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TRITICUM AESTIVUM (VAR. MARQUIS AND RIDEAU)

THE EFFECT OF IMBIBITION AND VERNALIZATION ON SOME PARAMETERS OF ROOT GROWTH

BY

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Statement of the Problem

Over the past three decades the major studies on the effect of vernalization on cereal growth have emphasised the effect of chilling on hastening the onset of flowering and have stressed attendant morphological changes in the shoot growth of treated plants.

Little information is available however on the specific effect of vernalization on root growth. Wort (1940) visually noted an increase in the total rooting system of a spring wheat and increased dry weight measurements following vernalization. Weinberger and Godin (1963) found that vernalization increased cell counts in a 10 mm. segment of the root apex.

The present study was undertaken in order to elucidate whether vernalization did in fact have any effect, (whether large or small), upon the growth of the primary rooting system. A spring and winter wheat were selected and exposed to two imbibition periods in order to ascertain whether there was a varietal difference in the rooting response to vernalization, and to determine whether this was modified by the imbibition period. The parameters selected were changes in length of the whole primary root and of seven 0.5 mm. delineated root tip segments together with changes in cell number, fresh and dry weights of each of these segments with time. This primary data yielded information on changes in cell number, average cell length, and average cell fresh and dry weights with distance from the root apex.

ABSTRACT

THE EFFECT OF A VERNALIZING TEMPERATURE ON THE EARLY ROOT GROWTH OF SPRING AND WINTER WHEAT (VAR. MARQUIS AND RIDEAU) HAS BEEN EXAMINED FOLLOWING TWO IMBIBITION PERIODS (5 AND 14 HOURS), AND 1-7 WEEKS OF COLD TREATMENT.

COMPLETION OF THE THERMO-PHASE, AS VERIFIED BY TWO STANDARD BIOCHEMICAL METHODS, VARIED WITH THE SEED VARIETY AND THE IMBIBITION PERIOD.

FOUR WEEKS OF PRIOR COLD TREATMENT PROVIDED THE MAXIMAL IMPETUS TO GERMINATION REGARDLESS OF THE CEREAL VARIETY, IMBIBITION PERIOD, OR THERMO-PHASE REQUIREMENