments (Trione and Metzger, 1970). Lights in the cold chamber were set at 8 h light and 16 h dark. Low light intensity was used to minimize plant growth during the vernalization period. A combination of fluorescent and incandescent bulbs was used.

After treatment, but before transferring to the open environment in the greenhouse, seedlings were placed in a 15 ^{0}C chamber for one week to reduce the risk of devernalization (Chourd, 1960). A complete household liquid fertilizer solution (10N - 15P - 10K) was applied weekly. Plants were watered when the surface of trays appeared dry. In the first study, after 8 weeks, ten plants from each treatment were dissected to determine if a head had formed. Plants remaining in the trays were allowed to mature. Vernalized plants headed in 10 to 14 weeks. In the second study, a headed or not headed determination was made after 14 weeks.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Weather Data

Low temperature is the driving factor behind vernalization. There were significant differences in temperature over the three years of this study. Weather data is shown in table 4.1.1. With an average temperature of 10.6 °C, 1991 was the coldest year as compared to 1992 (12.7 °C) and 1993 (10.9 °C). Differences in temperature are reflected in accumulated VD and GDD. Figure 4.1.1 shows differences in accumulated GDD for the three years of this study. Figure 4.1.2 shows accumulated VD. GDD accumulated most rapidly in 1992 while final VD accumulation was greatest in 1991.

4.2 Heading

Days from sowing to heading of each cultivar were converted to accumulated GDD to eliminate differences in temperature among years. All data were first graphed (GDD versus VD) and then break point, slope and end point were determined for each cultivar (Fig. 4.2.1- 4.5.4; only graphs for 1992 are shown as example). Break points for each cultivar were determined visually and slope of the line between break point and end point was determined. In these graphs, if a cultivar did not head, GDD is shown as 0 value.

Table 4.1.1. Weather summary of three consecutive years for the site.

Month	Ave. Air Temperature (C)			Total Precipitation (in)		
	1991	1992	1993	1991	1992	1993
January	3.8	6.3	1.5	2.7	4.5	4.1
February	8.9	8.4	3.8	3.2	4.5	2.2
March	7.0	10.3	9.5	5.9	1.0	4.9
April	9.3	12.1	10.1	3.5	4.1	6.8
May	11.3	15.7	14.9	3.9	0.0	4.5
June	14.1	18.5	15.7	1.5	1.2	2.1
July	19.2	20.1	17.0	0.4	1.2	0.8
August	19.7	20.3	19.6	0.7	0.4	0.3
September	18.8	16.6	17.0	0.2	0.6	0.1
October	2.7	12.8	13.4	2.6	3.5	1.1
November	8.5	7.5	4.2	5.1	5.0	1.0
December	5.1	3.8	4.3	4.4	7.4	7.2
Average	10.6	12.7	10.9	34.1	33.4	35.1

Source: George H. Taylor State Climatologist, Oregon Climatic Service 2.4

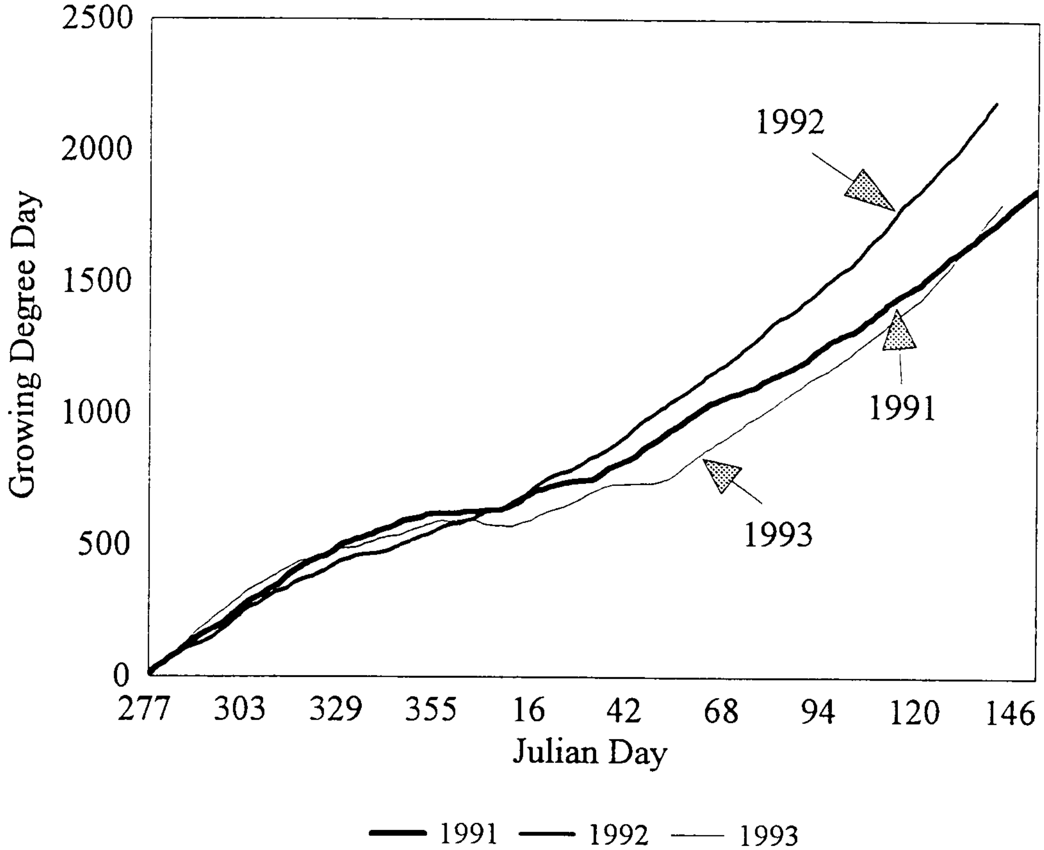

Figure 4.1.1 Accumulated growing degree days (GDD) from October 15 to May 30 for 1991, 1992 and 1993 growing seasons.

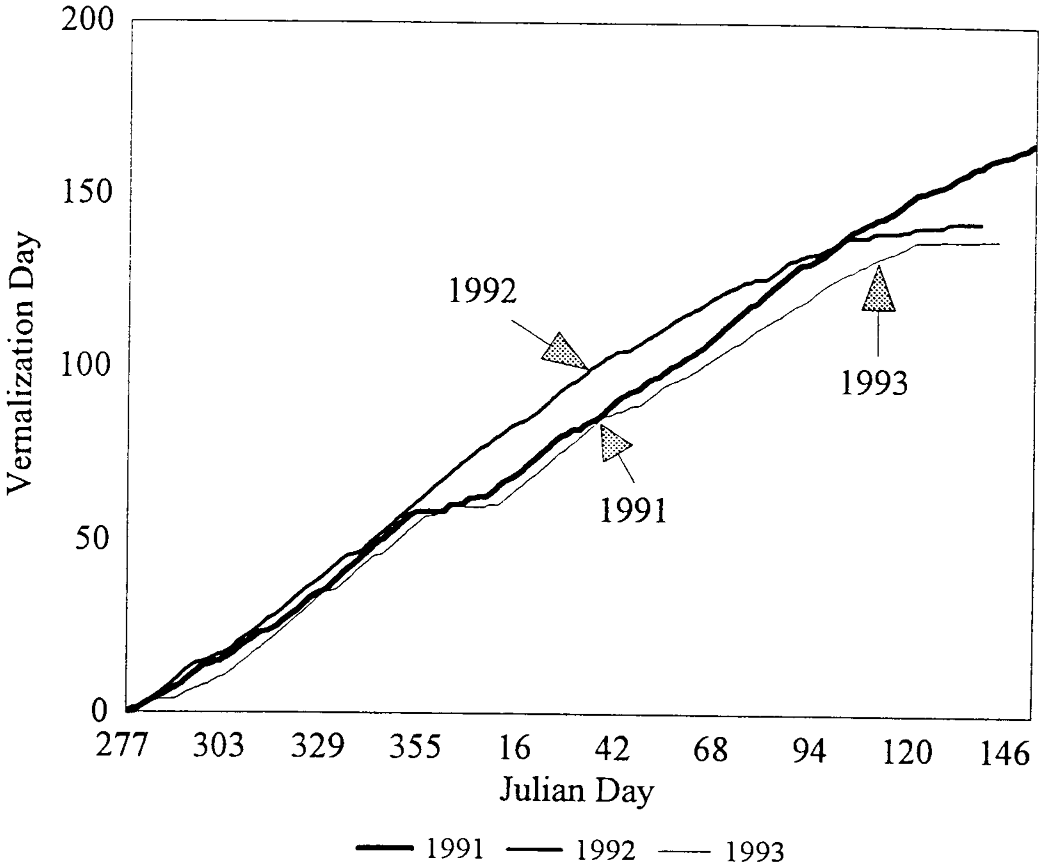

Figure 4.1.2 Accumulated vernalization days (VD) from October 15 to May 30 for 1991, 1992 and 1993 growing seasons.

Data were analyzed using a randomized complete block design with years as replications. Results of analysis are shown in Table 4.2.1 at the bottom of average columns.

All cultivars show a reduction in GDD required for heading in December versus October or November seedings. This is likely because cultivars accumulated heat units in the fall before they vernalized where later planted cultivars accumulated heat and vernalization units at the same time. Also, even if the vernalization requirement of fall and early winter seeded cultivars was met, they continued to accumulate GDD until a critical photoperiod level was reached in late winter. After this initial drop, the general trend among all cultivars, except Hoff, Treasure, Whitman and Oveson, was for the GDD required for heading to increase as seeding was delayed, i.e., it took more heat units to go from seed to headed plant (Fig. 4.2.3 to Fig. 4.2.4). For example, Hyak (Fig. 4.2.2) required only 1400 GDD to head when planted in December (@ 90 VD; see Table 2.2, Materials and Methods) whereas the March seedings (@ 30 VD) required over 2300 GDD to reach heading. These findings - delay of heading with delay of seedings - are consistent with those of many researchers (Mou, 1985; Levy and Peterson, 1972; Sutton and Bacon, 1988). Small change of GDD for heading was observed for Hoff, Treasure, Whitman and Oveson. In fact, GDD continued to drop. While other cultivars showed a similar trend in heading data delay with delayed seeding, it is obvious from the graphs that the rate of change (slope) from normal heading to delayed heading is quite different. Break point, slope and end point data are shown in Table 4.2.1.

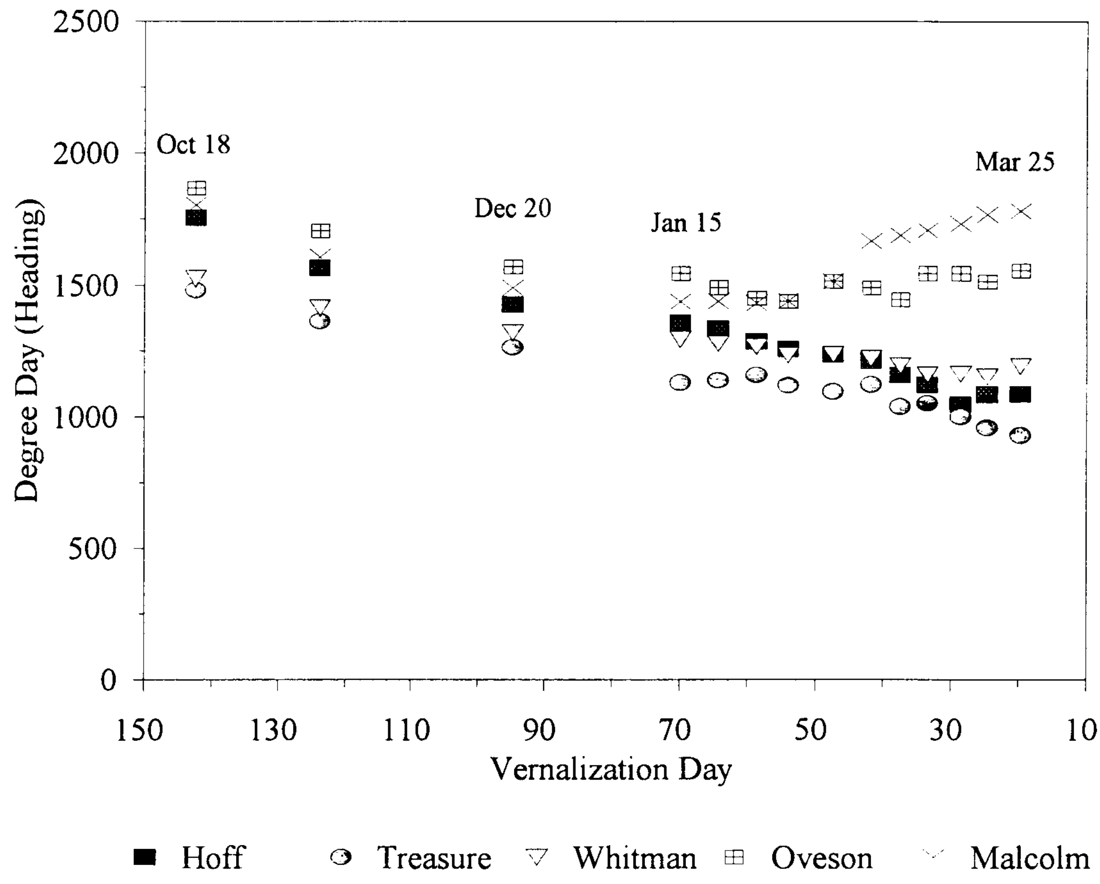

Figure 4.2.1 Degree days to heading of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

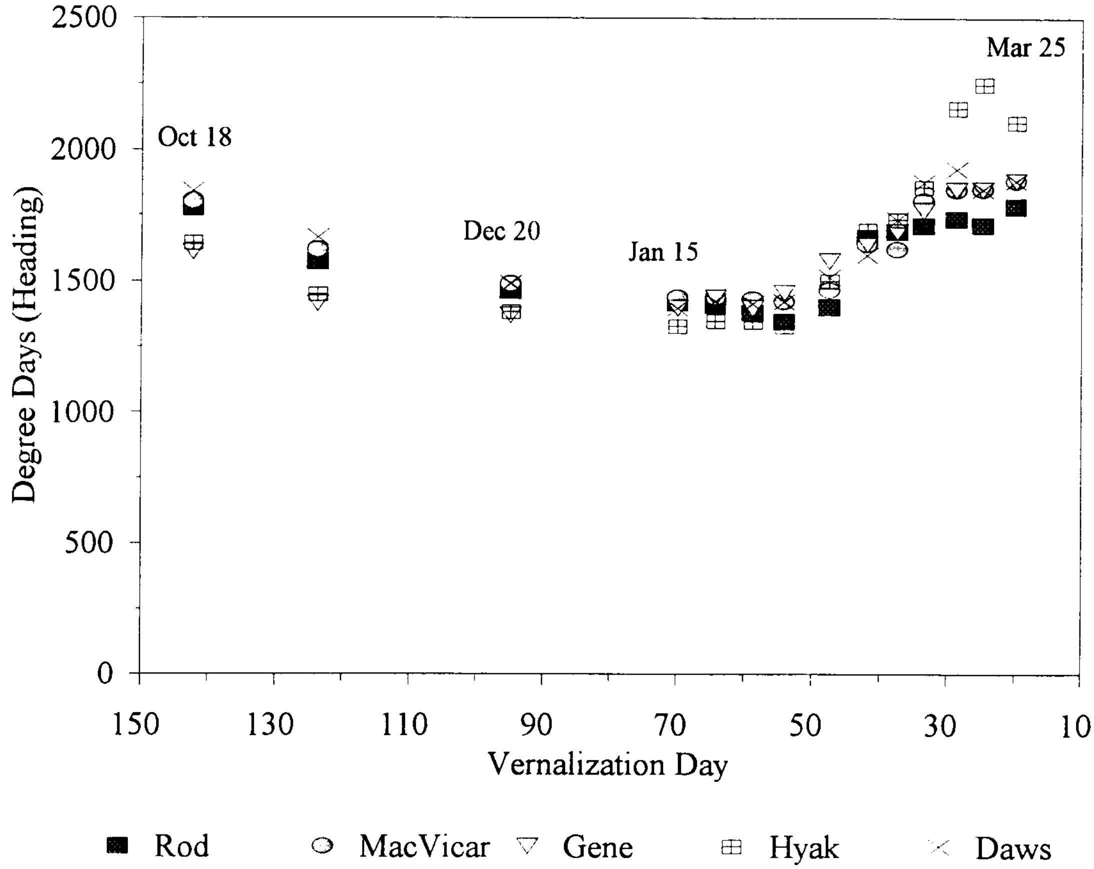

Figure 4.2.2 Degree days to heading of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

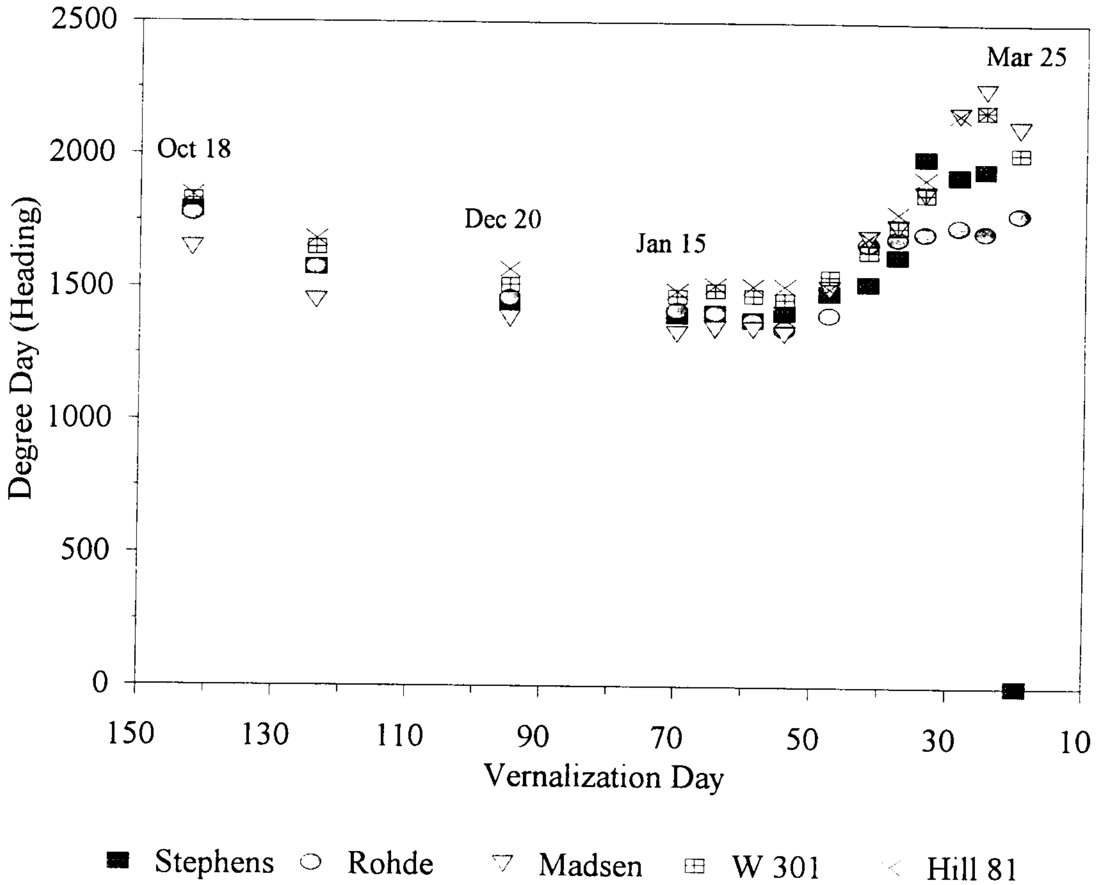

Figure 4.2.3 Degree days to heading of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

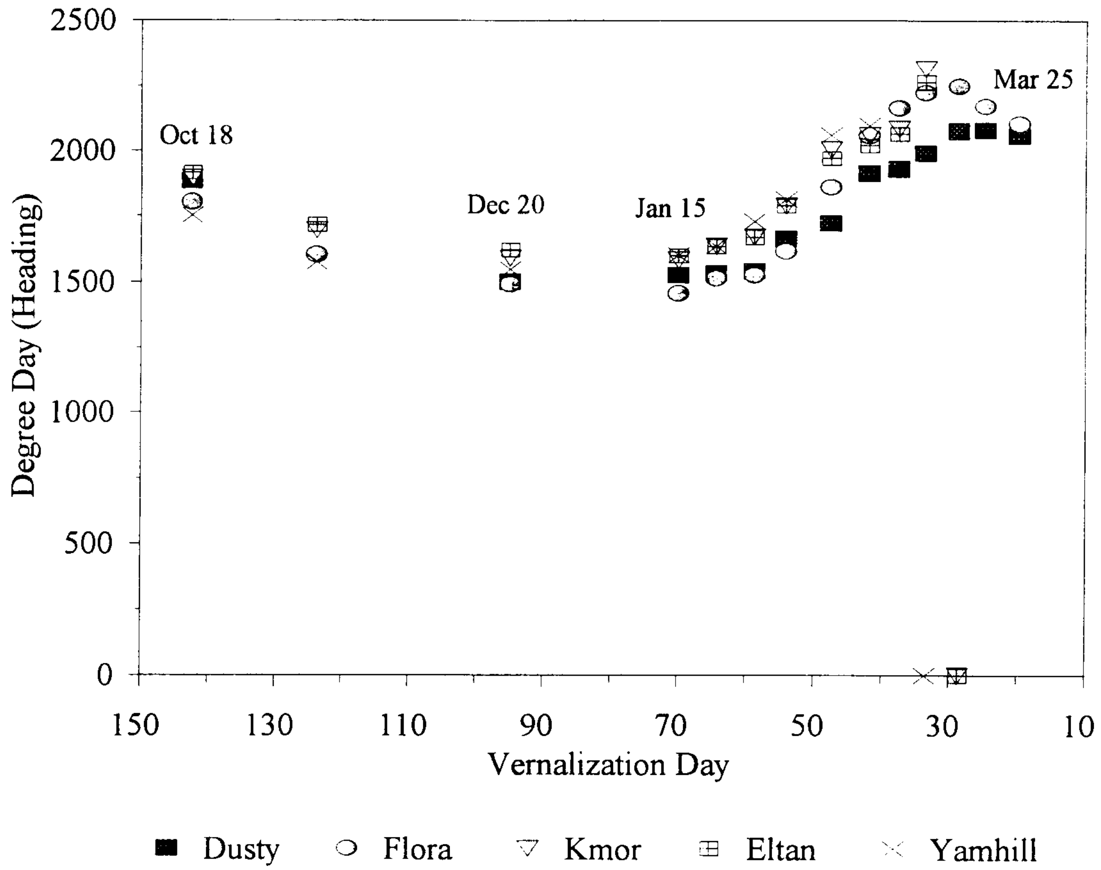

Figure 4.2.4 Degree days to heading of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

The average break point (the point at which cultivar performance started to show significant change) of all twenty cultivars over three years was 56 VD with a Protected Least Significant Difference (PLSD) of 9 at P = 0.05. There were few statistically significant differences among cultivars for break point. Only Flora, Eltan, Kmor and Yamhill, which are known to be obligate cultivars, had break point values different from those of the other cultivars. The small range of differences suggests that break point does not show good promise for ranking vernalization requirement of cultivars.

Differences among cultivars were observed in slope. Yamhill, and Flora had relatively steeper slopes (changed from "normal" GDD requirement for heading to a much greater requirement most rapidly) , whereas Hoff, Treasure, Oveson and Whitman had very shallow slopes. Other cultivars had intermediate slope values (Table 4.2.1). Yamhill and Flora are known to have a strong vernalization requirement whereas Whitman and Hoff are known to have a weak requirement. In fact they are facultative (can be planted in the winter or spring). As these cultivar groups showed significant differences in slope, with strong vernalization cultivars showing a faster change toward not heading, it seems that difference in slope can be used as a criteria to rank cultivars.

The average end point (EP; the point at which a cultivar did not head or the last seeding date if a cultivar headed at all seedings) for all the cultivars was 37 with a PLSD of 11 at P = 0.05. Varietal difference for EP was highly significant (P=0.00). Six cultivars (Hill 81, Dusty, Flora, Kmor, Eltan and Yamhill) had high EP values

Table 4.2.1 Break point, slope, vanishing point and relative vernalization index for Heading (growing degree days) for twenty cultivars over three years.

	Break Point Vernalization Days				Slope				End Point Vernalization Days				Relative Vernalization Index	
Variety	1991	1992	1993	Ave	1991	1992	1993	Ave	1991	1992	1993	Ave	(Slope x End Point)	
Hoff	70	60	60	63	5	6	3	5	38	20	19	26	298	a
Treasure	50	50	50	50	1	4	7	4	51	20	19	30	198	a
Whitman	60	40	40	47	5	2	6	4	38	20	19	26	193	a
Oveson	40	20	20	27	-1	-2	-5	-2	38	20	19	26	-53	a
Malcolm	42	50	50	47	-185	-8	-46	-80	51	20	29	33	-3490	ab
Hyak	50	50	50	50	-141	-26	-73	-80	51	20	35	35	-3995	ab
MacVicar	50	48	48	49	-188	-15	-45	-83	51	20	29	33	-4086	ab
Rod	50	50	50	50	-187	-13	-45	-82	51	20	29	33	-4093	ab
Madsen	50	50	50	50	-166	-21	-62	-83	58	20	33	37	-4138	ab
Daws	50	50	50	50	-196	-14	-46	-85	51	20	29	33	-4268	ab
W 301	50	50	50	50	-188	-7	-77	-90	51	20	33	35	-4523	ab
Stephens	50	50	50	50	-196	-33	-43	-91	45	20	29	31	-4542	ab
Dusty	80	58	50	63	-104	-13	-111	-76	79	20	39	46	-4877	ab
Hill 81	70	60	60	63	-152	-34	-43	-76	68	25	39	44	-5085	ab
Rohde	68	62	60	63	-196	-10	-46	-84	51	20	33	35	-5595	ab
Gene	70	60	60	63	-172	-12	-70	-85	45	20	33	33	-5670	ab
Eltan	80	70	62	71	-193	-23	-38	-84	79	34	39	51	-6455	ab
Kmor	78	70	60	69	-195	-26	-48	-90	79	34	43	52	-6629	ab
Flora	80	60	62	67	-191	-38	-47	-92	79	20	39	46	-6829	ab
Yamhill	80	70	58	69	-195	-38	-160	-131	68	38	56	54	-9173	abc
Average				56				-69				37	-4141	
PLSD (5 %)				9				67				11	4382	
CV (%)				10				59				18	64	
P-VALUE				0.00				0.01				0.00	0.04	

(required more accumulated cold, had stronger vernalization requirements) while Hoff, Whitman, Oveson and Treasure had low EP values suggesting that they can be planted later and still be expected to head.

It was noted that cultivar performance in slope and end point tended to be similar (Table 4.2.2) and that there was a good range of values. In order to utilize the data provided by each of these parameters, a value called a relative vernalization index (RVI) was calculated. This index value was generated by multiplying the slope by the end point value. By multiplying these values, differences were exaggerated. RVI values were generated for each year and analyzed over years. Mean values and statistics are presented in Table 4.2.1. The RVI is like the "relative importance values" used by Young (1961) for making theoretical comparisons among genotypes.

A significant difference for heading date RVI was observed. As would be expected, a similar pattern for vernalization response with in cultivars was observed as was seen for slope and EP, i.e., Hoff, Whitman, Oveson and Treasure appear to have a weak vernalization requirement, Hill 81, Dusty, Flora, Kmor, Eltan and Yamhill have a strong vernalization requirement while other cultivars appear to have a moderate requirement.

Cultivar values for break point, slope, end point and RVI were ranked and assigned rank values. Rankings are presented in the Table 4.2.2 based on RVI rank. As can be seen, there is general agreement among all rankings in terms of relative cultivar performance. Cultivars believed to have a low vernalization requirement tended to rank low in all parameters, while those believed to have a high vernalization requirement ranked high. This is even the case for break point, a parameter that was not used in developing the RVI.

High correlations were observed between slope x RVI and EP x RVI , 0.933 and 0.882, respectively (Table 4.2.3). This indicates that slope is probably the driving force for differentiating cultivars according to their vernalization repone and creating RVI. A weaker correlation (0.636) was seen for break point and RVI.

Table 4.2.2 Numeric ranking of cultivars according to relative vernalization index, slope, break point and end point for heading.

Variety	Break point	Slope	End point	RV Index
Hoff	5	1	1	1
Treasure	4	1	2	2
Whitman	2	1	1	3
Oveson	1	3	1	4
Malcolm	2	5	4	5
Hyak	4	5	5	6
MacVicar	3	7	4	7
Rod	4	6	4	8
Madsen	4	7	6	9
Daws	4	9	4	10
W 301	4	10	5	11
Stephens	4	11	3	12
Dusty	5	4	8	13
Hill 81	5	4	7	14
Rohde	5	8	5	15
Gene	5	9	4	16
Eltan	8	8	9	17
Kmor	7	10	10	18
Flora	6	12	8	19
Yamhill	7	13	11	20

Table 4.2.3. Correlation of break point, slope, end point and relative veranalization index for heading, plant height, no. of heads/m row and yield parameters.

Parameters		Break point	Slope	End point
Heading				
	Break point	1		
	Slope	0.471	1	
	End point	0.738	0.677	1
	RVI	0.636	0.933	0.882
Plant Height				
	Break point	1		
	Slope	0.451	1	
	End point	0.637	0.606	1
	RVI	0.549	0.937	0.834
No. heads/m row				
	Break point	1		
	Slope	0.486	1	
	End point	0.748	0.346	1
	RVI	0.666	0.936	0.646
Yield				
	Break point	1		
	Slope	0.581	1	
	End point	0.896	0.763	1
	RVI	0.735	0.958	0.891

4. 3 Plant Height

After graphing all data (plant height versus VD), break point, slope and end point were measured for each cultivar (Table 4.3.1.). Break point, the point at which a cultivar started to show significant change in height, was determined visually. Slope of the decay line, the line between the break and end points (EP), was determined. Because height was recorded by measuring plants from ground level to the panicle tip, the EP was the first sowing date at which a cultivar did not head and hence had no plants to measure. If a cultivar headed at all sowing dates, the last sowing date was used as the EP. The same procedure was used to analyze data as it was used for heading. Due to the large number of graphs, only graphs for 1992 are shown (Fig. 4.3.1 to 4.3.4).

Plant height of all cultivars decreased with fewer VD (late planting; Fig. 4.3.1 to Fig. 4.3.4); however, vernalization responsive cultivars, i. e., Dusty, Eltan, Kmor, Stephen and Yamhill, showed a more rapid reduction in height as a result of late planting (Fig. 4.3.4). Height reduction was probably due to high temperature.

The average break point was 69 VD and PLSD at P = 0.05 was 7. There was a significant difference (P = 0.00) among cultivars for break point and a definite separation of cultivars into low and high break point groups (Table 4.3.1); however, like heading date, there was a narrow range of break point values across cultivars and little consistency in values for a cultivar over years. This indicates that all cultivars started responding by reduction in height at approximately the same VD. It is obvious from looking at the graphs that all cultivars reached a point where reduction

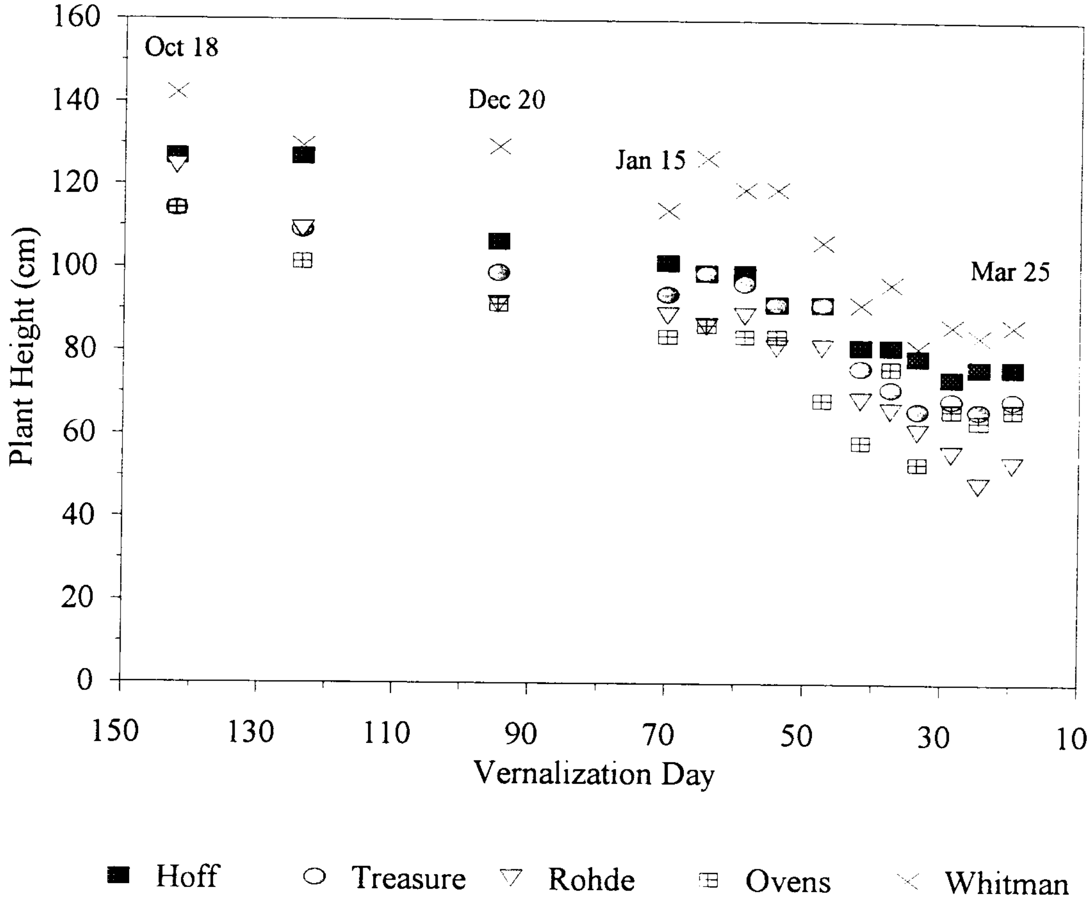

Figure 4.3.1 Plant height (cm) of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

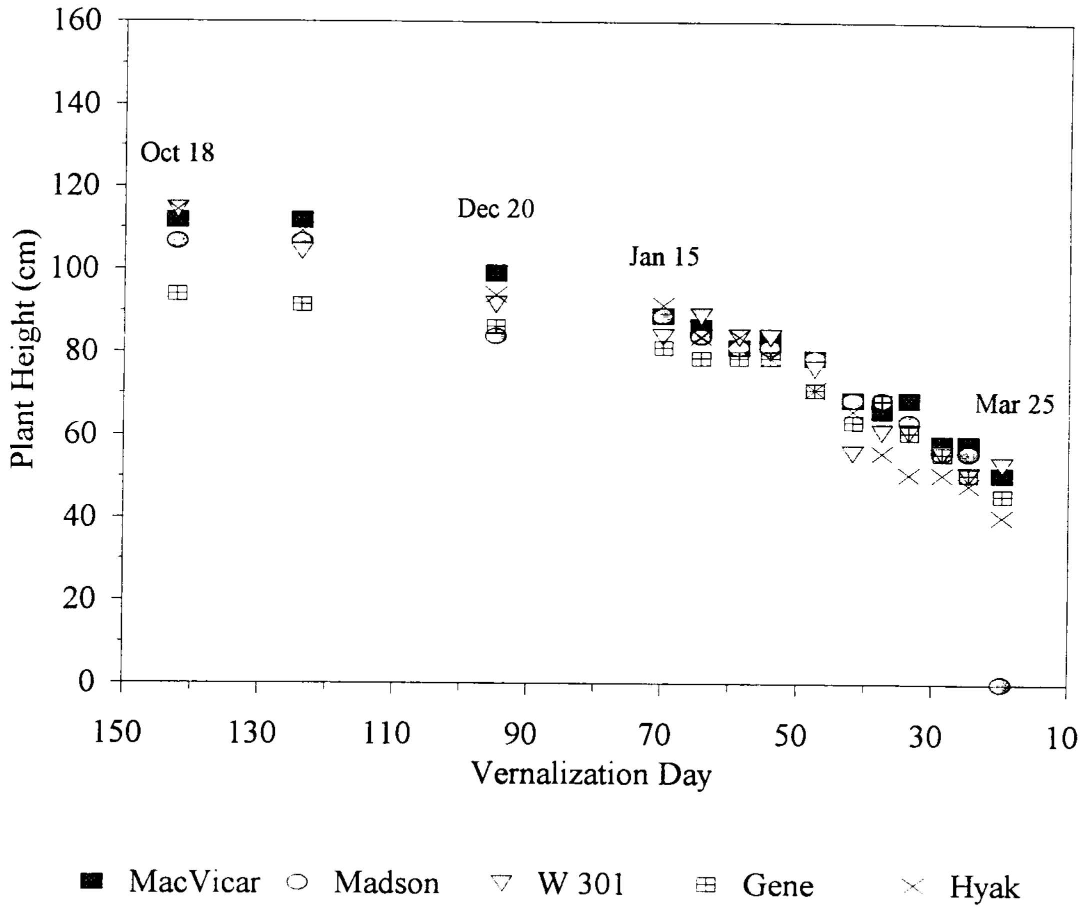

Figure 4.3.2 Plant height (cm) of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

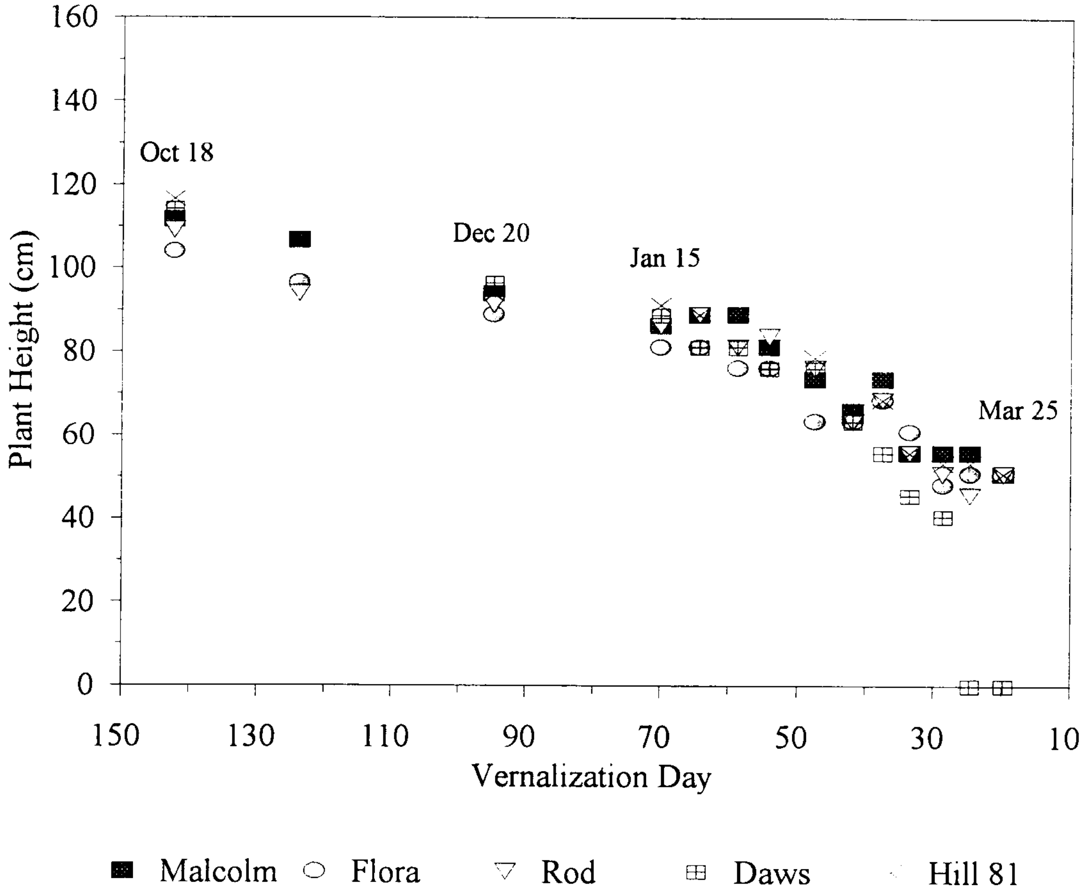

Figure 4.3.3 Plant height (cm) of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

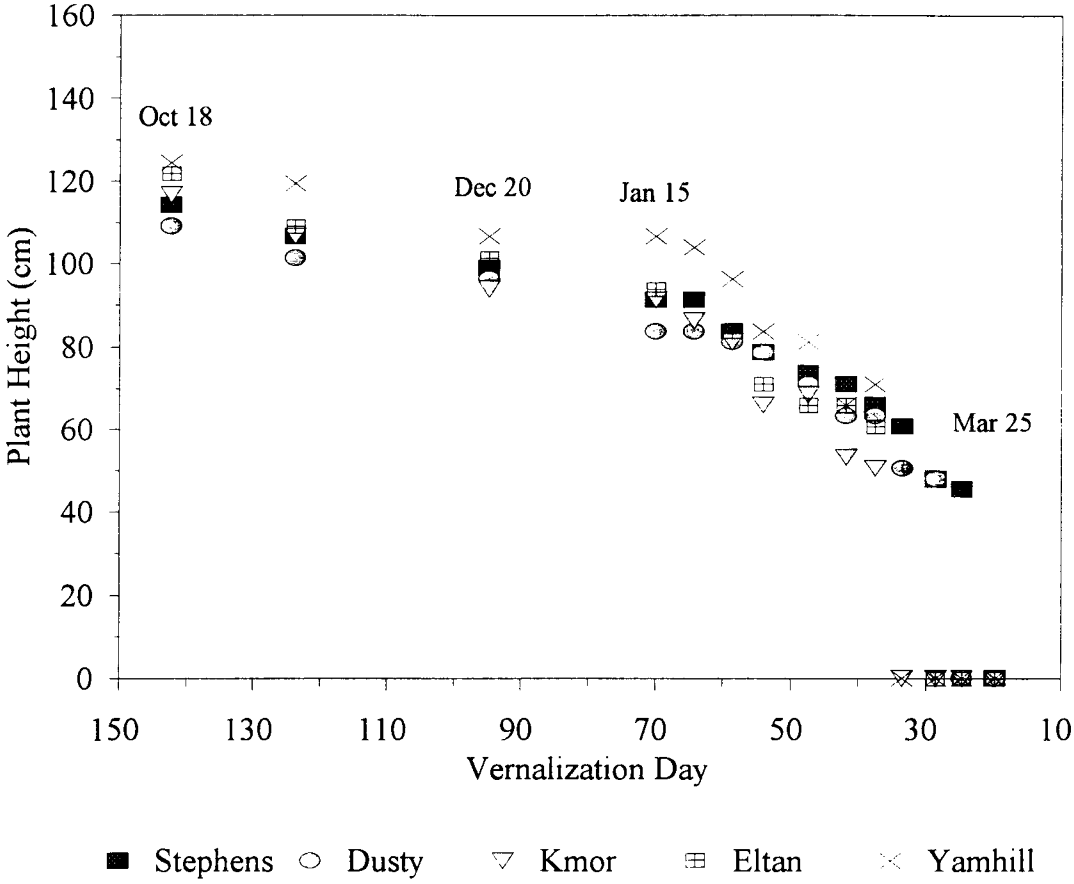

Figure 4.3.4 Plant height (cm) of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

in height became very rapid. Significant differences were observed for slope (P = 0.00). The average slope (change in height with respect to reduction in VD due to late sowing) for all cultivars was 0.3. At a 5 percent probability level, the PLSD was 0.13 (Table 4.3.1). Stephens and Yamhill had very steep slopes on average and across years (Table 4.3.1). They showed rapid height reduction in response to reduced vernalization. Hoff and Treasure, on the other hand, had shallow slopes (Table 4.3.1) which indicates that these cultivars were less affected by late sowing. There was a more than two-fold difference in slopes among cultivars which suggests that slope can be used for grouping cultivars according to their vernalization response.

Significant differences (P = 0.00) were also observed among cultivars for end point (the last sowing date a cultivar headed and hence had height). For all three years, the average EP was 29 VD. Protected Least Significant Difference (PLSD) was measured as 7 at 5 percent probability level (Table 4.3.1). Only the cultivars Dusty, Eltan, Kmor and Yamhill had high EP values, which indicates that they may have a higher vernalization requirement. Many cultivars had the same or a non-statistically significant different EP (Table 4.3.1).

As with heading, a Relative Vernalization Index (RVI) was generated using slope and EP values. The average RVI for plant height was 8.9 with a PLSD of 5.38 at 5 percent probability level. Differences were highly significant (P = 0.00) and there was a great range in RVI values, for example, 3.86 for Hoff and 20.59 for Yamhill (Table 4.3.1.). RVI values for height suggest that cultivars like Hoff and Treasure have a low vernalization requirement while Eltan and Yamhill have a strong

Table 4.3.1. Break point, slope, end point and relative vernalization index for plant height for twenty cultivars over three years.

Variety	Break Point Vernalization Days 1991	1992	1993	Ave	Slope 1991	1992	1993	Ave	End Point Vernalization Days 1991	1992	1993	Ave	Relative Vernalization Index (Slope x End Point)	
Hoff	71	60	70	67	0.13	0.24	0.08	0.15	38	20	19	26	3.85	a
Treasure	68	50	60	59	0.25	0.12	0.11	0.16	38	20	19	26	4.11	ab
Rohde	71	62	62	65	0.15	0.4	0.21	0.25	38	20	19	26	6.50	abc
Oveson	78	58	52	63	0.29	0.2	0.28	0.26	38	20	19	26	6.59	abc
Whitman	78	56	58	64	0.15	0.38	0.27	0.27	38	20	19	26	6.84	abcd
MacVicar	64	60	64	63	0.25	0.32	0.23	0.27	38	20	19	26	6.84	abcd
Madsen	74	68	70	71	0.28	0.3	0.1	0.23	38	25	29	31	6.95	abcd
Gene	70	60	56	62	0.23	0.33	0.27	0.28	38	20	19	26	7.10	abcd
W 301	70	70	72	73	0.29	0.32	0.22	0.28	38	20	19	26	7.10	abcd
Hyak	70	62	66	66	0.32	0.43	0.16	0.30	38	20	19	26	7.79	abcd
Malcolm	74	70	60	68	0.23	0.32	0.27	0.27	38	20	29	29	7.93	abcd
Flora	78	72	72	74	0.4	0.27	0.26	0.31	38	20	19	26	7.96	abcd
Rod	66	60	66	64	0.26	0.39	0.32	0.32	38	20	19	26	8.30	abcd
Daws	86	78	80	81	0.26	0.45	0.21	0.31	38	39	19	32	9.81	bcde
Hill 81	80	72	72	75	0.36	0.36	0.31	0.34	38	20	29	29	9.96	bcde
Stephens	64	64	62	63	0.3	0.43	0.39	0.37	38	25	19	27	10.20	cde
Dusty	78	74	76	76	0.27	0.36	0.36	0.33	38	29	39	35	11.66	de
Kmor	80	72	70	74	0.48	0.15	0.4	0.34	50	38	39	42	14.53	e
Eltan	80	78	78	79	0.42	0.39	0.45	0.42	38	34	33	35	14.70	e
Yamhill	80	72	64	72	0.62	0.5	0.52	0.55	45	38	30	38	20.59	f
Average				69				0.34				29	8.91	
PLSD (5 %)				7				0.13				7	5	
CV (%)				6				28				14	36	
P-VALUE				0.00				0.01				0.00	0.00	

requirement. RVI rankings for heading and height are similar. This suggests that RVI values may be useful for ranking cultivars according to their vernalization requirements.

Numerical ranking of the cultivars according to the RVI are shown in Table 4.3.2 along with ranks for break point, slope, and end point. Like heading, known obligate vernalization requirement cultivars have high ranked values and weak vernalization response cultivars have lower ranked values for slope and EP. This suggests that cultivars differ in their vernalization response and that they can be grouped by response.

There was a clear correlation (0.94) between slope and RVI. A high correlation (0.83) was also measured between EP and RVI, while correlation between break point and RVI was weak (Table 4.2.3). Results suggests that slope was the most important line feature for the ranking of the cultivars by height data.

Table 4.3.2 Numeric ranking of cultivars according to relative vernalization index, slope, break point and end point for plant height.

Variety	Break point	Slope	End point	RV Index
Hoff	6	1	1	1
Treasure	1	2	1	2
Rohde	4	4	1	3
Oveson	2	5	1	4
Whitman	3	7	1	5
MacVicar	2	6	1	6
Madsen	8	3	5	7
W 301	10	9	1	8
Gene	2	10	1	9
Hyak	5	11	1	10
Malcolm	7	8	3	11
Flora	11	13	1	12
Rod	3	14	1	13
Daws	16	12	6	14
Hill 81	13	16	4	15
Stephens	2	18	2	16
Dusty	14	15	8	17
Kmor	12	17	10	18
Eltan	15	19	7	19
Yamhill	9	20	9	20

4.4 Number of Heads / m row

The same procedure was undertaken to analyze and represent the data for heads/m as was used for heading and plant height parameters. For number of heads/m row, the end point was counted as the first sowing date at which fewer than 30 percent of the plants in a row, using visual estimation, headed.

Number of heads/m row for Hoff, Hyak, Oveson, Treasure and Whitman appeared to be stable across most planting dates (Fig. 4.4.1). There was a sharp decrease in heads/m at the break point, but in earlier seedings performance was similar. If we ignore the fact that number of heads/m row for each cultivar was counted regardless of the size and performance of a head, it can be inferred from the Figure 4.4.1 and from the data (not showed) that these cultivars can successfully be planted in the fall, as well as in early spring, and still a good production can be expected. A slow but steady reduction in number of heads for Flora, Madsen, Rohde, Stephens and MacVicar was seen (Fig. 4.4.2) with an even greater reduction for Gene, Malcolm, Rod, Daws and W301 (Fig.4.4.3). Because of reduction in VD, a rapid degradation in the number of heads/m of row is readily apparent for Dusty, Eltan, Hill 81, Kmor and Yamhill (Fig. 4.4.4). It indicates that late sowing of these cultivars can drastically reduce the number of heads produced which ultimately can affect crop yield.

While there were striking differences in the shape of the curves for heads/m among cultivars, all appeared to reach the point of rapid decline in performance (break point) at a similar VD. Only strong vernalization requirement cultivars such as

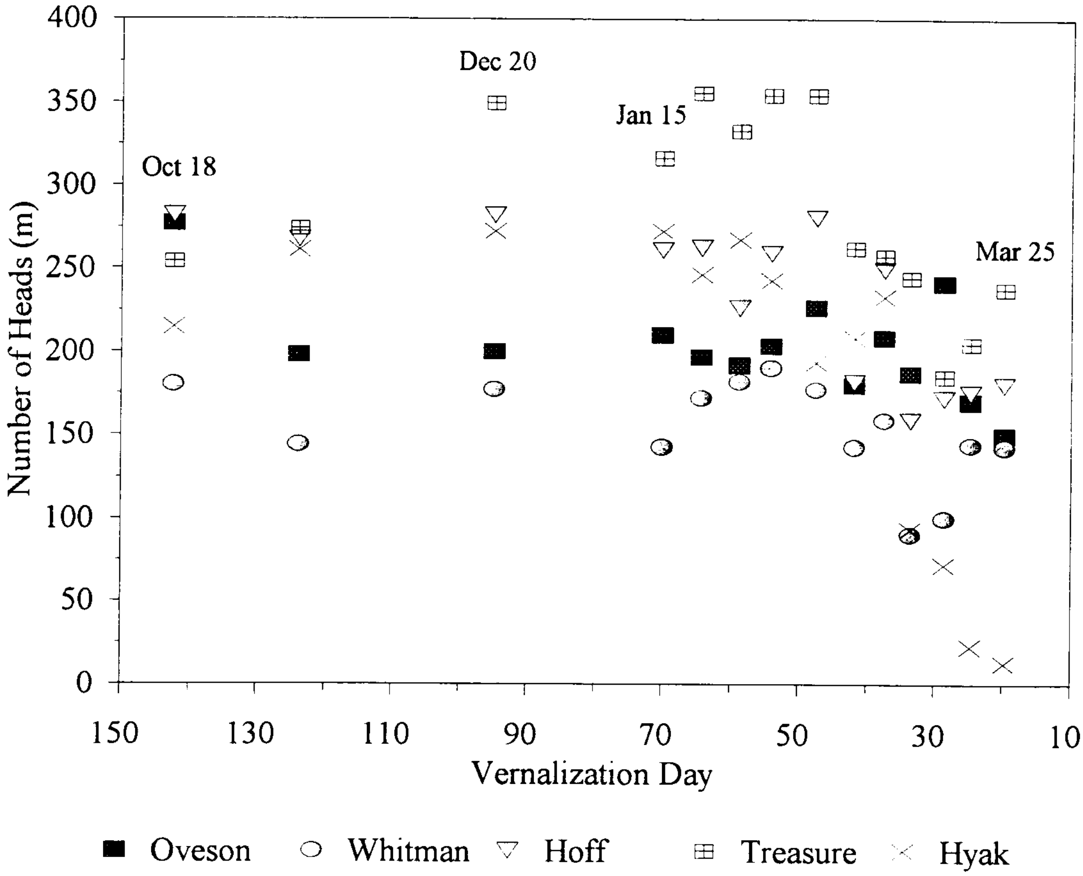

Figure 4.4.1 Number of heads/m row of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

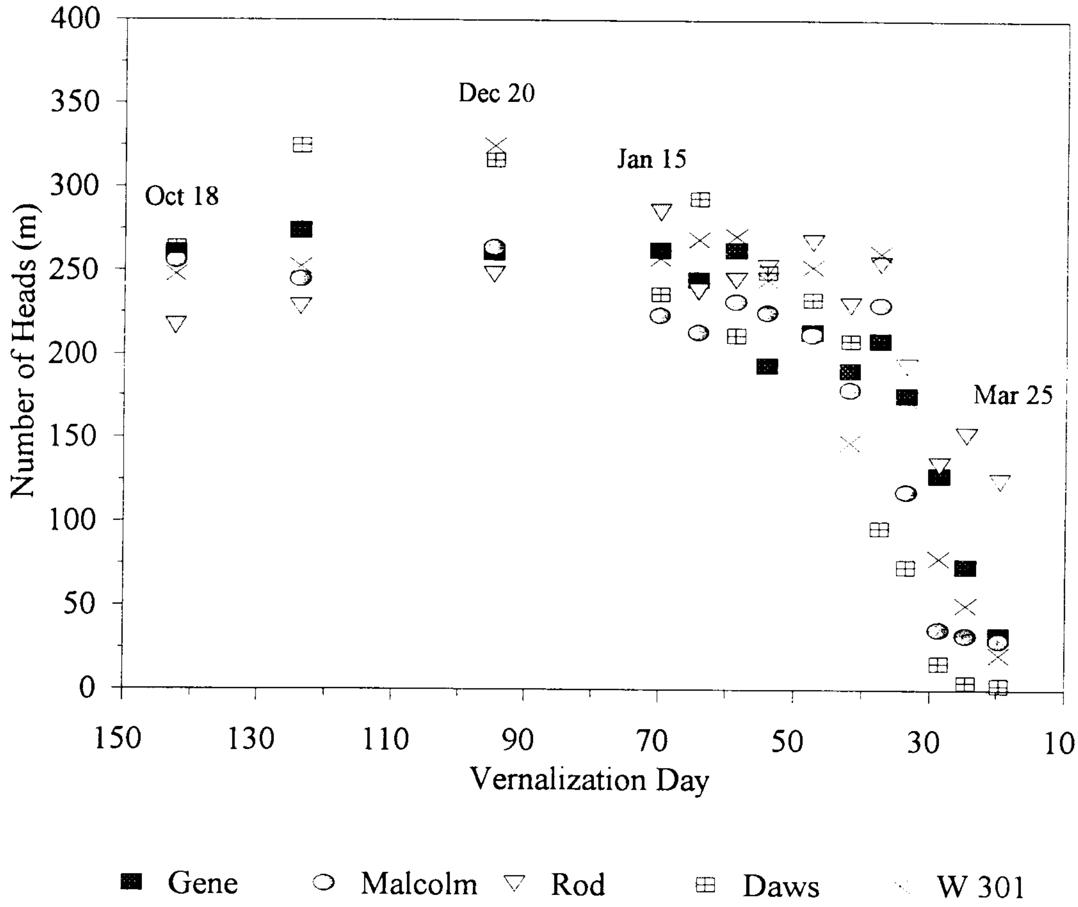

Figure 4.4.2 Number of heads/m row of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

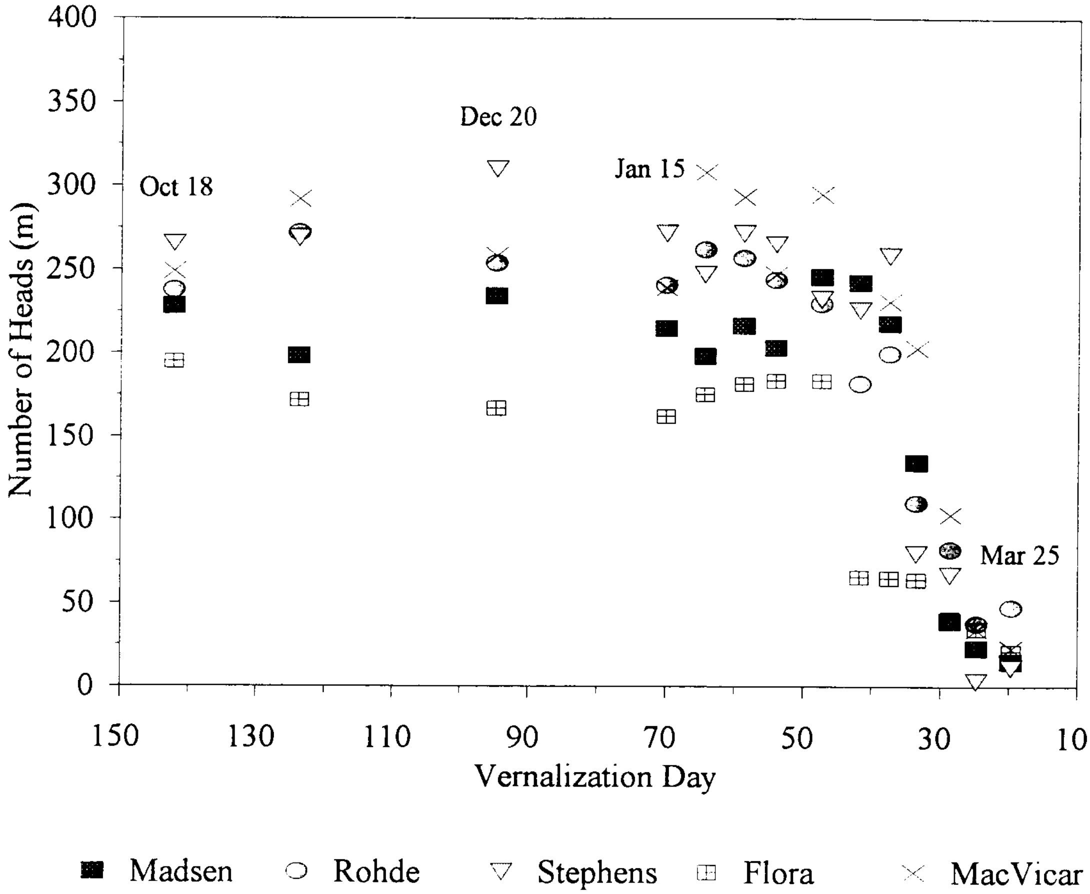

Figure 4.4.3 Number of heads/m row of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

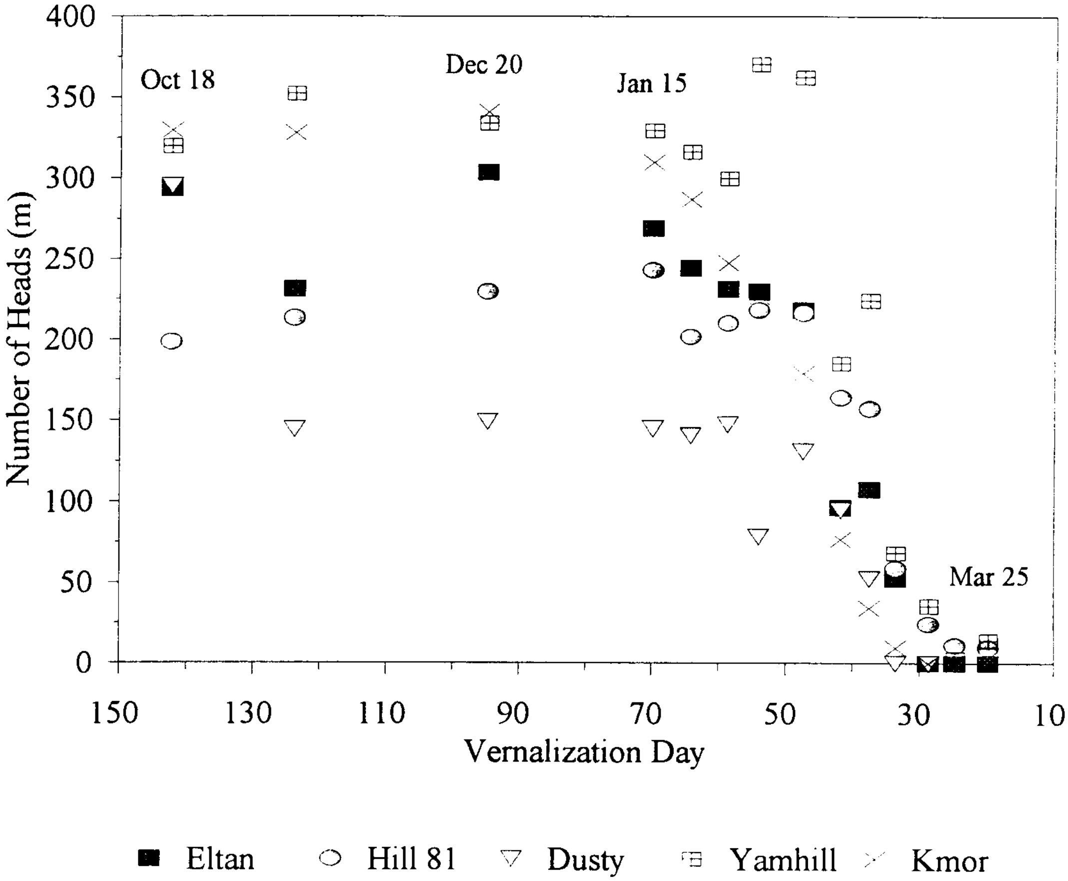

Figure 4.4.4 Number of heads/m row of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

Flora, Eltan, Hill 81, Yamhill and Kmor had differential break points (PLSD = 14 at 5 percent probability level) while the other cultivars had about the same break points; however, there was difference (P = 0.00) in break point among cultivars (Table 4.4.1). For number of heads/m row, break point shows limited promise for grouping cultivars.

The average slope for number of heads/m row of all twenty cultivars for three years was 4.7 with a PLSD at the 5 percent probability level of 2.7. There were significant differences in slope among cultivars with a 14-fold difference between the lowest and highest slope values. Oveson, Whitman, Hoff and Treasure had shallow slopes which indicates they are less responsive to vernalization. Flora, MacVicar, Eltan, Dusty, Kmor and Yamhill showed very steep slopes. Other cultivars were intermediate in slope (Table 4.4.1).

Difference in end point was not obvious for most cultivars, except Flora, Eltan, Hill 81, Yamhill and Kmor which showed higher end points in some or all years. This again suggests that these cultivars have a strong vernalization requirement.

Similar results were obtained from RVI analysis (slope x end point) as were observed for break point, slope and EP. Significant differences among RVI values (P = 0.00) were observed. PLSD at P = 0.05 was 119 and the RVI average was 128. While it may seem strange that the average and PLSD are so similar, it should be noted that there is an extremely large difference in RVI values, i.e., 15.7 - 281. Oveson, Whitman, Hoff and Treasure had small valves where as Eltan, Hill 81, Dusty, Yamhill and Kmor ranked high in RVI values (Table 4.4.1). Results of RVI analysis are similar to those for height and heading.

Table 4.4.1. Break point, slope, end point and relative vernalization index for heads /m row for twenty cultivars over three years.

Variety	Break Point Vernalization Days 1991	1992	1993	Ave	Slope 1991	1992	1993	Ave	End Point Vernalization Days 1991	1992	1993	Ave	Relative Vernalization Index (Slope x End Point)	
Oveson	70	28	40	46	0.11	0.85	0.87	0.6	38	20	19	26	15.7	a
Whitman	70	48	50	56	0.19	1.27	0.56	0.7	38	20	19	26	17.3	a
Hoff	60	48	50	53	1.47	3.13	0.47	1.7	38	20	19	26	43.4	ab
Treasure	70	40	40	50	1.25	1.75	6.81	3.3	38	20	19	26	83.9	abc
Hyak	56	50	56	54	2.01	8.34	1.14	3.8	38	20	29	29	111.1	abc
Gene	58	50	48	52	1.29	6.71	4.08	4.0	38	20	29	29	116.8	abc
Malcolm	64	52	50	55	2.22	9.18	0.87	4.1	38	20	29	29	118.6	abcd
Rod	70	40	48	53	2.62	6.74	5.28	4.9	38	20	19	26	125.3	abcd
Daws	70	60	50	60	2.22	7.25	6.06	5.2	38	20	19	26	132.9	abcde
W 301	60	50	50	53	5.31	8.45	3.15	5.6	38	20	19	26	144.7	abcde
Madsen	67	48	42	52	1.16	10.3	3.71	5.1	38	20	29	29	146.5	abcde
Rohde	60	50	48	53	0.32	7.48	7.41	5.1	38	20	29	29	147.0	bcde
Stephens	58	58	58	58	4.58	8.79	4.34	5.9	38	20	19	26	151.5	bcde
Flora	84	50	58	64	2.63	4.86	7.98	5.2	38	20	34	31	158.1	bcde
MacVicar	50	44	44	46	2.87	8.09	8.98	6.6	38	20	19	26	170.6	bcde
Eltan	80	70	70	73	1.98	5.81	7.41	5.1	35	35	33	34	174.0	fcde
Hill 81	80	52	68	67	4.15	8.33	4.96	5.8	38	20	34	31	178.3	fcde
Dusty	70	70	50	63	9.00	7.77	8.47	8.4	38	20	19	26	215.9	fde
Yamhill	70	72	66	69	3.34	4.55	9.62	5.8	38	34	43	38	223.7	fe
Kmor	80	80	50	70	4.52	8.77	9.49	7.6	38	34	39	37	281.0	f
Average				58				4.7				29	128	
PLSD (5 %)				14				4				8	119.1	
CV (%)				14				47				16	0.56	
P-VALUE				0.01				0.01				0.02	0.01	

Numeric ranking of the cultivars for break point, slope, end point and RVI are shown in Table 4.4.2. As was noted above, there were few differences among cultivars in end point, there was a large middle group with few cultivars on the extreme for break point, but a fairly good spread of cultivars according to slope. Slope appears to be the primary determinant in the RVI.

Results of correlation among break point, slope, end point and RVI are illustrated in Table 4.2.3. High correlation was observed between slope and RVI (0.94). Correlation between break point x RVI and EP x RVI were lower than seen for heading and height.

Table 4.4.2. Numeric ranking of cultivars according to relative vernalization index and slope, break point and end point for number of heads/m row.

Variety	Break point	Slope	End Point	RV Index
Oveson	1	1	1	1
Whitman	7	2	1	2
Hoff	5	3	1	3
Treasure	2	4	1	4
Hyak	6	5	2	5
Gene	4	6	2	6
Malcolm	5	7	2	7
Rod	5	8	1	8
Daws	9	13	1	9
W 301	5	14	1	10
Madsen	4	9	2	11
Rohde	5	11	2	12
Stephens	8	17	1	13
Flora	11	12	3	14
MacVicar	1	18	1	15
Eltan	15	10	4	16
Hill 81	12	15	3	17
Dusty	10	20	1	18
Yamhill	13	16	6	19
Kmor	14	19	5	20

4.5 Yield

All three years yield data were graphed by plotting yield in grams/meter of harvested row versus VD to find out break point, slope and end point of each cultivar. As an example of the types of graphs obtained, figures 4.5.1 to 4.5.4 show cultivar graphs for 1992. Line characteristics are shown in Table 4.5.1. The point at which a cultivar started showing rapid decline in yield with respect to low VD was designated as break point of that cultivar. End point of a cultivar was the sowing date at which a cultivar had no yield. Slope of the decay line, between break point and end point, was determined.

As was expected, reduction in yield for all twenty cultivars was observed as a result of late sowing, but the rate of reduction and general graph features were very much different between low and strong vernalization requirement cultivars (Fig. 4.5.1 to 4.5.4). Cultivars believed to have a lower vernalization requirement (Oveson, Whitman, Hoff, Treasure and Hyak; Fig. 4.5.1) showed a gradual decline in yield as VD decreased and showed scattered results. On the other hand, Dusty, Eltan, Flora, Hill 81, Kmor and Yamhill were the most vernalization responsive cultivars and showed a rapid reduction in yield (Fig. 4.5.4) due to late sowing and much more uniform response.

Marked differences ($P = 0.00$) of break point were determined among the cultivars for yield. Considering the PLSD of 14 at 5 percent probability level, obvious ranking can be made across cultivars for their vernalization response. Dusty, Eltan, Flora, Hill 81, Kmor and Yamhill (cultivars known to have a strong vernalization

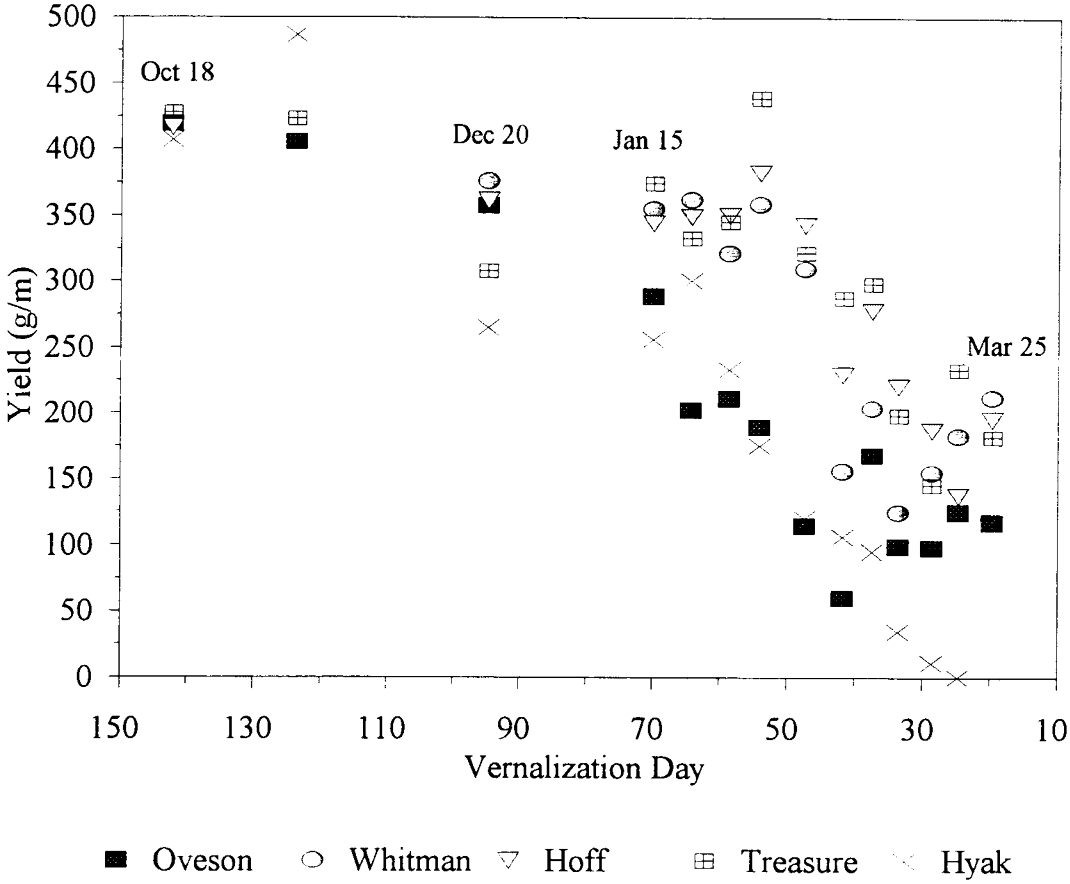

Figure 4.5.1 Yield (g/m row) of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

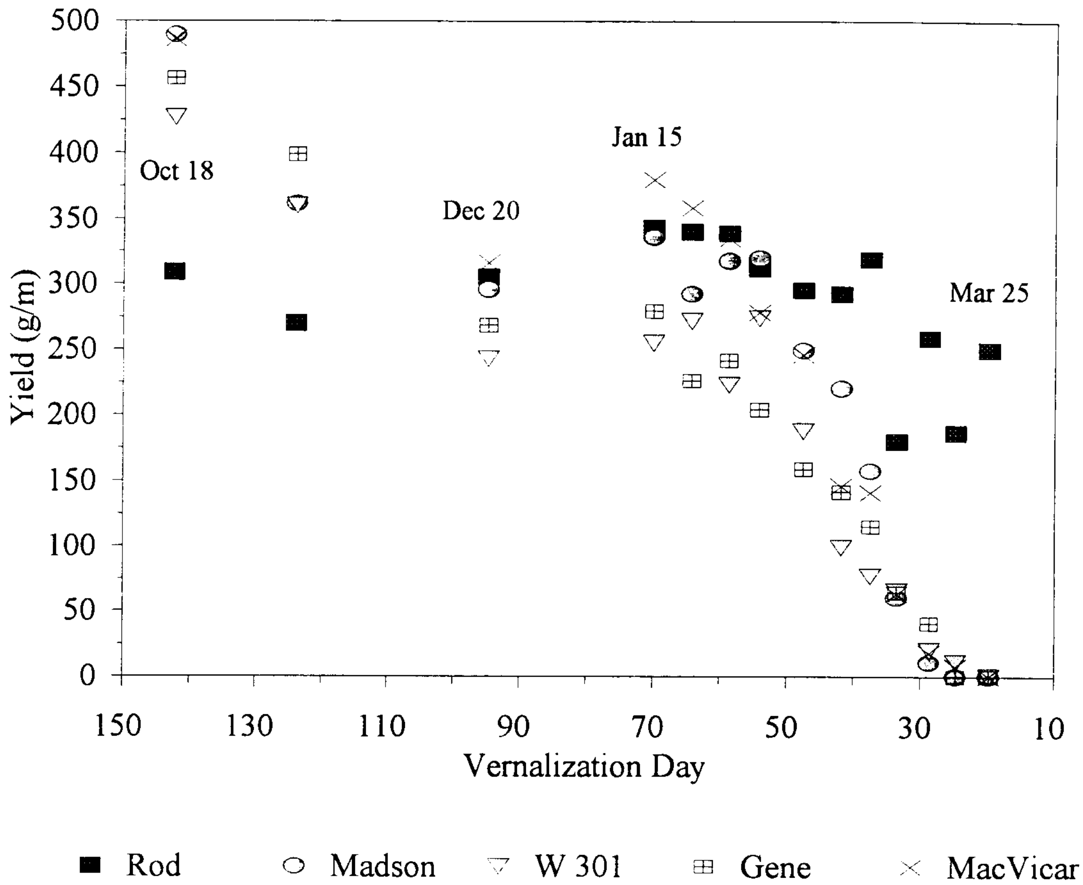

Figure 4.5.2 Yield (g/m row) of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

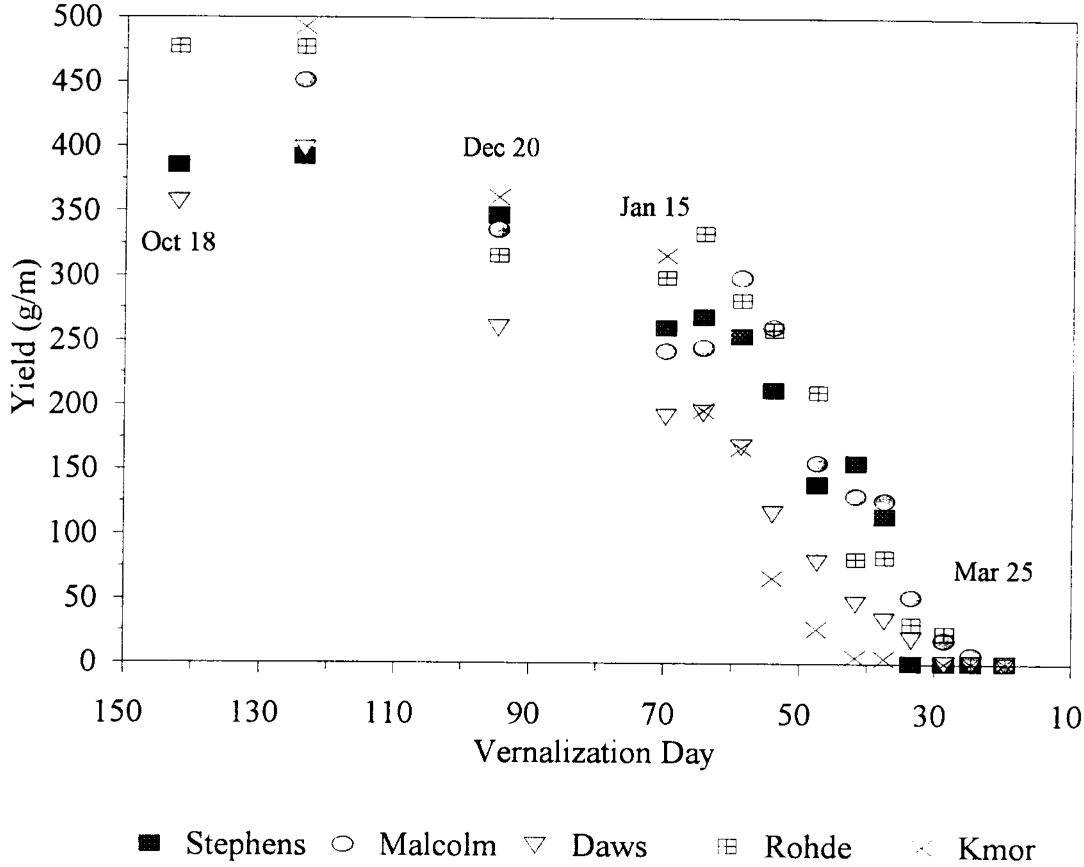

Figure 4.5.3 Yield (g/m row) of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

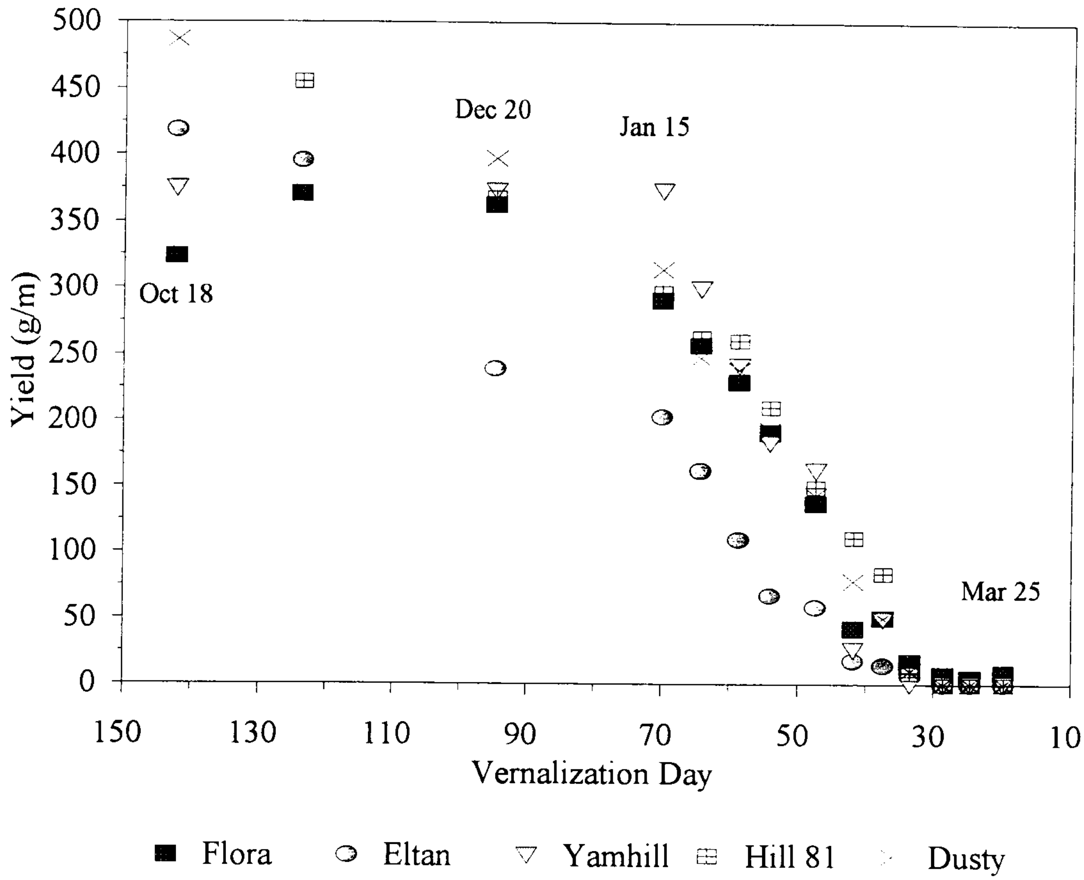

Figure 4.5.4 Yield (g/m row) of five wheat cultivars planted over 14 different seeding dates, measured in vernalization days, during the 1991-92 growing season.

vernalization requirement) had consistent high values over years (Table 4.5.1). Less coherence in break point values for less vernalization responsive cultivars i.e., Oveson, Whitman, Hoff, and Rohde, was observed over years. (Table 4.5.1). Result indicate that while all cultivars showed a significant reduction in yield after a certain sowing date, that date differed significantly among cultivars.

The effect of VD on the yield of individual cultivars was also seen by the differences in their slope. PLSD for the slope at 5 percent probably level was 5 and the average for all twenty cultivars over three year was determined as 6.6 VD. Low vernalization requirement cultivars had shallow slope while obligate cultivars had a much steeper slope (Table 4.5.1). Results illustrate that yield potential of vernalization responsive cultivars can be affected significantly by sowing date.

Significant differences (P=0.00) in end point (the sowing date at which a cultivar had no measurable yield) were observed among cultivars (Table 4.5.1). Consistently high EP values over the three years for Dusty, Eltan, Flora, Hill 81, Kmor and Yamhill strongly suggests a strong vernalization response. It also indicates that very low or even no yield can be expected if the above mentioned cultivars are sown late. On the other hand, consistently low EP values across years (Hoff, Treasure, Oveson and Whitman) shows their weak vernalization response and the possibility for late sowing. The large differences in slope and EP values for cultivars suggests that these two parameters can be used for the grouping of cultivars according to their vernalization response. The RVI values (slope x end point) presented in Table 4.5.1 showed nearly the same pattern as was observed for slope and EP.

Table 4.5.1. Break point, slope, end point and relative vernalization index for yield (g/m) row for twenty cultivars over three years.

Variety	Break Point Vernalization Days 1991	1992	1993	Ave	Slope 1991	1992	1993	Ave	End Point Vernalization Days 1991	1992	1993	Ave	Relative Vernalization Index (Slope x End Point)	
Oveson	65	60	60	62	0.2	2.1	3.0	1.75	38	20	19	26	44.9	a
Whitman	60	50	52	54	0.9	2.4	3.8	2.37	38	20	19	26	60.9	a
Hoff	62	50	58	57	3.2	5.7	2.2	3.70	38	20	19	26	94.9	ab
Treasure	72	58	58	63	4.4	6.0	2.5	4.29	51	20	19	30	128.6	abc
Madsen	66	54	62	61	0.5	10.7	5.5	5.57	29	38	33	33	185.6	abcd
Hyak	78	62	78	73	5.2	6.9	3.3	5.11	51	29	29	36	185.7	abcd
Rod	70	52	48	57	6.2	3.1	9.8	6.35	51	20	19	30	190.6	abcd
W 301	72	62	58	64	4.7	7.7	7.2	6.53	45	25	29	33	215.6	abcd
Gene	78	58	52	63	4.9	6.5	6.7	6.04	51	29	29	36	219.3	abcd
MacVicar	78	70	62	70	4.3	9.0	7.1	6.81	51	24	29	35	236.1	abcd
Stephens	80	70	60	70	6.0	5.0	9.0	6.64	51	38	29	39	261.0	abcd
Malcolm	60	58	58	59	7.4	8.7	7.9	8.00	51	25	29	35	279.8	abcd
Daws	80	85	51	72	8.0	5.4	8.4	7.25	51	34	33	39	285.2	abcd
Rohde	68	62	60	63	5.4	9.7	9.9	8.31	51	29	29	36	301.8	abcd
Kmor	100	64	72	79	4.2	7.8	6.7	6.24	68	38	42	49	308.0	abcd
Flora	87	78	80	82	14.4	6.4	5.8	8.88	68	20	39	42	375.7	bcd
Eltan	78	80	84	81	14.7	5.9	5.4	8.66	68	38	39	48	418.7	cde
Yamhill	100	92	70	87	4.9	10.4	9.3	8.21	68	38	51	52	429.6	de
Hill 81	90	64	70	75	8.4	8.2	11.1	9.23	68	34	43	48	446.1	de
Dusty	80	82	60	74	18.3	8.2	11.7	12.74	68	34	39	47	598.7	e
Average				69				6.63				37	268.6	
PLSD (5 %)				14				5				12	113	
CV (%)				12				44				19	0.22	
P-VALUE				0.01				0.05				0.00	0.03	

Low vernalization requirement vanities had low RVI values while strong vernalization requirement cultivars had high values.

The same numerical ranking procedure was followed to for the yield parameter as was carried out for heading, plant height and number of heads/m row. It can easily be noticed from Table 4.5.2 that weak or non-vernalization responsive cultivars had low ranking numbers for almost all graph characteristics whereas obligate or strong vernalization requirement cultivars possessed comparatively high ranking values. In summary, late sowing and associated low VD significantly reduced the yield potential of obligate cultivars such as Dusty, Eltan, Flora, Hill 81, Kmor and Yamhill. Spring cultivars or those having weak vernalization requirement cultivars i.e., Hoff, Treasure, Oveson and Whitman, were less effected by late sowing or low VD.

As it was seen for heading, plant height and number of heads/m row that slope and RVI were highly correlated and that slope and end point were the main factors for creating RVI to group the cultivars according to their vernalization response. Similar trends were seen for the yield parameter. The correlation between slope and RVI was 0.95. A strong correlation was also noticed between end point and RVI (Table 4.2.3.).

Table 4.5.2. Numeric ranking of cultivars according to relative vernalization index, slope, break point and end point for yield.

Variety	Break Point	Slope	End Point	RV Index
Oveson	4	1	1	1
Whitman	1	2	1	2
Hoff	2	3	1	3
Treasure	5	4	2	4
Hyak	10	5	5	5
Rod	2	9	2	6
Madsen	4	6	6	7
W 301	6	10	3	8
Gene	5	7	5	9
MacVicar	7	12	4	10
Stephens	7	11	7	11
Malcolm	3	14	4	12
Daws	9	13	8	13
Rohde	5	16	5	14
Kmor	13	8	12	15
Flora	15	18	9	16
Eltan	14	17	11	17
Yamhill	16	15	13	18
Hill 81	12	19	11	19
Dusty	11	20	10	20

4.6 Other Parameters

Kernels per head, number of spikelets and seed weight per kernel data was also collected but not analyzed. Raw data for these parameters are shown in appendix.

4.7 Growth Chamber/Greenhouse Experiments

Cultivars were rated as headed or not headed after different duration of cold treatments at 7 °C constant temperature. The same vernalization effectiveness function models were used to determine VD in the growth chamber as were used for field study. A difference between growth chamber VD and field VD was that the growth chamber VD were obtained at a constant temperature.

Significant differences in heading response among cultivars with respect to cold treatment were observed. Heading response of Oveson and Whitman appeared to be weak or cold neutral as they headed only after the cold treatment of 5 VD. Hoff, Hyak, Malcolm, Madsen, and Treasure were also among weak vernalization requirement cultivars where heading occurred after one week (6.82 VD) of vernalization (Table 4.7.1). The cultivars Eltan, Flora, Hill 81, Kmor, Rodhe and Yamhill showed marked response to vernalization. Heading of these cultivars occurred only after four or five weeks of cold treatment (Table 4.7.1). Vernalization response of remaining cultivars were intermediate. Approximately 10 to 14 VD were enough to cause them go to head.

Results of the greenhouse study indicate that the cultivars vary widely in vernalization response and that Hoff, Hyak, Oveson, Treasure and Whitman have weak or no vernalization response while Eltan, Flora, Hill 81, Rohde, Kmor and Yamhill have an obligate requirement. Results are very much analogous to the findings of field study. This suggests that the greenhouse procedure could be used to determine the relative vernalization requirement of new cultivars prior to release.

Table 4.7.1 Effect of vernalization on heading of twenty wheat cultivars expose to different period of cold treatment in greenhouse.

	Calendar Days						
	5	7	10	14	21	28	35
	Vernalization Days						
Variety	4.87	6.82	9.74	13.65	20.47	27.29	34.12
Whitman	H	H	H	H	H	H	H
Oveson	H	H	H	H	H	H	H
Treasure	ND	H	H	H	H	H	H
Hoff	ND	H	H	H	H	H	H
Hyak	ND	H	H	H	H	H	H
Daws	ND	ND	H	H	H	H	H
Gene	ND	ND	H	H	H	H	H
MacVicar	ND	ND	H	H	H	H	H
Madsen	ND	ND	H	H	H	H	H
Malcolm	ND	ND	H	H	H	H	H
Rod	ND	ND	ND	H	H	H	H
Dusty	ND	ND	ND	H	H	H	H
W 301	ND	ND	ND	H	H	H	H
Stephens	ND	ND	ND	H	H	H	H
Flora	ND	ND	ND	ND	ND	H	H
Rohde	ND	ND	ND	ND	ND	H	H
Hill 81	ND	ND	ND	ND	ND	H	H
Eltan	ND	ND	ND	ND	ND	ND	H
Kmor	ND	ND	ND	ND	ND	ND	H
Yamhill	ND	ND	ND	ND	ND	ND	H

H = Headed
ND = Not headed

CHAPTER 5

CONCLUSIONS

We've shown that RVI for each individual parameter seems to give a useful ranking of vernalization requirement of cultivars. There is great similarity among RVI rankings for cultivars across parameters. In order to determine an overall rating across parameters, RVI values for each of the four parameters were used as replications and a randomized complete block analysis was performed. Results of this analysis and numerical rankings of grand RVI are shown in Table 5.1. along with ranking for each parameter and the greenhouse data.

The grand index shows distinct groupings of cultivars. Oveson, Hoff, Whitman and Treasure ranked low in the grand index and low for most individual parameters. This suggests a low vernalization requirement. On the other hand, Flora, Hill81, Eltan, Dusty, Kmor and Yamhill were high in all rankings. This suggest a high vernalization requirement. Other cultivars were intermediate in ranking.

The relative rankings observed in the field trials are very similar to those observed in the greenhouse study. Whitman, Oveson, Hoff and Treasure headed after only one week of chill treatment while Eltan, Kmor and Yamhill required many weeks of chilling. The similarity of data from the two different types of trials suggests that the relative rankings of cultivars is valid and that the greenhouse procedure defined in this paper can be used to give relative rankings to cultivars.

The other objective of this study was to determine latest planting date recommendations for cultivars. Time limitations did not allow much work on this

Table 5.1. Numeric ranking of cultivars according to grand index, heading, height no. of heads/m row and yield parameters with compersion to greenhouse data.

Variety	Heading	Height	No. of Heads/m	Yield	Grand Index	Green house
Hoff	1	1	3	3	2.00	1
Oveson	4	4	1	1	2.50	1
Whitman	3	5	2	2	3.00	1
Treasure	2	2	4	4	3.00	1
Hyak	6	8	5	5	6.00	1
Gene	16	7	6	9	8.25	3
Rod	8	11	8	6	8.25	4
Malcolm	5	9	7	12	8.25	3
Madsen	9	6	11	7	9.00	3
W 301	11	7	10	8	9.00	4
MacVicar	7	5	14	10	9.50	3
Rohde	15	3	11	14	10.75	5
Stephens	12	14	12	11	11.00	4
Daws	10	12	9	13	12.25	3
Flora	19	10	13	16	14.50	5
Hill 81	14	13	16	19	15.50	5
Eltan	17	17	15	17	16.25	6
Dusty	13	15	17	20	16.50	4
Kmor	18	16	19	15	17.00	6
Yamhill	20	18	18	18	18.00	6
Average					10.05	
CV (5 %)					26	
PLSD (5 %)					3.6	
P-VALUE					0	

obective but some deductions and general observations can be made from the data. Yield is the main factor of interest to growers. My data shows that even high vernalization cultivars can be planted until the end of February and still get some yield, but not much (Fig 4.5.4 and Table 3.1.2). Low vernalization cultivars can be planted until late March and still have some yield (Fig 4.5.1). But yield decreases to about 50 percent of a normal fall seeding at about 40-50 VD. If 50 percent is used as the stopping point for acceptable yield, then the calendar date at which it can be reasonably expected to accumulate 40-50 VD, based on historic weather data, should be the last date on which any wheat cultivar is sown.

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APPENDIX

Ear data of wheat cultivars studied during 1991 to 1993 growing season.

Code	Year	Code	Variety	Code	Variety	Code	Variety
1	1991	1	Daws	11	Madsen	21	Celia
2	1992	2	Dusty	12	Malcolm	22	Juan
3	1993	3	Eltan	13	Oveson	23	Owens
		4	Flora	14	Rod	24	Lewjan
		5	Gene	15	Rohde	25	Penawawa
		6	Hill 81	16	Stephens	26	Rely
		7	Hoff	17	Treasure	27	Wadual
		8	Hyak	18	W 301		
		9	Kmor	19	Whitman		
		10	MacVicar	20	Yamhill		

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	1	1	19	19	17	22	21	43	47	29	55	53	2.0	1.6	1.1	2.3	2.0
1	1	2	22	19	21	18	16	75	45	55	48	40	3.7	1.6	2.4	1.9	1.7
1	1	3	18	21	20	20	17	60	65	66	63	50	2.7	1.7	3.1	2.6	2.3
1	1	4	20	20	18	21	21	60	74	72	79	78	2.3	3.2	2.4	3.0	3.9
1	1	5	17	19	19	19	17	44	65	58	60	46	1.7	3.5	2.6	2.9	2.0
1	1	6	20	16	20	17	17	67	60	76	52	51	1.8	2.9	3.7	2.6	2.0
1	1	7	18	18	16	15	19	68	65	45	37	66	3.0	2.7	1.7	1.6	3.1
1	1	8	18	17	17	16	16	61	50	57	53	43	2.2	1.9	2.5	2.5	1.8
1	1	9	16	17	18	17	17	40	51	56	45	46	1.6	1.8	2.1	1.9	2.1
1	1	10	12	21	16	19	17	24	52	50	61	43	0.7	2.3	2.0	2.0	1.0
1	1	11	13	18	18	18	17	27	55	58	60	42	0.8	1.6	2.6	2.5	1.0
1	1	12	17	18	15	17	17	42	57	36	61	34	1.4	2.7	1.3	2.5	1.7
1	1	13	19	18	16	17	20	60	50	48	39	68	2.1	2.4	1.7	1.5	2.2
1	1	14	16	16	17	15	18	49	45	49	34	59	0.5	1.6	1.9	0.6	1.8
1	1	15	15	17	15	16	15	36	35	40	26	31	0.5	0.9	1.2	0.2	1.1
1	1	16	18	16	15	15	15	36	23	39	27	44	1.2	0.6	1.2	0.7	2.0
1	2	1	17	21	18	17	15	49	77	59	60	33	1.8	3.1	1.9	2.4	1.1
1	2	2	21	18	18	15	17	76	49	54	41	59	3.2	1.8	2.0	1.6	2.3
1	2	3	19	22	18	19	19	67	90	56	63	73	2.8	3.5	2.3	2.4	2.9
1	2	4	18	15	19	18	16	65	55	66	70	40	2.5	1.8	2.7	2.6	1.6
1	2	5	18	16	15	17	15	66	44	47	48	40	3.1	1.8	1.9	2.2	1.1
1	2	6	18	19	18	16	17	64	63	74	54	53	2.8	2.1	3.0	2.0	1.8
1	2	7	19	15	18	17	18	62	39	69	58	55	2.4	1.8	2.4	2.0	1.7
1	2	8	14	14	18	17	15	49	50	66	65	51	2.2	1.9	2.8	2.7	1.9
1	2	9	19	18	16	15	15	59	68	53	42	44	2.4	2.6	2.1	1.5	1.3
1	2	10	17	16	17	18	16	48	46	54	57	48	2.0	1.9	1.6	1.5	1.3
1	2	11	18	20	19	17	18	36	53	55	49	59	1.0	1.9	1.8	1.8	2.3
1	2	12	19	18	16	17	22	33	48	45	60	58	1.2	1.2	0.7	2.3	0.4
1	2	13	25	14	17	22	14	68	38	40	56	37	2.4	1.1	1.0	1.6	1.1
1	2	14	17	20	16	16	20	40	0	44	34	0	1.0	0.0	2.0	1.0	0.0
1	2	15	19	16	22	13	17	0	39	36	22	31	0.0	1.1	0.2	0.3	0.5
1	2	16	16	11	19	15	14	35	25	0	0	20	0.1	0.1	0.0	0.0	0.1
1	3	1	17	16	16	18	17	41	53	39	47	44	1.7	2.5	1.4	2.2	1.4

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	3	2	18	18	18	17	17	49	52	53	43	44	2.0	2.0	2.1	1.8	1.7
1	3	3	17	20	17	15	17	46	71	55	51	45	1.9	2.8	2.4	1.9	1.8
1	3	4	17	17	15	16	19	60	59	40	50	64	2.7	2.5	1.7	2.1	2.3
1	3	5	18	16	17	14	17	60	40	49	43	65	2.7	1.8	2.1	1.7	2.9
1	3	6	17	16	19	15	15	45	50	53	46	43	1.7	2.1	1.8	1.1	1.7
1	3	7	18	18	17	17	13	59	67	69	47	38	3.2	2.6	2.5	1.5	1.6
1	3	8	15	15	16	15	15	48	45	57	56	41	1.9	1.6	2.1	2.4	1.7
1	3	9	16	18	15	17	15	47	57	44	55	42	2.0	2.6	1.6	2.4	1.3
1	3	10	18	15	17	16	14	55	44	56	49	34	2.1	1.9	2.4	1.1	1.6
1	3	11	17	14	14	12	17	47	36	42	28	55	1.7	1.0	1.5	0.6	2.0
1	3	12	14	14	15	15	17	32	35	43	41	39	0.7	1.3	1.3	0.1	1.3
1	3	13	15	12	13	10	11	35	29	31	19	27	0.7	1.2	0.5	0.7	1.1
1	3	14	15	16	15	13	12	20	37	18	35	26	0.6	1.1	0.5	1.4	0.4
1	3	15	14	17	13	14	15	35	0	32	0	28	0.8	0.0	0.8	0.0	0.5
1	3	16	13	11	13	13	14	0	19	21	0	31	0.0	0.2	0.3	0.0	0.8
1	4	1	29	35	33	31	0	49	107	71	72	0	2.1	4.9	2.9	3.8	0.0
1	4	2	34	31	36	37	27	76	69	65	85	0	3.6	3.8	2.2	5.0	0.0
1	4	3	30	31	37	36	35	78	68	79	66	83	4.1	3.8	5.7	2.9	4.5
1	4	4	28	34	33	33	24	60	68	96	88	74	3.2	3.0	4.4	3.9	3.5
1	4	5	34	33	36	34	37	90	90	94	105	98	4.6	4.4	4.1	5.3	4.2
1	4	6	33	31	36	34	32	82	84	131	78	86	3.4	4.5	5.7	3.7	4.6
1	4	7	30	35	37	36	38	58	87	56	89	52	2.2	4.8	2.2	4.9	1.9
1	4	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	4	9	31	32	28	34	32	69	44	56	89	46	2.5	1.0	2.7	3.8	1.5
1	4	10	38	28	31	32	29	58	80	79	76	48	1.9	2.7	2.9	2.8	2.2
1	4	11	32	34	30	33	38	67	64	60	60	78	2.5	2.2	1.9	1.7	3.0
1	4	12	35	24	34	31	36	67	36	64	60	75	1.7	1.3	2.1	2.6	2.5
1	4	13	30	32	35	32	39	17	55	71	49	67	0.3	2.2	3.0	1.2	2.8
1	4	14	26	30	32	29	27	40	61	63	54	45	0.5	1.9	1.8	0.4	1.0
1	4	15	24	27	29	29	26	23	20	54	43	0	0.1	0.1	1.2	0.7	0.0
1	4	16	24	25	25	19	27	0	20	21	31	0	0.0	0.1	0.0	0.2	0.0
1	5	1	20	21	23	22	19	58	61	69	57	44	3.1	2.9	3.3	2.5	2.0
1	5	2	14	24	13	21	20	20	65	20	47	68	1.0	2.9	1.1	2.2	3.2
1	5	3	16	18	20	23	23	28	37	46	67	72	1.4	1.9	2.2	3.3	3.3
1	5	4	21	21	18	23	19	43	60	47	49	48	2.4	3.0	2.2	2.5	2.2
1	5	5	17	21	21	22	21	18	59	71	78	69	1.0	2.6	3.2	3.3	3.1
1	5	6	21	18	21	22	21	64	43	64	65	62	2.7	2.0	3.2	3.2	2.9
1	5	7	23	20	23	17	24	80	54	84	46	90	3.2	2.5	3.8	2.1	3.9
1	5	8	19	15	18	19	19	49	35	47	50	45	2.2	1.6	2.5	2.5	2.0
1	5	9	20	21	21	18	18	46	63	53	42	45	1.9	3.0	2.0	2.0	2.0
1	5	10	23	21	22	20	19	78	46	51	60	39	3.0	1.2	1.4	2.3	1.1
1	5	11	16	18	21	23	21	26	41	49	74	50	1.2	1.6	2.0	3.5	1.6
1	5	12	18	18	17	18	22	47	39	31	48	56	2.2	1.8	1.5	2.1	2.4
1	5	13	19	22	18	22	22	37	50	47	67	59	1.3	1.7	2.0	3.0	2.5
1	5	14	23	22	25	23	24	56	52	79	68	68	1.5	1.9	3.6	3.2	2.6
1	5	15	21	23	18	16	19	35	52	29	37	32	1.0	2.3	1.1	1.1	1.7
1	5	16	12	16	17	20	22	16	38	27	50	65	0.5	1.2	0.6	1.6	2.4
1	6	1	19	23	21	21	0	39	73	98	51	0	1.8	3.5	2.7	2.1	0.0
1	6	2	22	21	22	19	13	47	58	54	50	21	2.4	2.8	3.0	2.4	1.0
1	6	3	19	19	18	17	18	61	45	59	41	43	3.2	2.0	3.0	1.5	2.1

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	6	4	16	21	20	17	18	48	68	46	46	47	2.6	3.5	3.7	1.9	2.5
1	6	5	17	14	21	18	20	50	37	76	59	74	2.4	1.6	3.8	2.8	3.8
1	6	6	22	21	21	19	17	73	75	69	40	55	3.0	3.5	3.5	1.7	2.4
1	6	7	22	21	19	19	22	97	71	59	60	68	4.3	3.6	2.5	2.8	3.7
1	6	8	21	18	19	22	21	83	60	59	76	79	4.3	2.9	2.4	3.8	3.8
1	6	9	19	17	23	11	21	60	57	82	54	76	3.1	2.8	3.4	2.7	3.3
1	6	10	16	21	21	21	22	45	67	66	72	69	1.8	2.4	3.5	3.3	3.0
1	6	11	18	19	21	20	21	47	53	71	49	59	2.1	1.5	3.3	2.0	2.2
1	6	12	18	17	21	18	18	42	51	67	45	55	1.7	2.2	2.2	1.8	2.0
1	6	13	23	19	17	19	20	62	52	42	62	53	1.9	1.8	1.4	2.2	1.9
1	6	14	18	20	17	22	21	29	11	40	52	52	0.5	0.3	1.5	1.0	1.3
1	6	15	15	19	16	22	21	37	45	29	49	26	1.5	0.9	0.8	1.8	0.3
1	6	16	16	16	19	17	19	38	43	38	36	47	1.0	1.4	0.4	1.4	1.9
1	7	1	19	22	16	17	18	52	60	32	49	44	2.1	3.2	1.0	1.7	1.9
1	7	2	18	17	17	19	17	39	40	34	44	34	2.2	1.8	1.6	2.5	1.2
1	7	3	19	17	20	20	21	36	37	48	51	36	1.9	1.9	2.4	2.7	1.2
1	7	4	17	17	19	19	16	42	43	50	59	39	2.3	1.7	2.3	1.8	1.1
1	7	5	19	18	18	19	23	42	48	57	52	89	2.0	2.3	2.7	2.2	3.5
1	7	6	17	18	20	19	17	51	54	59	45	43	2.4	2.4	3.0	1.8	1.6
1	7	7	19	19	17	20	18	60	56	40	44	54	3.0	2.8	2.1	2.7	2.9
1	7	8	20	17	18	19	16	63	39	47	60	32	3.3	1.9	2.5	3.3	1.5
1	7	9	18	17	16	17	18	51	54	40	35	50	2.8	3.0	1.8	1.8	2.7
1	7	10	17	16	14	14	17	47	53	37	35	56	2.3	2.4	1.6	1.5	2.9
1	7	11	15	14	15	16	16	45	45	49	50	55	2.0	2.2	2.3	2.4	2.2
1	7	12	17	15	13	17	16	48	42	43	51	46	2.2	2.0	2.1	2.6	2.4
1	7	13	15	13	13	16	17	39	47	45	47	50	1.6	2.3	2.3	2.3	2.5
1	7	14	15	15	13	16	15	41	52	39	47	39	2.0	2.3	1.6	2.0	1.8
1	7	15	13	14	13	13	15	30	35	41	39	46	1.4	1.9	2.0	1.9	2.5
1	7	16	13	11	11	13	16	35	16	28	27	40	1.7	0.7	1.3	1.3	2.2
1	8	11	19	18	17	16	19	65	70	51	50	59	2.9	3.4	2.1	1.9	2.6
1	8	12	18	17	19	20	16	71	57	62	69	40	3.6	2.5	3.2	3.3	1.8
1	8	9	18	18	17	19	18	65	59	66	67	62	3.1	2.7	2.9	2.8	2.7
1	8	10	20	19	19	14	20	69	63	66	66	68	2.3	2.6	2.8	2.9	2.8
1	8	15	15	16	20	18	16	39	61	51	60	46	1.7	1.4	3.0	1.7	2.5
1	8	16	16	16	18	15	19	49	28	29	41	59	1.8	0.6	1.6	1.6	2.9
1	8	13	19	19	17	18	17	66	73	29	52	58	3.3	3.7	1.1	2.5	2.7
1	8	14	19	18	19	17	18	75	66	72	29	56	3.9	3.0	2.2	1.6	2.4
1	8	3	17	19	17	14	18	58	59	69	69	59	2.1	3.2	3.1	2.7	2.7
1	8	4	20	18	19	18	17	92	60	61	61	46	3.6	2.2	2.7	2.7	2.2
1	8	1	20	19	19	20	19	60	52	56	60	59	2.9	2.0	2.3	2.5	2.2
1	8	2	17	19	17	17	19	50	59	49	42	54	2.7	2.2	2.7	2.1	2.3
1	8	7	18	22	17	20	16	78	83	46	72	48	4.7	5.8	2.2	3.7	2.0
1	8	8	22	19	17	19	18	63	65	66	61	59	2.2	3.3	2.8	2.8	3.2
1	8	5	20	19	19	17	17	67	60	56	66	51	2.6	2.7	2.3	3.3	2.4
1	8	6	17	18	18	19	20	109	65	49	67	83	5.9	3.1	2.4	2.9	4.4
1	9	1	17	17	16	20	19	40	43	49	56	52	1.9	2.1	2.4	2.1	2.2
1	9	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	9	3	18	19	15	15	13	59	44	39	40	31	2.4	1.6	1.9	1.7	1.3
1	9	4	18	14	16	18	20	64	42	48	53	64	2.3	1.2	1.6	1.7	2.3
1	9	5	17	20	17	18	17	53	53	60	57	56	2.2	2.5	2.8	2.4	2.6
1	9	6	19	18	17	16	18	66	52	51	49	61	3.6	2.2	2.2	1.9	2.6

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	9	7	13	13	16	17	17	32	30	64	52	58	1.3	1.0	2.6	2.2	2.4
1	9	8	16	13	16	16	19	34	33	39	46	53	1.5	1.5	1.6	2.1	2.4
1	9	9	15	13	17	16	18	43	32	56	47	59	1.3	1.5	2.8	1.7	2.3
1	9	10	15	15	16	17	16	37	44	44	53	51	1.2	1.4	1.7	1.9	1.6
1	9	11	13	14	17	20	18	28	33	42	45	59	1.1	1.1	1.7	1.8	2.1
1	9	12	14	11	16	16	16	15	24	32	30	39	0.1	0.9	1.0	0.8	1.4
1	9	13	12	12	17	15	18	5	29	37	39	45	0.1	0.5	0.9	0.4	1.4
1	9	14	14	13	12	13	15	34	28	29	26	27	0.7	0.1	0.4	0.6	0.5
1	9	15	12	16	13	15	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
1	9	16	13	12	11	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
1	10	1	14	14	16	17	14	36	25	38	51	37	1.8	1.4	1.4	3.0	2.0
1	10	2	19	19	16	19	17	55	48	30	54	35	2.4	3.1	1.9	2.9	2.2
1	10	3	19	20	16	21	18	43	53	39	51	42	2.6	2.7	2.4	1.8	2.2
1	10	4	20	20	18	19	17	63	65	51	66	44	3.4	3.5	2.5	3.8	2.6
1	10	5	18	15	17	18	15	46	78	53	57	37	2.8	2.4	3.1	3.5	1.6
1	10	6	16	14	19	14	16	38	41	62	37	47	2.1	2.3	4.1	2.0	2.0
1	10	7	21	15	20	15	19	85	34	74	55	58	5.5	1.9	3.4	3.1	3.4
1	10	8	17	18	14	16	18	57	61	35	44	49	3.2	3.8	1.9	2.7	3.2
1	10	9	16	18	15	19	14	48	63	45	65	40	2.7	3.9	2.2	3.6	2.4
1	10	10	20	15	19	18	19	65	42	53	56	60	2.6	2.0	2.6	3.2	3.0
1	10	11	19	18	16	18	17	35	44	49	50	53	1.6	2.2	2.5	2.4	2.5
1	10	12	19	15	19	18	19	65	32	44	36	53	3.3	1.9	2.7	2.1	2.4
1	10	13	17	17	17	14	19	49	45	42	38	49	1.5	1.9	1.5	1.1	1.6
1	10	14	13	16	14	17	17	32	38	35	43	39	1.6	1.8	1.3	1.3	2.0
1	10	15	13	19	15	16	16	25	51	32	38	40	0.6	2.3	1.6	1.0	1.3
1	10	16	15	12	16	17	16	25	20	0	38	41	0.3	0.6	0.0	1.1	1.1
1	11	1	17	20	19	23	22	31	47	46	76	77	1.3	1.9	1.8	3.6	3.4
1	11	2	18	18	17	15	18	45	51	42	28	41	1.5	2.3	1.4	1.1	1.7
1	11	3	16	19	16	21	21	35	55	40	56	59	1.4	2.1	1.5	2.7	2.2
1	11	4	20	21	21	19	15	25	62	67	45	40	0.9	2.6	3.0	0.9	1.6
1	11	5	20	16	16	20	19	65	46	49	62	65	3.0	1.9	2.1	2.7	2.5
1	11	6	20	17	18	19	17	64	59	55	52	55	3.0	2.3	2.3	2.1	2.0
1	11	7	19	17	20	17	20	57	50	56	58	83	2.4	2.2	2.2	2.2	3.1
1	11	8	20	19	17	18	17	56	71	45	47	48	2.1	3.0	1.9	2.0	2.1
1	11	9	20	18	11	18	18	61	55	18	51	51	2.9	2.3	1.0	2.1	2.1
1	11	10	20	21	19	21	16	63	61	62	89	39	2.7	2.7	2.1	4.0	1.3
1	11	11	17	17	17	18	18	34	47	49	52	43	1.2	2.1	2.2	2.2	2.0
1	11	12	20	17	20	16	18	58	50	61	42	55	2.4	2.1	2.8	1.6	1.7
1	11	13	17	20	18	21	19	59	70	47	67	50	1.9	3.0	1.9	1.4	1.7
1	11	14	16	15	17	19	17	47	34	46	57	56	2.3	1.3	1.4	2.1	2.2
1	11	15	15	18	20	14	17	45	55	36	36	53	1.7	2.4	1.2	0.6	2.1
1	11	16	21	19	19	19	19	33	51	45	47	107	0.5	1.6	1.4	0.9	0.5
1	12	1	15	19	20	16	17	36	55	61	41	51	1.6	3.3	3.5	2.5	2.9
1	12	2	17	16	14	17	15	42	32	30	39	38	2.6	1.9	1.6	2.1	2.3
1	12	3	17	17	14	17	20	32	41	28	46	5	1.7	2.3	1.0	3.3	3.7
1	12	4	20	16	20	17	15	63	40	58	44	41	3.9	2.3	3.5	2.0	2.2
1	12	5	14	16	20	17	18	33	39	60	50	48	2.9	2.4	3.5	2.8	2.0
1	12	6	15	17	17	19	15	24	57	37	52	38	1.2	3.6	2.3	2.6	2.0
1	12	7	20	19	17	14	15	55	58	40	47	24	3.3	3.5	2.3	3.2	0.7
1	12	8	16	18	17	19	17	43	56	35	45	45	2.5	3.6	1.9	2.4	2.4
1	12	9	16	16	15	17	14	33	47	45	55	36	1.7	2.9	2.4	3.1	2.1

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	12	10	19	17	18	17	19	62	46	50	40	53	2.6	2.2	2.2	1.3	2.1
1	12	11	17	17	15	16	16	50	50	34	44	44	2.8	2.9	2.0	1.7	2.4
1	12	12	15	18	17	17	19	49	64	40	55	46	2.7	3.0	2.0	2.9	2.7
1	12	13	15	20	20	14	15	35	54	41	30	37	1.5	3.2	2.3	1.4	1.7
1	12	14	18	17	17	16	14	46	38	36	53	33	2.3	1.6	1.3	2.4	1.4
1	12	15	19	14	18	16	15	40	30	43	47	30	0.4	1.0	1.4	2.3	1.2
1	12	16	14	17	14	15	0	33	32	30	38	0	1.5	1.1	1.6	1.6	0.0
1	13	1	17	17	18	20	13	42	31	42	43	23	1.8	1.3	2.1	2.3	1.0
1	13	2	17	18	19	20	16	38	39	43	56	31	1.7	1.7	2.0	3.0	1.4
1	13	3	16	17	16	19	16	37	36	34	40	36	1.7	1.6	1.6	2.3	1.5
1	13	4	18	18	19	18	20	43	47	44	55	51	0.4	0.2	0.3	2.4	2.2
1	13	5	19	15	17	18	17	48	35	44	43	41	1.8	1.9	1.8	2.1	1.7
1	13	6	15	15	15	16	21	40	30	41	44	59	1.9	1.5	1.6	1.4	2.5
1	13	7	15	19	14	15	18	26	59	37	35	59	1.2	2.6	1.5	1.2	2.5
1	13	8	17	20	19	17	17	43	59	61	44	51	2.4	1.7	2.7	2.0	2.2
1	13	9	14	14	18	17	13	34	33	42	45	24	1.3	1.1	1.8	1.6	1.0
1	13	10	18	16	18	17	19	54	42	59	39	55	1.7	1.4	2.1	0.9	1.9
1	13	11	19	20	18	21	16	51	61	58	59	42	1.7	1.8	2.2	1.6	1.4
1	13	12	19	17	18	19	19	57	46	38	51	39	2.1	1.5	0.9	2.0	1.2
1	13	13	17	15	12	17	17	47	32	23	57	46	1.4	0.7	0.7	2.3	1.2
1	13	14	17	18	14	17	17	41	36	25	42	42	0.8	0.4	0.4	1.0	1.4
1	13	15	18	15	15	13	14	46	39	36	36	34	1.4	1.1	1.2	0.9	1.2
1	13	16	13	19	12	14	17	30	43	26	38	53	0.9	1.8	0.7	1.5	1.7
1	14	1	19	16	17	19	19	62	35	43	60	58	3.0	1.5	1.5	2.5	1.8
1	14	2	19	18	19	18	18	46	43	53	46	43	2.0	1.8	2.4	1.5	2.4
1	14	3	17	23	20	18	16	44	72	67	58	44	1.8	3.1	2.4	2.0	1.4
1	14	4	21	18	20	19	19	73	51	70	61	70	2.9	2.0	2.8	2.4	2.8
1	14	5	19	15	17	18	18	65	48	45	54	55	1.7	1.9	1.7	2.1	2.2
1	14	6	17	16	22	17	16	55	46	89	52	42	2.4	1.5	4.0	2.1	1.5
1	14	7	16	19	21	17	19	46	70	79	69	57	2.2	2.6	3.4	2.4	1.7
1	14	8	16	19	15	22	18	47	67	40	84	48	1.9	2.6	1.4	4.6	2.0
1	14	9	14	20	17	17	18	38	68	49	58	42	1.3	3.1	2.4	2.7	2.0
1	14	10	21	21	16	20	16	67	73	52	64	64	3.6	3.5	1.9	3.6	1.8
1	14	11	15	17	16	17	20	37	40	42	58	77	1.1	1.0	1.3	2.1	3.0
1	14	12	17	20	17	16	17	47	62	53	39	51	1.8	1.7	1.8	1.3	1.7
1	14	13	17	17	21	13	16	49	56	77	30	47	1.2	1.3	2.2	0.8	1.3
1	14	14	17	18	15	17	14	58	55	41	56	36	2.0	1.9	1.8	1.4	0.7
1	14	15	13	14	16	15	15	36	35	35	23	43	1.0	0.8	1.0	0.4	0.5
1	14	16	17	19	15	15	18	21	63	46	36	56	0.3	0.6	1.0	0.8	1.3
1	15	1	19	22	21	20	21	42	53	63	51	55	1.8	2.1	3.0	2.1	2.1
1	15	2	20	18	19	23	19	51	58	36	60	69	1.6	2.2	1.1	2.0	2.5
1	15	3	23	17	18	17	20	72	42	48	56	54	2.6	1.5	1.7	2.6	1.8
1	15	4	17	20	21	17	19	42	76	79	70	70	0.8	3.0	1.9	2.6	2.3
1	15	5	20	19	20	21	22	57	56	57	74	67	2.4	2.1	2.3	2.7	2.2
1	15	6	15	22	19	18	20	37	70	66	50	77	1.5	2.9	2.9	1.8	3.2
1	15	7	18	21	20	19	20	69	77	80	68	60	3.0	3.1	2.8	2.5	1.8
1	15	8	21	19	18	19	21	84	66	64	66	59	3.3	2.5	2.4	2.6	2.0
1	15	9	19	19	20	20	19	63	60	73	61	71	2.5	2.5	2.6	2.3	2.7
1	15	10	15	18	20	18	17	39	68	78	52	61	1.2	2.5	2.4	1.7	1.8
1	15	11	21	19	19	21	20	72	51	59	67	71	2.7	1.9	2.1	2.4	2.2
1	15	12	19	17	17	19	17	68	59	59	70	57	2.2	2.3	1.9	2.2	2.0

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	15	13	18	19	19	21	21	65	49	60	57	62	1.7	1.7	2.3	1.3	2.4
1	15	14	19	20	19	19	19	41	46	55	66	60	1.1	1.2	1.7	1.9	1.6
1	15	15	17	18	18	20	17	47	47	64	48	35	1.4	1.6	2.1	0.6	0.5
1	15	16	21	19	16	18	15	56	51	31	56	45	2.1	1.7	0.6	1.5	1.9
1	16	1	16	12	16	16	14	37	24	39	39	33	0.7	0.4	2.1	1.6	1.6
1	16	2	15	18	14	17	16	33	42	25	45	47	2.6	2.4	1.3	2.1	2.6
1	16	3	17	17	16	16	14	49	44	38	50	38	2.5	2.2	1.8	2.7	1.6
1	16	4	16	17	19	17	17	46	44	56	46	53	2.4	2.3	2.6	2.4	2.2
1	16	5	18	16	18	17	18	56	41	48	45	47	3.3	1.9	2.6	2.2	2.4
1	16	6	18	16	15	15	19	51	44	47	42	61	2.4	1.7	2.4	2.1	2.2
1	16	7	15	16	19	16	18	35	51	65	55	67	1.2	2.3	2.8	2.6	3.5
1	16	8	17	16	15	18	17	57	53	42	54	57	2.7	2.5	2.1	2.6	3.0
1	16	9	14	16	13	15	15	36	41	30	40	45	1.7	2.0	1.4	2.2	2.2
1	16	10	17	18	18	18	19	34	64	64	38	64	1.9	2.4	2.4	0.9	2.2
1	16	11	19	14	13	18	19	55	39	30	59	72	2.5	1.5	0.9	1.5	2.8
1	16	12	15	18	13	18	14	40	56	31	56	52	1.6	2.4	1.0	2.1	1.7
1	16	13	15	17	16	14	11	47	50	51	36	23	1.2	1.6	1.0	1.0	0.5
1	16	14	12	15	17	15	14	24	49	46	37	34	0.4	1.6	1.3	1.2	0.8
1	16	15	14	13	13	14	13	40	32	25	13	36	1.2	0.7	0.6	0.1	1.3
1	16	16	16	12	17	8	11	38	20	48	14	21	0.5	0.1	0.1	0.5	0.5
1	17	1	20	21	21	23	20	54	61	48	75	59	1.7	2.3	1.4	2.9	2.1
1	17	2	22	19	25	25	20	69	36	82	74	50	2.2	0.5	2.9	2.8	1.7
1	17	3	20	19	22	23	22	46	45	55	75	67	1.4	1.5	1.9	3.1	2.3
1	17	4	20	20	19	23	19	62	69	48	107	60	2.1	2.2	1.3	4.2	2.0
1	17	5	23	17	21	20	23	84	36	76	77	86	3.2	1.2	2.8	3.0	2.9
1	17	6	18	21	20	19	19	68	65	61	66	69	2.2	2.1	2.0	2.3	2.5
1	17	7	20	18	21	19	21	69	59	86	55	69	0.8	2.0	3.0	2.2	2.7
1	17	8	20	17	18	21	18	59	10	58	72	64	2.5	1.5	2.3	3.0	2.8
1	17	9	19	19	19	18	19	56	69	72	54	61	2.2	3.0	3.0	2.2	2.1
1	17	10	19	19	21	18	18	59	75	44	39	66	1.8	2.5	1.8	1.0	2.4
1	17	11	17	21	20	19	20	56	70	64	68	55	1.5	1.8	2.0	2.0	1.2
1	17	12	21	16	19	17	19	68	49	50	43	53	2.8	0.7	2.1	1.6	1.8
1	17	13	21	18	19	21	20	71	59	59	66	56	1.8	1.4	1.9	1.9	1.4
1	17	14	20	17	19	20	21	50	36	52	44	67	1.3	0.9	1.2	0.7	***
1	17	15	19	17	19	17	16	24	16	40	36	26	0.6	0.1	1.2	0.5	1.0
1	17	16	21	15	22	19	17	29	28	20	0	0	0.3	0.5	0.2	0.0	0.0
1	18	1	16	15	16	17	18	38	30	39	50	39	1.9	1.5	1.8	3.1	1.9
1	18	2	18	15	16	17	16	55	41	35	42	41	1.4	2.2	1.8	2.3	2.0
1	18	3	21	16	19	16	18	71	47	55	41	44	1.6	2.2	3.1	2.1	2.4
1	18	4	15	14	15	18	17	41	24	34	57	59	1.0	1.1	1.7	3.2	2.6
1	18	5	15	18	18	13	17	43	60	50	32	53	2.0	3.4	2.4	1.5	3.2
1	18	6	14	15	15	16	16	33	35	39	41	39	1.7	1.6	2.0	2.0	1.9
1	18	7	17	17	17	18	14	52	52	47	64	39	2.7	0.8	2.6	3.6	2.0
1	18	8	15	14	14	11	15	49	39	38	20	41	2.6	2.0	2.3	0.8	2.5
1	18	9	12	15	15	14	14	26	48	41	45	32	1.1	2.3	1.8	1.8	1.4
1	18	10	15	13	18	15	15	45	35	68	43	37	1.3	1.2	2.8	1.3	0.9
1	18	11	15	13	14	16	16	40	22	38	41	45	1.7	0.8	1.7	1.3	1.9
1	18	12	14	13	16	14	14	34	33	56	30	36	1.2	1.1	2.1	0.9	1.5
1	18	13	15	13	17	12	16	31	29	43	25	33	0.9	0.6	1.8	0.9	1.3
1	18	14	13	14	17	13	14	35	46	45	36	32	1.2	1.4	0.8	1.3	0.7
1	18	15	12	12	14	13	15	25	22	48	35	45	1.0	0.5	1.3	0.5	1.4

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	18	16	14	17	14	13	15	25	53	31	31	41	0.3	1.8	0.3	1.8	0.5
1	19	1	32	30	33	18	13	75	54	77	51	22	4.4	3.0	4.8	3.3	1.0
1	19	2	37	30	33	29	36	76	50	49	39	74	4.5	2.8	3.0	2.5	4.1
1	19	3	32	37	31	34	37	71	62	54	116	79	4.1	2.5	2.2	7.3	2.8
1	19	4	31	29	33	33	31	86	63	77	75	44	4.1	3.4	2.2	3.9	3.1
1	19	5	35	32	31	30	33	110	90	60	75	69	5.1	4.8	2.8	4.2	3.6
1	19	6	31	31	31	30	32	83	32	76	98	62	4.4	1.9	4.5	3.1	2.3
1	19	7	31	30	30	32	33	70	66	88	89	95	4.0	3.8	4.6	4.1	5.5
1	19	8	31	35	27	29	28	57	92	44	73	43	2.9	4.5	1.8	3.9	2.2
1	19	9	34	33	31	26	29	113	64	95	68	51	6.8	2.2	5.4	3.0	3.3
1	19	10	26	31	29	31	30	67	94	83	54	72	4.1	5.8	4.8	2.8	3.8
1	19	11	31	30	27	29	27	80	88	65	94	44	4.2	4.0	2.8	4.9	2.2
1	19	12	34	26	25	30	33	46	70	61	62	94	1.3	4.2	3.0	3.1	5.3
1	19	13	27	31	24	27	29	83	81	66	62	73	4.4	5.0	2.3	2.7	4.7
1	19	14	23	25	31	28	26	55	47	56	52	57	2.2	3.1	1.6	1.9	2.0
1	19	15	30	28	29	32	30	59	81	69	66	61	1.9	4.3	3.1	2.3	3.1
1	19	16	25	23	26	27	30	58	60	76	52	55	2.5	3.0	4.8	2.6	2.0
1	20	1	19	21	19	19	18	44	76	58	46	37	2.4	3.7	3.2	1.7	1.7
1	20	2	20	17	15	21	19	33	30	29	63	57	0.7	2.2	0.7	3.5	2.5
1	20	3	21	18	22	20	19	65	45	67	59	43	3.2	1.8	3.5	3.0	2.9
1	20	4	21	19	18	19	22	69	48	48	45	64	2.4	1.6	2.2	1.5	2.7
1	20	5	19	20	19	19	17	60	57	43	48	42	2.5	2.6	1.9	2.1	1.5
1	20	6	19	17	21	17	22	59	41	68	43	72	2.6	1.4	3.1	1.6	3.4
1	20	7	20	21	21	21	21	69	55	63	59	50	3.2	2.3	2.0	2.6	2.4
1	20	8	19	23	20	21	21	51	70	52	66	45	2.1	2.8	2.3	2.4	1.1
1	20	9	19	21	19	21	22	49	74	44	65	54	1.7	2.2	1.2	2.2	1.9
1	20	10	21	18	23	23	20	50	26	54	55	45	1.9	0.5	1.9	1.6	1.0
1	20	11	24	23	23	22	16	56	42	46	56	34	1.7	0.7	1.5	1.9	0.7
1	20	12	21	20	19	18	20	0	36	0	35	36	0.0	1.2	0.0	1.2	1.0
1	20	13	20	14	18	16	19	0	18	28	26	14	0.0	0.2	0.6	0.6	0.4
1	20	14	21	12	17	21	22	37	0	0	0	0	0.3	0.0	0.0	0.0	0.0
1	20	15	18	18	19	20	23	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
1	20	16	16	16	19	23	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	1	1	22	23	17	23	23	60	74	52	58	58	3.1	3.1	2.6	3.2	2.3
2	1	2	24	23	22	19	21	74	70	55	48	68	3.2	2.6	2.2	2.2	2.6
2	1	3	19	17	20	18	17	45	44	57	44	45	1.3	2.2	2.8	2.1	1.8
2	1	4	19	19	17	20	18	49	55	45	45	69	1.9	3.1	2.5	1.5	3.2
2	1	5	20	20	19	19	16	61	60	47	49	34	2.8	2.7	1.2	1.3	1.4
2	1	6	19	18	17	18	19	48	47	47	45	45	1.3	2.0	2.3	1.6	1.6
2	1	7	20	17	20	18	18	49	0	39	50	38	1.7	0.0	1.0	1.5	1.3
2	1	8	22	19	21	21	19	46	32	52	50	41	1.7	1.3	2.3	2.1	1.7
2	1	9	14	15	20	21	17	30	34	25	50	43	1.4	1.7	0.6	1.7	2.1
2	1	10	22	19	19	18	18	0	0	0	32	34	0.0	0.0	0.0	0.5	0.8
2	1	11	13	14	21	21	14	22	34	38	31	37	0.8	1.5	1.2	1.5	1.7
2	1	12	14	15	17	14	13	23	0	0	20	0	0.8	0.0	0.0	1.3	0.0
2	1	13	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	1	14	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	2	1	17	18	17	19	0	44	55	38	60	0	1.9	2.3	1.5	2.2	0.0
2	2	2	20	19	20	22	23	65	60	59	70	68	2.8	2.4	1.8	3.1	3.2
2	2	3	17	18	17	20	17	49	65	62	64	54	2.0	3.0	2.4	2.7	3.0
2	2	4	20	19	19	19	20	60	52	61	50	50	2.1	1.8	2.7	2.2	2.1

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2	2	5	19	20	21	18	19	58	67	66	48	60	2.4	2.3	2.5	2.4	2.6
2	2	6	19	18	20	18	19	66	56	53	43	46	2.3	1.9	1.1	1.3	1.4
2	2	7	20	21	18	19	25	61	53	50	46	61	1.7	2.3	2.3	1.8	1.2
2	2	8	19	24	18	18	20	58	61	47	43	43	2.1	1.9	1.7	1.5	0.0
2	2	9	25	22	16	17	18	55	58	32	38	24	1.6	1.6	0.5	1.1	0.2
2	2	10	16	17	17	22	17	0	0	30	32	38	0.0	0.0	1.1	1.3	1.0
2	2	11	12	15	20	16	14	21	30	0	0	0	0.6	1.1	0.0	0.0	0.0
2	2	12	14	12	13	15	14	25	29	24	35	24	0.7	0.9	0.7	1.2	0.1
2	2	13	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	2	14	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	3	1	20	21	20	19	20	55	76	66	52	58	2.2	3.3	2.9	2.3	2.5
2	3	2	21	20	19	22	19	62	63	68	77	64	2.6	2.5	3.1	3.4	2.7
2	3	3	6	14	18	16	18	16	38	52	46	55	0.4	1.8	2.2	1.6	2.2
2	3	4	20	20	19	20	18	61	56	61	51	53	2.0	2.2	2.7	2.0	2.0
2	3	5	19	18	14	18	21	58	54	63	59	43	2.5	2.0	2.9	2.2	1.4
2	3	6	16	18	17	20	17	41	54	51	48	50	1.9	2.1	2.1	1.7	2.0
2	3	7	14	17	18	15	16	37	29	41	38	36	1.0	1.0	1.6	1.3	1.2
2	3	8	15	19	17	19	23	35	38	32	35	50	0.9	1.2	1.2	1.3	1.4
2	3	9	20	15	15	19	15	40	25	0	0	0	1.3	0.7	0.0	0.0	0.0
2	3	10	0	14	15	14	12	0	30	36	33	17	0.0	0.7	1.0	0.8	0.5
2	3	11	16	14	15	10	9	32	31	37	26	18	0.9	0.8	1.1	0.5	0.5
2	3	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	3	13	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	3	14	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	4	1	43	39	40	41	40	93	101	69	89	90	3.5	3.9	2.3	3.1	3.3
2	4	2	41	36	40	39	33	77	79	107	86	67	2.7	4.4	5.3	2.7	2.2
2	4	3	42	41	37	40	34	100	99	68	75	84	4.8	4.7	2.5	3.4	3.9
2	4	4	40	43	41	42	0	66	92	99	56	0	3.5	4.2	4.6	1.5	0.0
2	4	5	35	35	36	33	33	59	54	49	57	59	1.8	1.7	1.3	2.8	2.9
2	4	6	36	34	27	36	36	61	52	41	61	57	2.3	1.9	1.2	2.0	1.8
2	4	7	37	34	37	30	39	59	48	63	50	60	2.4	1.5	2.6	1.7	1.9
2	4	8	40	30	32	30	30	81	47	47	43	49	2.2	1.5	1.6	1.2	1.6
2	4	9	29	23	31	24	33	58	46	55	0	50	1.8	6.7	0.7	0.0	1.8
2	4	10	29	31	25	24	31	43	65	38	0	53	0.6	2.3	0.9	0.0	1.7
2	4	11	20	26	25	21	17	47	47	59	50	40	1.8	0.7	2.0	1.7	1.3
2	4	12	16	22	23	17	16	18	47	40	13	24	0.6	1.5	1.3	0.3	0.6
2	4	13	14	15	19	21	17	40	37	36	31	42	1.3	1.5	1.1	0.2	1.5
2	4	14	19	18	17	15	15	37	34	31	23	20	1.2	1.1	1.3	0.6	0.5
2	5	1	22	23	24	23	22	74	67	77	66	73	3.8	3.7	3.9	2.8	3.3
2	5	2	21	22	23	24	23	53	76	76	76	67	2.7	3.5	4.0	3.6	2.0
2	5	3	20	26	24	22	18	55	86	72	56	55	2.3	3.1	3.2	2.2	2.0
2	5	4	21	24	23	21	23	53	60	54	47	65	2.3	2.5	2.4	2.4	3.1
2	5	5	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	5	6	20	21	18	18	17	73	63	66	46	43	2.5	2.4	2.6	2.2	1.9
2	5	7	20	20	18	22	20	65	71	40	74	55	2.1	2.4	1.3	2.0	1.4
2	5	8	17	20	16	20	18	45	37	52	41	38	1.8	0.9	2.3	1.5	1.6
2	5	9	21	22	21	18	18	37	62	49	33	51	0.8	2.6	2.3	1.4	2.3
2	5	10	26	17	21	19	20	51	35	59	47	48	1.4	0.8	2.4	2.2	1.4
2	5	11	23	21	16	21	17	58	37	46	63	44	1.4	1.1	1.6	2.5	1.9
2	5	12	17	14	15	14	14	18	25	41	31	35	0.8	0.6	1.8	1.0	1.4
2	5	13	21	22	20	16	18	51	53	37	48	42	2.1	2.3	1.4	1.9	1.4

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2	5	14	12	16	13	12	14	23	38	35	33	30	0.6	1.2	1.3	1.2	1.2
2	6	1	24	27	23	23	27	96	100	75	66	101	4.8	5.0	3.6	3.0	4.8
2	6	2	23	25	24	26	24	95	92	89	101	93	3.9	4.1	3.1	4.3	3.9
2	6	3	23	22	22	22	24	72	77	67	77	78	3.3	3.4	2.9	2.8	3.2
2	6	4	23	23	20	22	22	67	70	61	46	67	2.5	3.3	2.2	1.6	2.9
2	6	5	24	25	24	21	21	76	56	79	55	39	2.7	1.8	3.1	2.4	0.8
2	6	6	23	22	26	21	27	69	53	55	64	84	3.2	1.6	6.7	2.3	2.9
2	6	7	22	22	22	26	25	57	60	51	81	54	2.2	2.4	1.9	3.0	1.9
2	6	8	22	20	25	25	20	53	43	66	70	56	1.7	1.4	2.4	2.6	1.3
2	6	9	18	18	23	18	19	44	49	36	41	47	1.3	1.5	1.7	1.1	1.3
2	6	10	24	21	23	20	22	43	47	53	40	41	1.3	1.2	1.1	0.9	1.3
2	6	11	18	21	14	19	22	44	41	24	25	39	1.1	1.3	0.7	0.9	1.3
2	6	12	17	15	19	17	13	29	27	37	32	26	0.5	0.7	1.1	0.8	0.7
2	6	13	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	6	14	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	7	1	20	21	19	19	19	86	68	71	51	57	4.5	2.3	2.6	2.8	3.2
2	7	2	20	21	21	22	22	48	57	69	73	73	2.1	2.6	3.6	3.3	3.5
2	7	3	23	23	23	22	21	65	77	56	57	71	2.9	4.0	1.9	3.1	3.6
2	7	4	20	21	20	19	19	57	65	56	55	47	2.5	3.6	2.9	2.8	2.3
2	7	5	18	18	18	19	18	56	53	63	50	62	2.9	2.9	3.2	2.8	2.7
2	7	6	18	18	17	18	14	62	55	53	54	67	3.0	3.0	2.8	2.5	3.5
2	7	7	19	14	15	16	15	72	60	44	64	46	3.5	2.3	2.3	3.0	2.4
2	7	8	16	18	15	15	16	55	68	62	61	60	2.6	3.3	3.4	3.0	3.0
2	7	9	20	19	19	18	18	65	61	59	51	57	3.1	3.2	3.2	2.6	2.8
2	7	10	15	18	18	17	19	52	67	62	59	78	2.7	3.4	2.8	2.5	3.4
2	7	11	15	13	15	15	12	50	42	56	57	45	2.5	2.0	3.0	3.1	2.3
2	7	12	14	15	15	15	16	52	49	66	55	56	2.7	2.3	3.0	2.7	2.7
2	7	13	15	15	16	16	17	57	53	59	47	55	2.5	2.6	2.6	2.2	2.0
2	7	14	16	15	14	16	16	55	41	38	44	45	2.2	1.8	1.8	2.2	1.8
2	8	1	17	23	20	19	19	57	105	74	82	80	2.1	5.8	3.0	3.5	3.6
2	8	2	19	18	21	19	21	92	62	91	92	78	4.3	2.4	4.9	3.6	3.2
2	8	3	19	20	17	18	21	62	66	50	69	81	2.2	3.2	2.2	3.3	3.7
2	8	4	18	15	15	17	18	55	44	55	69	60	2.4	1.7	2.5	3.4	1.6
2	8	5	17	18	17	21	18	40	63	45	75	60	1.2	2.9	1.4	2.3	2.8
2	8	6	19	19	18	20	21	80	78	70	60	76	2.9	2.8	2.7	1.9	2.3
2	8	7	21	20	18	21	21	55	71	72	66	75	1.8	3.6	3.4	2.7	3.3
2	8	8	22	19	23	21	21	68	60	78	71	70	3.2	2.7	2.7	2.6	2.7
2	8	9	21	21	22	21	18	53	55	43	49	48	1.8	1.9	1.3	1.7	2.7
2	8	10	20	21	21	21	21	54	42	40	59	53	1.4	1.2	1.0	2.1	1.8
2	8	11	19	16	20	18	18	0	37	42	28	32	0.0	1.3	1.2	1.1	1.3
2	8	12	18	21	19	18	20	43	35	15	37	31	0.4	1.1	0.2	1.1	0.7
2	8	13	17	16	17	15	16	52	16	17	38	15	0.9	0.0	0.1	1.0	0.3
2	8	14	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	9	1	19	21	25	18	23	41	78	79	41	94	2.1	3.7	3.2	1.6	4.6
2	9	2	25	18	15	20	19	83	43	45	51	48	2.8	1.7	1.9	2.2	2.1
2	9	3	21	17	15	17	17	69	45	43	58	61	3.1	1.7	1.5	2.7	2.5
2	9	4	17	17	20	19	16	44	46	52	66	35	1.6	1.7	2.5	2.8	1.3
2	9	5	22	19	21	18	0	56	48	47	55	0	2.3	1.8	1.8	2.3	0.0
2	9	6	21	16	18	18	18	63	40	44	50	48	2.2	1.4	1.9	2.3	2.1
2	9	7	15	21	21	22	21	30	49	47	45	52	1.0	1.9	1.8	1.9	2.2
2	9	8	19	20	19	23	17	42	56	40	40	32	1.3	2.4	1.2	1.7	0.7

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2	9	9	19	16	11	9	11	36	20	0	0	21	1.2	0.4	0.0	0.0	1.0
2	9	10	12	10	18	11	14	36	9	0	22	0	0.8	0.3	0.0	0.4	0.0
2	9	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	9	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	9	13	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	9	14	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	10	1	22	23	18	21	24	72	69	52	64	82	3.8	3.3	2.8	3.6	4.7
2	10	2	23	23	23	22	22	72	62	66	65	60	3.5	2.5	3.5	2.9	2.5
2	10	3	20	21	20	21	18	60	66	57	48	31	3.3	3.8	2.4	2.6	1.7
2	10	4	22	15	21	16	21	75	27	59	52	55	4.3	1.6	3.5	3.0	3.1
2	10	5	22	21	19	21	17	84	82	71	70	61	4.1	4.6	3.2	3.7	2.5
2	10	6	17	20	18	19	18	55	64	60	78	70	2.8	2.7	2.9	3.9	3.1
2	10	7	18	21	22	17	14	72	76	91	57	36	3.2	3.6	4.4	2.5	1.4
2	10	8	20	23	21	17	19	71	73	57	42	50	3.2	2.8	2.1	1.5	2.4
2	10	9	17	18	19	15	15	67	63	80	46	41	3.0	2.2	4.0	2.0	1.7
2	10	10	17	18	17	18	19	48	29	37	49	48	1.8	1.4	1.4	2.0	2.3
2	10	11	15	17	16	15	16	20	54	42	37	42	0.6	1.8	1.2	1.4	1.1
2	10	12	16	14	20	15	15	48	34	34	49	44	1.7	0.3	1.0	0.8	1.2
2	10	13	12	11	10	14	9	27	27	34	36	27	0.8	0.9	0.9	1.1	0.7
2	10	14	14	15	12	12	10	34	40	19	17	24	1.0	1.4	0.7	0.5	0.9
2	11	1	21	21	23	24	25	53	51	77	77	76	2.5	2.1	4.0	3.6	3.6
2	11	2	24	23	22	24	23	75	54	66	68	54	3.8	2.3	2.0	3.3	2.3
2	11	3	20	19	20	21	21	55	54	56	62	58	2.5	2.5	2.8	3.1	2.3
2	11	4	20	19	23	22	23	42	52	62	68	69	1.5	2.7	2.8	3.1	3.5
2	11	5	21	21	21	18	16	78	64	73	44	63	3.3	2.5	3.0	1.6	2.7
2	11	6	17	21	17	19	17	57	76	56	61	48	2.2	3.2	2.0	2.5	1.6
2	11	7	20	18	18	17	19	70	63	63	43	47	2.8	2.4	2.4	1.6	1.4
2	11	8	20	18	18	18	17	67	51	54	60	45	2.0	2.0	1.9	2.3	1.5
2	11	9	18	19	17	17	18	59	60	47	54	61	2.4	2.7	1.9	2.1	2.5
2	11	10	20	19	17	14	16	45	51	55	46	59	1.8	1.8	1.7	1.6	2.2
2	11	11	15	16	17	13	14	36	44	32	29	41	1.3	1.4	1.0	0.8	1.2
2	11	12	16	14	20	14	11	48	35	53	36	24	1.5	1.3	1.8	1.2	0.7
2	11	13	10	15	13	11	8	26	42	43	24	9	0.9	1.3	1.3	0.8	0.2
2	11	14	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	12	1	22	21	24	20	18	70	75	82	50	47	4.2	4.2	5.5	2.9	2.9
2	12	2	24	25	21	25	19	72	88	65	87	47	4.5	5.2	3.5	5.5	2.7
2	12	3	20	21	23	21	20	55	57	69	63	47	2.3	2.5	3.5	3.9	2.3
2	12	4	17	19	19	22	21	45	44	56	72	81	2.4	1.9	2.3	2.9	3.1
2	12	5	21	21	22	20	21	46	57	55	61	52	1.5	2.7	2.9	3.4	3.3
2	12	6	19	21	19	24	21	41	55	52	56	43	1.6	1.4	2.0	1.8	1.7
2	12	7	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	12	8	15	16	17	17	14	53	44	56	58	51	2.1	1.9	1.9	2.0	1.7
2	12	9	17	18	20	17	16	41	41	49	41	39	1.8	1.7	2.4	1.5	1.5
2	12	10	19	18	18	15	15	54	62	58	42	36	2.5	2.9	2.2	1.6	1.4
2	12	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	12	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	12	13	21	18	10	15	17	37	36	11	30	28	1.8	1.7	0.4	0.8	0.7
2	12	14	10	15	15	9	10	31	29	30	28	27	1.1	0.9	0.7	0.8	0.9
2	13	1	23	25	24	24	24	63	74	66	70	79	3.8	4.4	3.7	3.5	4.0
2	13	2	25	24	22	22	20	68	74	64	67	50	3.9	3.7	2.9	3.6	2.5
2	13	3	22	23	21	20	19	56	61	54	47	47	2.6	2.9	2.5	2.2	2.0

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2	13	4	18	19	22	21	20	36	49	55	47	48	1.7	2.7	3.1	1.9	2.1
2	13	5	21	19	21	20	20	69	90	83	56	75	3.1	4.4	3.4	2.5	3.7
2	13	6	19	20	20	17	18	65	66	63	44	58	3.0	2.8	2.9	2.1	2.8
2	13	7	21	22	20	20	20	60	70	60	65	61	2.2	2.9	2.6	2.4	2.5
2	13	8	17	18	19	15	17	42	61	45	40	50	1.0	2.5	1.7	1.6	2.5
2	13	9	16	14	15	14	14	38	31	24	24	20	1.5	1.2	0.6	0.9	0.6
2	13	10	19	19	20	23	17	48	46	47	48	55	2.2	1.8	1.7	1.0	2.5
2	13	11	17	17	21	19	19	58	39	43	40	55	1.8	1.5	1.5	1.6	1.8
2	13	12	13	14	14	14	15	25	33	40	34	46	1.0	1.1	0.8	0.8	1.8
2	13	13	18	14	15	14	15	42	32	37	29	29	1.5	1.4	1.6	1.2	1.1
2	13	14	13	16	14	13	12	29	41	45	34	22	0.9	1.3	1.5	1.4	1.1
2	14	1	24	19	25	23	20	83	53	100	69	59	4.4	2.1	5.3	2.5	2.3
2	14	2	22	25	23	22	21	71	75	72	54	64	3.4	4.2	4.1	2.5	2.6
2	14	3	19	14	21	14	22	50	56	63	50	76	2.0	2.9	2.7	3.0	3.5
2	14	4	20	24	16	22	21	57	85	41	79	65	2.3	4.6	1.2	3.9	2.4
2	14	5	20	21	16	22	20	50	53	47	73	49	2.3	2.5	2.1	3.2	2.4
2	14	6	21	21	24	20	19	55	69	66	74	61	2.3	3.8	2.6	3.7	2.6
2	14	7	21	20	20	21	22	77	49	54	65	85	4.1	2.2	2.0	2.7	4.0
2	14	8	0	21	17	21	17	0	66	45	59	49	0.0	2.7	1.8	1.8	2.0
2	14	9	21	17	18	21	21	44	34	35	63	56	1.4	1.3	1.4	3.1	2.2
2	14	10	21	20	20	21	16	70	54	49	57	34	3.0	2.1	1.1	2.5	0.0
2	14	11	17	19	18	20	18	44	46	48	47	41	1.1	1.3	1.7	2.3	2.0
2	14	12	15	18	18	18	17	42	47	0	57	36	1.3	1.1	0.0	1.6	1.4
2	14	13	0	15	16	14	17	0	32	23	30	40	0.0	1.2	0.6	0.6	1.6
2	14	14	14	13	10	10	11	24	35	24	25	23	0.8	1.3	0.7	0.9	0.8
2	15	1	27	23	24	22	24	95	67	80	72	86	4.6	2.7	3.8	3.4	2.9
2	15	2	23	22	25	26	26	73	83	89	100	95	2.9	3.4	3.7	3.2	1.9
2	15	3	23	22	23	20	19	71	51	77	35	41	3.1	1.4	3.5	1.3	2.2
2	15	4	21	20	18	22	21	57	72	40	59	64	1.3	2.9	1.5	2.3	2.6
2	15	5	20	18	19	19	20	80	60	58	70	73	3.4	2.3	2.5	2.6	4.1
2	15	6	19	18	17	20	18	74	73	56	65	63	2.4	2.7	1.5	1.3	4.0
2	15	7	20	17	19	19	20	81	62	86	61	42	2.5	2.5	2.9	1.9	1.9
2	15	8	20	21	19	20	17	75	53	7	70	56	2.6	1.7	0.3	2.3	0.6
2	15	9	19	17	19	20	18	58	50	43	62	50	2.1	1.2	1.6	1.9	1.0
2	15	10	19	17	18	16	20	52	50	52	38	47	1.8	1.8	1.9	1.2	0.8
2	15	11	17	15	15	18	16	38	35	45	43	27	0.6	1.1	0.8	1.1	0.9
2	15	12	17	17	15	11	16	19	34	47	20	61	0.3	1.0	1.3	0.1	2.2
2	15	13	15	17	14	12	13	42	18	18	31	30	1.3	0.4	0.6	0.4	1.8
2	15	14	15	14	16	15	15	28	30	40	21	30	0.7	1.0	0.8	0.5	0.8
2	16	1	20	21	20	19	18	62	69	61	60	48	3.2	3.3	2.9	2.8	1.3
2	16	2	19	21	23	19	20	67	70	81	66	72	3.4	3.0	4.0	4.3	2.8
2	16	3	21	19	17	20	19	63	70	59	53	50	3.5	3.9	1.8	1.5	1.3
2	16	4	19	15	15	19	17	47	35	37	66	57	1.1	1.2	0.8	2.8	2.2
2	16	5	20	16	14	17	17	63	46	37	47	40	2.8	1.9	2.2	2.2	1.5
2	16	6	18	18	16	18	17	40	46	42	49	39	2.2	1.8	2.0	1.7	1.3
2	16	7	16	16	19	15	20	26	43	33	31	48	0.7	2.3	0.6	1.1	1.7
2	16	8	14	20	21	21	16	29	34	42	75	24	1.1	0.7	1.4	3.1	0.7
2	16	9	21	17	20	17	22	45	40	39	45	67	1.3	1.8	1.5	2.3	3.1
2	16	10	20	19	17	17	18	38	45	48	42	35	1.9	1.6	2.1	1.6	1.4
2	16	11	15	16	19	15	20	41	46	42	44	39	1.1	0.7	1.3	0.8	0.7
2	16	12	14	20	21	21	16	27	36	21	30	13	0.8	0.9	0.5	0.8	0.5

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2	16	13	11	14	17	15	20	22	24	31	27	19	0.5	0.9	0.0	0.5	0.6
2	16	14	9	14	9	11	13	8	18	19	19	21	0.2	0.7	0.5	0.6	0.8
2	17	1	21	19	21	19	15	64	54	61	65	52	2.9	3.0	3.4	3.7	1.4
2	17	2	20	19	23	20	21	75	48	59	48	58	4.0	2.1	2.9	2.5	2.7
2	17	3	20	23	20	23	19	62	61	47	70	55	2.6	2.5	2.2	3.1	2.4
2	17	4	19	20	22	19	20	57	67	61	52	57	2.6	2.9	2.5	2.1	2.8
2	17	5	20	20	21	22	19	64	61	58	58	53	2.4	2.2	2.4	1.9	2.4
2	17	6	22	22	19	19	18	57	54	59	65	61	2.0	2.1	2.2	2.4	1.4
2	17	7	21	20	20	20	21	65	50	55	50	58	2.0	2.8	1.7	2.5	1.3
2	17	8	20	19	20	23	19	62	61	47	70	55	2.6	2.5	2.2	3.1	2.6
2	17	9	19	20	22	19	20	57	67	61	52	60	2.6	2.9	2.5	2.1	2.0
2	17	10	20	20	21	25	19	60	61	58	60	67	1.8	2.2	2.0	1.9	1.8
2	17	11	22	23	18	19	23	56	68	61	65	57	2.6	2.5	2.2	3.1	2.6
2	17	12	20	21	21	20	20	55	69	57	54	60	2.6	2.9	2.5	2.2	2.0
2	17	13	21	19	23	25	19	60	58	60	54	63	1.8	2.2	2.1	1.9	1.8
2	17	14	19	19	21	21	22	51	60	39	45	57	1.8	1.9	2.0	1.4	2.3
2	18	1	19	17	21	16	18	60	59	38	49	49	3.3	2.8	2.2	2.3	2.7
2	18	2	18	20	23	20	20	55	63	82	64	60	2.1	3.4	3.1	2.1	3.0
2	18	3	17	19	17	15	17	50	57	51	51	45	2.3	2.8	2.8	2.2	1.7
2	18	4	15	16	18	16	16	46	51	40	47	37	1.8	2.8	0.9	2.6	1.6
2	18	5	17	19	19	19	18	62	73	67	74	68	3.2	3.6	3.1	3.4	3.8
2	18	6	17	15	16	18	14	48	49	50	54	35	1.7	1.6	1.7	2.3	1.4
2	18	7	16	18	18	17	16	51	57	72	49	44	2.4	2.3	2.7	2.0	2.3
2	18	8	18	18	19	19	18	63	43	53	77	56	1.8	1.8	2.1	3.0	1.9
2	18	9	18	14	16	15	16	34	33	33	41	57	1.2	1.5	1.0	2.0	2.5
2	18	10	16	17	16	14	16	60	54	44	35	38	3.0	1.9	1.5	1.4	2.0
2	18	11	15	15	15	15	13	53	48	54	36	36	1.4	1.6	1.5	1.6	1.6
2	18	12	10	14	15	11	13	33	20	46	30	38	1.2	0.1	1.5	0.5	0.3
2	18	13	16	16	15	14	11	58	57	43	50	28	2.1	2.7	2.0	2.2	1.0
2	18	14	14	13	14	12	13	25	25	39	32	16	1.1	0.9	1.9	1.4	0.2
2	19	1	19	30	33	34	24	70	47	66	67	52	4.8	2.3	4.5	4.6	3.9
2	19	2	39	36	34	35	38	125	97	58	100	123	7.9	4.3	3.8	3.9	6.9
2	19	3	37	31	32	33	35	61	79	67	65	72	2.8	4.3	2.1	3.3	3.8
2	19	4	30	32	33	32	34	64	80	76	58	78	2.9	4.3	2.1	1.7	3.9
2	19	5	37	34	35	34	36	65	66	41	58	85	3.2	1.9	2.0	2.9	5.3
2	19	6	33	29	29	33	33	93	67	63	90	95	4.8	3.3	3.1	4.6	4.7
2	19	7	32	32	32	35	35	58	51	49	62	65	2.9	2.5	2.3	3.0	3.3
2	19	8	25	31	32	32	34	52	35	90	83	78	2.3	1.6	5.1	4.8	4.0
2	19	9	30	29	27	27	25	73	68	63	64	58	3.7	2.8	2.7	2.6	2.3
2	19	10	27	33	27	37	27	79	68	64	59	69	3.3	2.9	2.9	2.2	3.1
2	19	11	26	27	27	18	30	58	62	63	33	49	2.1	2.4	2.5	0.8	1.0
2	19	12	32	32	29	33	32	76	73	68	81	79	4.4	4.3	3.5	5.1	4.7
2	19	13	23	29	25	25	29	50	65	51	43	69	2.0	2.3	2.7	2.1	3.2
2	19	14	22	20	23	24	23	47	42	43	50	48	1.9	3.0	2.1	2.6	2.3
2	20	1	19	22	22	19	20	48	62	74	63	69	2.1	3.0	3.9	3.3	3.7
2	20	2	23	23	22	23	22	56	77	76	74	73	2.8	4.0	3.6	4.1	3.7
2	20	3	21	19	18	20	19	50	36	51	44	38	1.0	0.5	1.3	1.8	1.1
2	20	4	22	24	21	22	23	60	69	47	63	71	2.9	3.2	2.6	3.1	4.2
2	20	5	23	23	20	22	24	62	62	49	63	54	2.5	1.9	1.8	2.6	2.1
2	20	6	25	24	24	24	23	63	60	50	42	52	1.2	2.3	1.4	1.3	2.2
2	20	7	25	23	20	24	23	63	31	45	36	29	1.7	1.0	1.9	1.0	0.7

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2	20	8	23	25	21	20	20	51	50	46	45	39	1.6	1.7	1.5	1.5	1.4
2	20	9	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	20	10	15	17	17	18	18	39	37	42	45	31	1.2	0.0	1.0	1.1	0.9
2	20	11	23	18	21	18	21	52	29	38	37	38	1.4	0.9	1.2	1.4	1.2
2	20	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	20	13	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	20	14	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	23	1	21	20	20	29	21	52	63	51	92	61	1.8	3.1	2.3	4.2	2.5
2	23	2	26	19	21	23	20	92	53	60	100	80	4.2	2.5	2.5	4.4	2.9
2	23	3	21	20	19	20	21	69	64	48	61	72	1.4	2.7	2.3	2.5	2.3
2	23	4	21	21	18	19	21	71	68	51	59	69	3.0	2.9	2.1	2.5	3.1
2	23	5	18	22	20	20	20	52	76	61	58	63	2.8	3.2	2.4	2.3	2.5
2	23	6	19	18	20	19	19	54	55	60	53	56	2.4	2.3	2.6	2.5	2.7
2	23	7	17	19	18	16	18	45	64	49	43	57	2.4	2.9	2.5	1.7	2.8
2	23	8	20	15	18	22	16	64	43	45	49	48	2.6	2.1	2.1	1.7	2.3
2	23	9	16	24	19	21	18	45	61	63	65	58	2.2	2.9	3.0	2.8	2.9
2	23	10	17	16	21	19	15	50	41	65	53	30	2.5	2.0	3.4	2.0	1.7
2	23	11	17	19	19	17	17	40	71	52	42	39	1.8	3.4	1.6	1.9	2.1
2	23	12	16	19	17	18	19	37	56	54	39	53	1.5	3.0	2.7	1.6	2.6
2	23	13	16	17	18	16	18	40	42	40	39	45	1.9	2.1	2.1	1.8	2.3
2	23	14	17	18	19	19	17	40	47	52	53	46	1.7	2.1	3.1	2.4	2.2
2	24	1	20	21	20	13	21	62	67	55	38	68	2.6	2.6	2.0	1.4	2.8
2	24	2	21	21	19	22	20	69	70	57	72	56	2.8	2.4	2.4	3.0	2.0
2	24	3	18	17	18	18	17	59	46	51	45	47	1.6	1.6	1.9	1.5	1.5
2	24	4	20	19	19	18	16	38	43	45	51	46	1.2	1.3	1.5	1.7	1.4
2	24	5	17	17	17	14	14	42	55	50	41	38	1.2	1.5	1.7	1.3	0.8
2	24	6	15	16	17	12	15	43	48	55	31	53	1.4	1.6	1.8	0.5	1.6
2	24	7	16	19	15	16	10	42	49	47	34	33	1.1	1.2	1.2	0.9	0.3
2	24	8	16	16	16	14	20	48	49	35	42	50	0.7	0.6	0.4	0.4	0.6
2	24	9	14	15	13	13	8	45	40	22	31	16	0.3	0.7	0.4	0.2	0.5
2	24	10	14	14	15	11	14	22	34	28	15	16	0.4	0.8	0.2	0.1	0.4
2	24	11	9	12	8	12	10	20	14	16	21	15	0.6	0.3	0.3	0.1	0.4
2	24	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	24	13	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	24	14	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	26	1	26	27	20	25	24	97	103	93	89	87	4.0	4.7	2.3	3.6	3.7
2	26	2	24	29	23	24	26	75	100	87	93	127	2.3	3.6	2.0	3.2	4.6
2	26	3	22	22	21	20	23	68	87	60	52	92	2.8	3.4	2.0	1.3	3.8
2	26	4	24	19	18	20	17	72	46	48	72	74	2.5	1.3	1.9	2.0	2.8
2	26	5	22	22	23	21	17	69	64	70	55	58	2.5	2.3	1.5	1.9	1.6
2	26	6	21	19	19	23	19	29	57	57	61	51	1.0	1.9	1.8	1.5	1.0
2	26	7	23	22	22	24	21	50	69	56	73	70	1.6	2.3	1.8	2.2	2.2
2	26	8	22	24	24	23	22	39	39	58	79	31	0.8	1.1	1.7	2.7	0.8
2	26	9	22	25	21	20	19	28	38	45	46	42	0.9	1.4	1.3	2.1	1.4
2	26	10	20	23	22	19	14	32	48	39	29	26	0.5	1.3	0.8	0.6	0.7
2	26	11	18	26	22	23	20	45	36	40	42	37	1.2	1.0	0.8	0.9	1.0
2	26	12	14	12	14	16	10	20	16	19	30	12	0.6	0.4	0.5	0.6	0.3
2	26	13	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	26	14	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	27	1	20	21	25	26	27	65	72	83	71	69	2.9	3.3	4.0	3.1	3.1
2	27	2	25	24	24	24	25	75	0	95	68	90	3.9	0.0	4.7	3.2	4.4

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2	27	3	18	24	23	23	25	53	49	52	58	63	2.6	0.8	1.2	1.3	2.1
2	27	4	21	22	25	17	23	70	69	69	49	66	3.2	3.4	2.3	2.3	2.9
2	27	5	22	24	21	22	20	70	81	61	61	70	3.7	3.3	2.9	2.9	3.5
2	27	6	20	19	17	20	21	54	62	60	59	40	2.2	2.8	3.0	2.4	1.0
2	27	7	18	20	22	12	0	31	52	68	29	0	1.4	3.0	3.1	0.9	0.0
2	27	8	19	20	21	21	0	55	58	58	61	0	2.8	2.8	2.7	2.0	0.0
2	27	9	19	19	18	18	20	55	72	51	50	76	2.7	3.6	1.9	1.3	3.8
2	27	10	17	23	18	17	19	53	70	60	52	46	2.6	1.8	3.2	2.8	2.4
2	27	11	19	19	20	21	18	45	58	59	67	49	2.0	2.9	3.0	3.6	1.8
2	27	12	17	18	19	13	17	54	52	52	48	59	2.3	1.0	2.4	2.2	2.9
2	27	13	20	17	20	17	19	58	40	60	39	52	3.1	1.6	3.0	1.7	2.5
2	27	14	14	22	19	19	17	43	70	54	50	48	1.6	3.2	2.2	1.6	2.2
3	1	1	17	16	81	20	19	59	59	33	65	45	3.1	3.6	1.9	3.3	2.8
3	1	2	18	19	20	15	19	55	56	42	49	40	3.2	3.1	2.6	3.0	2.3
3	1	3	19	19	20	20	16	60	75	72	70	26	3.4	4.5	4.2	3.5	1.6
3	1	4	23	22	19	25	19	87	90	73	93	67	5.1	5.0	4.4	5.3	3.6
3	1	5	21	18	21	22	18	81	70	74	73	59	4.5	2.1	4.5	3.7	3.3
3	1	6	25	22	21	20	21	89	81	76	78	85	4.7	4.7	3.1	4.2	5.0
3	1	7	19	13	18	19	19	68	43	77	76	72	3.3	2.5	3.0	3.9	3.9
3	1	8	19	15	18	17	15	46	63	75	59	44	1.6	3.5	4.2	3.0	2.3
3	1	9	16	18	19	17	18	48	50	49	54	50	2.4	1.4	1.8	2.0	2.1
3	1	10	19	20	20	17	19	46	63	60	53	56	1.4	3.0	2.0	2.6	2.5
3	1	11	20	19	17	20	19	49	53	30	64	57	1.9	1.0	1.5	2.4	2.1
3	1	12	14	21	16	18	13	20	46	23	52	35	0.4	0.8	0.6	1.3	0.4
3	2	1	16	17	17	18	18	53	65	92	59	59	2.8	4.4	4.6	2.6	2.7
3	2	2	19	19	16	23	20	44	66	55	87	78	2.5	4.4	3.9	4.8	4.1
3	2	3	18	18	22	16	16	68	66	74	60	71	5.0	3.9	5.1	2.9	3.4
3	2	5	18	17	19	19	19	71	85	63	86	72	3.7	4.4	2.7	5.0	5.0
3	2	6	19	20	21	19	19	89	80	77	76	82	5.8	3.8	5.3	4.7	5.0
3	2	7	19	21	18	17	16	76	91	68	74	76	4.0	4.5	2.2	3.8	5.3
3	2	8	19	18	18	18	16	92	57	55	53	45	4.1	2.4	1.6	1.7	1.6
3	2	9	20	22	21	20	20	74	56	79	55	45	4.0	1.8	4.4	1.0	0.9
3	2	10	17	20	18	13	16	43	45	53	29	31	1.6	1.0	2.0	1.0	1.0
3	2	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	2	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	3	1	18	17	18	17	19	74	66	69	54	71	3.9	3.5	4.0	3.0	3.8
3	3	2	20	21	18	19	19	56	84	59	86	64	2.8	4.2	3.7	5.3	2.5
3	3	3	17	17	18	20	15	66	72	76	86	65	2.7	3.8	3.2	3.9	3.7
3	3	4	16	14	22	17	19	71	25	105	72	110	3.0	0.4	4.6	3.3	3.3
3	3	5	17	19	19	16	18	74	73	79	72	73	3.6	2.9	4.0	3.3	3.3
3	3	6	17	17	18	20	19	71	72	73	74	73	3.1	3.2	2.8	3.7	2.9
3	3	7	20	19	17	16	20	92	80	77	67	75	4.2	3.9	3.5	3.1	2.5
3	3	8	21	21	13	20	18	75	64	42	80	52	2.8	2.8	1.7	3.0	2.2
3	3	9	16	17	16	16	15	34	32	31	57	51	0.9	1.7	0.6	2.0	1.0
3	3	10	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	3	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	3	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	4	1	37	32	30	32	32	101	72	73	83	82	6.8	3.7	4.1	4.0	3.8
3	4	2	36	33	31	37	38	90	78	82	90	96	5.0	4.7	3.8	4.0	5.6
3	4	3	23	32	36	32	19	45	88	120	95	35	2.1	3.8	7.2	4.7	1.4
3	4	4	29	27	25	32	29	60	75	76	83	81	2.7	2.4	3.2	4.3	2.8

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3	4	5	27	27	25	24	24	97	72	114	52	88	5.9	3.4	5.2	2.0	4.8
3	4	6	26	27	32	32	33	91	90	75	47	88	3.5	4.2	3.3	1.0	3.0
3	4	7	35	37	34	32	27	64	102	72	79	59	2.6	4.8	2.6	2.2	1.8
3	4	8	27	28	28	32	25	64	71	67	70	52	2.6	3.0	2.2	2.9	2.3
3	4	9	17	15	21	23	19	48	35	33	70	34	2.1	1.4	1.2	2.6	0.9
3	4	10	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	4	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	4	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	5	1	21	19	21	17	21	79	51	72	44	62	3.7	2.5	3.4	2.1	3.1
3	5	2	21	20	18	21	17	65	62	60	62	38	2.9	2.7	3.0	2.8	1.7
3	5	3	19	16	16	21	17	63	53	57	52	67	3.1	2.5	2.9	2.1	2.9
3	5	4	22	23	25	20	23	84	79	92	60	99	4.2	4.6	4.0	3.4	4.6
3	5	5	21	20	21	20	22	60	54	61	56	67	2.9	2.1	3.0	2.5	3.2
3	5	6	20	18	18	20	18	84	63	71	78	54	4.9	2.5	4.2	4.3	2.4
3	5	7	17	18	21	17	19	78	61	82	57	74	3.7	2.9	4.2	2.5	3.3
3	5	8	25	27	25	25	17	61	67	67	46	47	1.9	3.2	3.4	0.4	1.8
3	5	9	20	20	21	18	19	58	65	46	49	50	2.6	2.4	2.2	2.1	2.5
3	5	10	22	18	17	18	18	43	42	36	29	35	1.6	1.9	1.7	1.2	1.3
3	5	11	16	21	20	20	18	39	46	47	60	52	1.8	2.2	0.5	2.2	2.0
3	5	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	6	1	24	23	25	25	21	106	93	100	92	54	5.1	4.5	5.0	5.0	2.3
3	6	2	22	20	22	21	25	85	81	81	78	97	3.8	3.5	3.9	3.6	4.7
3	6	3	14	23	19	24	14	62	83	73	90	57	2.7	4.4	3.7	4.1	2.8
3	6	4	24	22	23	24	21	101	90	105	103	87	4.7	4.9	5.2	4.7	3.7
3	6	5	20	22	17	19	21	83	92	66	65	82	3.5	4.4	3.3	3.4	4.0
3	6	6	23	21	23	23	22	63	66	64	80	69	3.0	3.4	4.0	3.8	3.7
3	6	7	21	20	24	19	19	65	69	85	75	67	2.7	2.0	3.9	3.4	2.5
3	6	8	17	22	26	21	18	63	63	75	60	34	2.0	2.0	3.1	2.7	0.9
3	6	9	21	24	17	22	18	58	75	51	67	50	1.9	2.7	2.0	1.7	1.3
3	6	10	20	21	15	23	20	52	72	47	79	67	1.9	2.3	1.6	2.5	1.7
3	6	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	6	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	7	1	29	19	19	16	17	64	70	65	45	38	3.3	4.0	3.5	2.3	2.0
3	7	2	19	20	20	19	19	57	49	61	47	49	3.0	3.3	3.2	2.5	2.5
3	7	3	18	20	20	17	19	68	65	60	71	82	3.2	2.5	3.2	4.0	4.0
3	7	4	23	17	19	17	17	92	65	69	66	67	4.6	4.2	3.4	4.0	3.9
3	7	5	21	20	16	17	21	71	75	57	66	71	4.1	3.9	3.5	3.8	4.1
3	7	6	15	18	20	18	19	54	68	75	46	54	3.1	3.7	4.0	1.9	3.4
3	7	7	17	19	25	17	18	56	52	59	56	69	2.9	1.3	2.8	3.3	4.3
3	7	8	16	16	17	16	19	55	58	58	27	61	3.1	2.3	3.2	1.8	1.9
3	7	9	15	17	15	16	16	55	55	61	49	57	2.9	3.0	3.5	3.1	3.1
3	7	10	16	16	15	17	12	50	55	48	49	33	3.1	3.4	2.7	2.7	1.9
3	7	11	17	17	17	17	14	47	47	46	39	29	2.5	2.6	2.8	2.3	1.6
3	7	12	11	13	13	14	9	37	43	50	53	35	1.9	1.9	2.7	2.4	1.8
3	8	4	19	19	19	20	21	97	62	76	82	89	4.8	3.0	2.0	4.3	4.0
3	8	2	20	20	19	18	18	68	52	73	66	76	3.4	2.1	3.6	3.1	3.5
3	8	1	18	18	17	16	17	80	87	74	76	61	3.8	4.1	3.5	3.3	2.6
3	8	5	19	18	17	19	16	64	73	62	67	72	3.0	3.7	2.6	3.1	3.6
3	8	7	19	18	19	18	17	85	50	84	71	53	4.2	2.7	4.0	3.6	2.3
3	8	6	18	18	16	18	17	80	81	53	81	71	3.9	3.9	1.7	3.9	2.9
3	8	10	25	23	26	24	25	78	73	87	71	76	3.3	2.3	3.4	3.4	1.7

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3	8	8	21	20	18	19	17	85	84	82	97	70	2.2	4.1	4.0	4.7	3.4
3	8	9	21	24	21	23	21	76	65	83	91	38	3.5	1.7	1.9	4.2	0.8
3	8	3	16	20	17	19	21	60	68	45	73	63	3.0	2.9	1.8	2.0	1.4
3	8	11	22	20	22	24	17	74	50	62	36	18	2.4	1.5	2.3	1.2	0.3
3	8	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	9	1	17	16	18	17	19	69	68	57	59	75	3.5	3.7	2.7	3.0	3.8
3	9	2	18	17	20	20	17	56	54	66	67	58	3.0	2.7	3.6	4.0	2.7
3	9	3	17	16	18	16	18	54	55	65	63	73	2.7	2.4	3.2	3.3	3.6
3	9	4	20	19	18	17	19	68	67	76	64	67	3.9	3.6	4.3	1.6	3.4
3	9	5	17	17	17	18	17	61	59	59	66	59	2.7	2.8	2.6	3.0	3.1
3	9	6	14	20	17	20	20	55	80	65	60	54	1.6	3.1	3.1	3.1	2.6
3	9	7	15	17	21	19	18	43	56	59	62	52	1.5	0.7	2.0	2.0	0.9
3	9	8	20	20	21	14	19	57	67	66	44	58	1.3	2.3	0.8	1.6	1.9
3	9	9	10	16	51	15	15	25	55	31	38	39	1.1	0.8	0.3	0.2	0.3
3	9	10	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	9	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	9	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	10	1	15	16	16	18	16	49	30	48	45	49	2.8	2.2	2.8	2.7	2.8
3	10	2	20	22	17	20	16	62	75	56	64	47	4.2	4.7	3.4	4.1	3.1
3	10	3	19	18	19	15	15	58	52	59	37	48	3.8	3.4	3.6	2.1	2.6
3	10	4	21	19	21	22	21	66	67	52	57	72	4.5	4.4	3.4	3.8	4.9
3	10	5	19	18	22	17	17	65	53	61	56	51	3.9	3.5	4.0	3.6	3.4
3	10	6	20	18	17	18	17	48	57	33	49	50	3.2	3.8	1.8	3.2	3.3
3	10	7	16	17	16	16	18	64	62	52	55	60	4.1	4.2	3.7	3.5	3.8
3	10	8	15	18	16	17	16	63	73	45	41	41	3.7	4.0	1.9	1.7	1.4
3	10	9	23	22	23	19	17	81	76	74	42	37	3.7	4.6	3.9	2.1	2.1
3	10	10	17	19	20	16	19	46	65	73	32	51	1.8	3.0	2.7	1.9	2.0
3	10	11	20	16	14	17	16	66	37	37	41	31	2.4	1.4	1.3	1.3	1.5
3	10	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	11	1	15	19	20	20	**	53	69	62	80	74	2.6	3.3	2.7	4.1	3.8
3	11	2	15	18	15	23	18	45	51	39	78	52	2.2	2.3	1.8	3.7	2.2
3	11	3	21	19	21	16	19	60	68	84	54	61	2.8	3.3	4.4	2.5	3.2
3	11	5	20	21	21	19	17	62	76	70	57	61	3.7	3.9	3.8	3.0	3.3
3	11	6	19	18	17	17	18	63	65	61	56	54	3.4	3.2	3.0	2.8	2.5
3	11	7	20	16	19	17	19	74	67	68	78	81	2.9	3.2	3.3	3.6	3.9
3	11	8	19	19	22	18	19	75	81	77	70	68	3.5	3.7	3.7	3.1	3.2
3	11	9	15	18	22	21	17	42	46	68	65	52	1.8	1.3	3.0	2.4	2.3
3	11	10	16	22	19	22	20	16	50	47	50	28	0.5	1.4	1.6	1.9	1.1
3	11	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	11	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	12	1	21	16	22	22	16	65	39	60	92	39	4.1	2.5	3.8	5.9	2.4
3	12	2	19	18	18	21	21	59	65	57	62	66	3.5	3.9	2.9	4.2	4.4
3	12	3	14	21	19	20	18	51	69	67	65	44	2.7	4.4	4.3	4.4	3.1
3	12	4	23	21	21	22	20	76	77	78	83	69	3.9	3.8	3.9	4.2	3.6
3	12	4	20	21	21	20	22	72	75	64	52	89	4.3	4.3	4.3	3.3	5.5
3	12	5	24	21	20	24	25	83	80	43	60	79	5.8	5.7	2.6	4.0	5.0
3	12	6	21	18	19	17	17	65	60	55	58	58	3.8	4.4	3.2	3.5	2.7
3	12	7	20	20	15	20	18	79	86	55	88	80	4.8	5.7	3.4	5.4	4.9
3	12	8	17	19	21	26	17	79	102	83	57	56	4.5	5.9	4.8	3.1	2.9
3	12	9	20	20	15	21	18	78	66	59	53	59	3.1	3.2	3.5	1.6	2.0
3	12	10	15	22	16	18	22	39	55	43	51	43	1.5	1.5	1.2	2.4	1.1

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3	12	11	17	18	19	16	18	34	38	34	24	25	0.5	1.4	1.6	0.2	1.1
3	12	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	13	1	21	23	16	22	19	64	64	49	52	52	3.7	3.3	2.2	2.8	3.0
3	13	2	17	18	18	21	19	40	46	59	78	56	2.2	2.6	3.7	4.5	3.0
3	13	3	19	17	19	21	16	58	45	58	74	55	3.4	2.4	3.1	4.6	3.1
3	13	4	22	20	21	20	19	71	76	66	68	56	4.5	5.0	3.7	4.0	3.5
3	13	5	18	19	16	11	17	54	62	58	23	41	3.3	3.5	3.7	1.3	2.5
3	13	6	18	17	16	15	16	60	53	56	39	59	3.7	3.0	3.0	2.1	3.0
3	13	7	18	18	17	17	18	67	77	60	60	67	3.6	4.0	3.5	3.6	4.0
3	13	8	20	15	15	15	16	57	57	50	51	60	3.0	2.8	2.6	2.4	2.6
3	13	9	16	19	15	16	18	49	66	39	42	77	2.8	2.8	1.9	2.3	4.0
3	13	10	16	19	16	19	18	50	68	59	50	60	2.3	2.8	2.6	2.4	2.9
3	13	11	18	17	19	19	19	56	53	47	54	42	2.0	2.3	1.1	1.5	1.7
3	13	12	18	17	15	14	20	50	48	44	39	66	2.5	2.0	2.0	1.3	3.1
3	14	1	21	21	21	21	20	60	70	66	52	66	3.4	3.6	3.7	2.6	3.5
3	14	2	19	20	19	20	16	70	84	73	68	51	4.0	4.9	3.6	3.2	2.6
3	14	3	21	19	21	17	18	84	66	61	54	71	4.7	2.8	3.2	2.4	2.5
3	14	4	21	21	19	15	20	81	71	68	53	65	4.9	3.8	3.8	2.7	3.7
3	14	5	20	18	22	19	22	65	70	70	66	83	3.1	4.1	4.5	3.1	4.5
3	14	6	18	17	16	21	18	54	52	45	74	55	2.9	3.2	2.7	4.2	3.3
3	14	7	14	17	15	16	19	56	60	54	55	63	3.0	3.1	3.0	3.0	3.4
3	14	8	18	18	16	21	16	60	71	82	84	63	3.1	4.0	3.4	4.9	3.1
3	14	9	19	17	17	21	16	73	57	72	69	46	3.8	2.7	3.7	3.7	2.0
3	14	10	21	24	19	22	19	67	86	67	90	62	3.3	4.1	3.4	4.7	3.1
3	14	11	22	21	22	23	22	77	58	74	19	75	3.9	2.6	3.5	3.9	3.1
3	14	12	22	21	21	19	19	44	70	72	46	34	0.9	2.5	3.8	1.1	1.2
3	15	1	24	22	21	21	22	88	84	79	64	68	4.0	3.3	3.7	2.8	3.9
3	15	2	22	18	22	21	23	67	72	79	70	65	3.1	3.3	3.7	3.1	2.9
3	15	3	20	18	18	21	18	78	75	71	72	32	3.7	3.5	2.6	2.9	3.0
3	15	4	23	20	24	17	18	82	75	82	68	66	3.9	3.1	3.5	3.0	2.9
3	15	5	22	20	20	16	22	80	82	44	84	83	3.5	3.8	2.1	3.4	1.4
3	15	6	21	16	16	18	17	79	66	53	64	65	3.6	3.1	2.3	3.0	3.2
3	15	7	18	20	19	19	17	67	78	72	69	77	3.1	3.5	3.1	3.1	3.0
3	15	8	22	20	20	20	21	92	70	75	85	76	3.5	2.2	3.0	3.2	2.9
3	15	9	17	24	20	25	20	43	62	54	71	64	1.7	1.7	1.7	3.3	3.1
3	15	10	19	24	19	20	17	64	72	64	48	65	1.9	2.1	1.4	1.7	3.4
3	15	11	20	23	17	20	18	25	28	48	40	35	0.2	0.4	1.1	1.3	1.5
3	15	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	16	1	17	15	14	16	14	47	40	35	42	36	2.8	2.3	1.9	2.2	2.1
3	16	2	17	14	18	19	16	59	55	63	71	61	3.9	3.7	4.0	4.4	3.5
3	16	3	12	20	16	19	17	37	68	52	59	50	2.4	4.3	3.5	3.9	1.9
3	16	4	20	18	15	18	18	68	59	62	73	74	4.8	3.7	4.0	4.9	4.7
3	16	5	18	14	14	17	18	72	54	40	60	70	4.9	2.9	2.8	3.9	5.0
3	16	6	13	16	17	13	14	43	63	68	35	45	3.1	4.1	5.8	1.9	3.1
3	16	7	16	16	15	12	14	54	57	63	38	41	2.7	3.4	4.0	2.5	2.8
3	16	8	17	18	15	16	15	56	66	65	65	75	2.6	3.3	3.0	3.1	4.5
3	16	9	17	19	16	17	14	48	65	57	46	50	1.8	3.3	3.1	2.1	2.6
3	16	10	14	11	15	15	21	37	29	42	38	25	1.1	0.8	1.6	1.2	0.8
3	16	11	12	13	17	18	18	26	27	47	57	44	1.1	0.9	1.6	1.8	1.5
3	16	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	17	1	20	16	20	21	19	50	44	62	65	53	2.1	1.9	2.7	3.0	2.9

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3	17	2	16	19	20	19	18	55	53	69	66	48	2.3	2.3	3.3	3.4	2.6
3	17	3	19	19	17	18	16	58	60	66	58	48	3.3	2.9	2.9	2.9	2.1
3	17	4	21	18	18	21	18	82	68	64	78	58	4.4	4.1	2.9	4.6	2.1
3	17	5	13	9	15	16	18	44	33	36	55	65	2.2	1.6	1.9	2.5	2.9
3	17	6	16	15	18	16	15	39	34	68	57	38	1.8	1.6	3.1	2.5	3.0
3	17	7	18	15	17	16	16	41	41	48	45	44	2.2	2.0	2.5	2.3	2.5
3	17	8	16	17	18	18	15	59	53	56	47	48	2.7	2.7	3.3	2.3	2.3
3	17	9	14	17	19	17	16	45	52	51	53	56	2.2	2.8	2.7	2.6	2.2
3	17	10	19	15	16	14	19	57	42	58	45	58	2.9	2.1	2.9	2.0	1.8
3	17	11	15	16	17	15	18	45	50	55	49	57	2.4	2.5	2.5	2.4	3.1
3	17	12	16	16	12	15	14	51	50	30	40	48	2.4	2.3	1.6	1.9	2.9
3	18	1	17	16	16	16	15	43	41	42	38	34	3.0	2.5	2.9	2.3	2.1
3	18	2	16	16	15	16	17	49	45	53	59	46	3.1	2.7	3.6	3.8	3.2
3	18	3	16	16	19	15	16	43	54	65	46	42	3.1	3.2	4.5	3.1	2.3
3	18	4	16	17	19	20	18	55	63	77	24	59	3.5	3.9	5.2	5.3	3.3
3	18	5	17	19	16	15	16	55	76	69	48	62	4.1	5.5	4.7	3.3	4.3
3	18	6	15	14	11	14	13	53	38	30	52	37	3.4	2.4	2.0	3.7	2.3
3	18	7	15	18	17	18	17	52	77	57	76	61	3.6	4.7	4.1	4.4	3.7
3	18	8	15	19	14	16	16	59	84	47	61	62	3.7	4.7	2.6	3.9	3.3
3	18	9	20	16	19	16	15	71	49	67	45	60	3.6	1.8	3.0	2.8	3.8
3	18	10	20	13	15	15	19	50	30	33	41	47	2.0	0.7	0.9	1.7	1.5
3	18	11	17	21	12	14	11	50	22	39	36	39	1.1	0.2	1.4	1.2	0.0
3	18	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	1.2
3	19	1	30	29	28	28	27	53	67	41	49	32	3.5	4.4	3.0	3.2	4.4
3	19	2	28	34	34	28	25	51	106	129	66	64	2.8	7.1	8.6	4.2	4.4
3	19	3	20	33	20	23	22	78	112	52	80	61	2.8	7.7	2.3	4.5	7.2
3	19	4	28	25	26	29	26	78	89	88	97	80	5.2	3.5	3.9	4.9	2.2
3	19	5	31	30	29	31	32	114	103	99	94	111	7.5	7.0	5.7	5.6	2.3
3	19	6	27	30	28	27	31	91	96	94	91	103	6.0	6.0	7.0	6.1	3.6
3	19	7	24	29	37	26	32	77	989	121	76	108	4.4	6.2	7.6	3.5	4.2
3	19	8	28	31	28	28	26	91	100	99	73	83	5.0	4.8	5.2	4.6	4.2
3	19	9	31	33	35	27	25	109	110	117	82	83	5.3	6.3	6.2	5.5	2.2
3	19	10	26	21	25	22	24	99	57	74	52	77	4.5	1.9	3.7	3.0	7.0
3	19	11	21	27	22	19	23	84	54	76	60	63	2.7	1.0	3.2	3.0	6.6
3	19	12	23	28	29	26	25	57	49	93	85	48	2.9	2.0	5.0	4.7	3.8
3	20	1	19	19	20	18	17	49	62	74	50	57	2.4	3.2	3.9	2.6	3.0
3	20	2	18	19	15	18	19	54	57	50	56	49	2.9	3.2	2.8	2.9	2.7
3	20	3	16	22	18	21	22	23	80	66	98	77	1.6	4.7	3.7	5.4	4.6
3	20	4	21	22	19	20	19	85	81	77	74	59	4.3	4.4	3.9	3.7	2.8
3	20	5	21	24	19	19	24	72	62	54	74	58	4.1	2.7	2.5	3.7	2.4
3	20	6	20	19	21	21	16	73	62	58	54	47	3.6	2.8	2.4	2.1	2.1
3	20	7	21	21	26	21	27	45	56	74	51	62	1.8	2.3	2.0	1.5	1.5
3	20	8	22	26	16	18	18	40	64	50	42	54	1.4	2.3	2.0	1.7	2.3
3	20	9	20	23	23	21	15	32	49	42	49	32	1.1	1.6	1.7	1.7	1.1
3	20	10	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	20	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	20	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	21	1	37	36	38	42	37	80	71	62	90	71	4.6	4.1	3.8	5.3	3.6
3	21	2	28	30	38	34	35	73	94	82	65	62	4.1	5.8	4.8	3.3	3.6
3	21	4	37	35	30	33	35	116	123	95	105	126	6.7	7.0	6.0	6.7	6.8
3	21	5	30	32	30	29	33	75	63	68	77	83	4.2	3.7	4.1	3.5	5.4

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3	21	6	28	32	31	32	27	92	106	93	108	38	5.5	6.8	6.2	6.8	1.8
3	21	6	33	32	30	29	19	88	79	68	72	44	5.7	4.9	3.9	3.9	2.0
3	21	7	27	32	35	31	32	60	61	89	61	62	3.3	3.6	5.5	3.2	1.7
3	21	9	32	30	30	23	33	75	57	68	48	80	4.0	3.3	4.3	2.5	4.0
3	21	10	30	32	29	34	26	78	78	72	74	73	4.2	4.4	3.8	4.6	4.2
3	21	11	24	25	24	28	26	53	66	46	59	49	2.8	2.9	2.8	2.9	2.8
3	21	12	27	26	23	19	18	81	57	56	46	45	4.6	3.4	2.5	2.4	2.4
3	22	1	19	21	20	21	21	34	47	49	49	60	2.0	2.7	2.1	1.9	4.0
3	22	2	23	23	19	23	18	57	64	41	65	38	3.5	4.1	2.2	4.5	2.7
3	22	3	25	19	19	20	17	88	63	67	50	58	5.8	3.1	4.5	3.2	2.7
3	22	4	25	26	25	24	27	83	99	84	96	93	5.5	5.5	5.5	5.2	6.2
3	22	5	24	25	23	24	24	72	73	67	97	74	4.3	4.7	4.4	6.8	4.4
3	22	5	18	17	16	17	16	72	61	65	66	57	3.3	2.5	2.9	3.0	2.6
3	22	6	23	27	24	28	25	46	101	67	93	70	2.2	6.7	3.8	6.0	4.5
3	22	7	30	27	26	24	26	108	107	84	78	89	6.7	6.1	6.1	5.4	5.4
3	22	9	24	26	25	26	26	77	85	71	85	77	5.5	6.1	4.6	6.0	5.8
3	22	10	27	26	26	30	26	90	80	80	81	75	6.2	5.6	5.6	5.5	5.9
3	22	11	27	28	28	24	24	85	74	78	69	64	5.9	5.6	5.4	4.5	5.2
3	22	12	15	17	17	16	14	35	34	48	40	42	1.8	2.4	2.5	2.1	2.0
3	23	1	15	21	19	20	19	49	57	60	69	61	2.4	2.1	2.3	3.4	3.5
3	23	2	15	20	21	17	19	50	64	77	60	69	2.3	2.9	3.4	1.8	1.7
3	23	3	19	21	20	19	19	69	84	66	69	70	2.6	3.8	3.0	3.4	3.6
3	23	4	21	19	18	17	19	86	66	65	65	79	4.2	2.1	3.4	3.2	3.3
3	23	5	17	18	19	17	16	55	63	58	51	46	2.6	2.9	3.0	2.4	2.9
3	23	6	16	16	16	12	15	50	54	61	33	51	2.6	2.6	2.6	1.3	3.0
3	23	7	16	21	14	10	14	45	107	48	34	53	2.5	5.6	1.9	1.3	3.1
3	23	8	16	19	17	16	17	68	67	56	56	62	3.4	3.2	3.1	2.7	2.7
3	23	9	17	15	17	15	15	57	43	65	37	48	3.0	2.1	2.8	1.9	2.7
3	23	10	17	16	17	15	16	58	35	44	50	35	3.1	1.8	2.5	2.6	2.3
3	23	11	15	16	15	16	16	52	46	52	61	59	2.6	1.5	2.4	3.3	2.0
3	23	12	14	13	18	13	15	62	51	69	53	45	2.9	2.4	3.3	2.4	1.9
3	24	1	18	19	18	15	14	37	65	66	48	34	1.5	3.2	3.1	2.2	1.4
3	24	2	15	19	15	17	19	55	69	47	61	62	2.6	3.3	2.2	3.1	2.9
3	24	3	18	18	18	16	19	58	61	77	53	66	2.8	3.0	3.4	2.1	3.7
3	24	4	19	18	19	17	20	71	77	78	62	87	2.5	3.7	2.7	2.9	4.1
3	24	6	19	17	16	15	16	74	64	45	58	58	3.1	2.9	1.2	2.4	2.0
3	24	7	21	18	19	19	19	73	47	72	49	69	2.1	1.0	2.9	0.8	2.1
3	24	8	18	14	20	13	13	53	43	38	25	19	1.8	1.0	1.9	0.9	0.5
3	24	9	17	15	16	18	17	54	30	35	39	40	1.5	0.6	0.8	1.3	1.3
3	24	10	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	24	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	24	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	25	1	13	16	17	16	15	44	56	53	51	34	2.2	2.4	2.6	2.3	1.9
3	25	2	16	16	17	19	19	55	58	57	58	73	2.5	2.7	3.1	2.9	3.4
3	25	3	16	17	16	17	18	53	57	48	59	60	2.9	2.9	2.5	2.9	3.0
3	25	4	19	18	19	16	17	71	67	78	64	62	4.1	4.0	5.0	3.7	3.6
3	25	5	16	19	19	17	18	62	62	80	58	72	3.4	3.5	4.9	3.0	3.7
3	25	6	13	14	15	15	15	34	38	54	47	45	1.8	1.8	2.5	2.6	2.2
3	25	7	14	14	13	12	13	40	39	44	32	40	2.2	1.9	2.1	1.9	2.0
3	25	8	16	17	20	18	54	68	54	83	68	64	3.7	2.9	4.5	3.7	3.0
3	25	9	20	17	20	20	16	75	56	70	60	57	4.2	2.9	3.6	3.4	3.0

Year	Variety	S Date	# of Spikelets/hd					# of Kernals/spikelet					Seed Weight				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3	25	10	16	16	13	12	15	48	37	43	32	45	2.5	1.6	2.0	1.6	2.4
3	25	11	15	14	14	14	12	56	47	34	44	39	2.4	2.4	1.5	2.2	1.8
3	25	12	14	15	14	12	15	48	53	57	36	48	2.2	2.5	2.9	1.0	2.3
3	26	1	24	22	21	21	21	106	97	95	87	85	4.8	4.0	4.3	4.2	2.9
3	26	2	20	20	18	22	21	85	60	64	89	77	3.8	2.7	2.7	4.3	3.8
3	26	3	16	17	24	21	21	44	58	85	81	61	1.4	2.4	4.1	3.4	1.9
3	26	4	22	22	19	18	22	72	88	77	57	64	3.5	3.7	3.4	2.5	2.7
3	26	5	18	19	21	14	19	70	87	67	46	81	2.8	3.5	2.3	1.7	4.3
3	26	6	19	20	20	21	19	61	73	63	85	60	2.8	3.0	2.8	3.6	2.8
3	26	7	21	23	19	18	20	101	88	77	78	77	4.5	4.1	3.6	3.7	2.9
3	26	8	22	18	22	21	19	97	81	98	82	75	4.7	3.2	4.4	3.8	2.3
3	26	9	18	19	21	26	15	64	62	83	60	54	2.6	2.2	2.6	0.9	1.2
3	26	10	18	19	19	17	16	38	58	48	24	50	0.8	1.1	0.5	0.7	1.0
3	26	11	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	26	12	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3	27	1	17	19	19	15	17	42	45	50	35	42	2.0	2.9	2.8	2.0	2.3
3	27	2	21	20	20	19	18	58	42	65	57	52	2.9	2.3	3.5	3.5	2.9
3	27	3	20	19	16	19	15	83	70	49	74	46	4.5	4.0	3.0	4.0	2.3
3	27	4	19	21	20	19	17	64	81	71	65	52	3.3	4.5	3.9	3.7	3.0
3	27	5	15	19	19	18	17	47	61	63	60	56	2.5	3.6	4.0	3.7	2.6
3	27	6	22	20	22	17	17	77	60	81	53	50	4.5	3.5	4.7	2.6	3.2
3	27	7	13	12	15	14	17	30	35	32	57	64	1.9	1.9	1.6	2.9	3.7
3	27	8	17	16	11	18	18	58	52	28	64	64	3.1	2.9	1.4	3.3	3.4
3	27	9	16	15	18	13	13	50	49	52	35	34	2.0	2.4	3.1	1.9	2.1
3	27	10	13	17	18	17	16	38	57	56	58	47	2.0	3.3	3.0	2.9	2.5
3	27	11	12	14	12	12	13	38	52	36	35	44	1.8	3.1	2.1	1.7	2.2
3	27	12	10	13	15	16	14	37	35	47	40	47	1.6	1.5	2.5	2.1	2.3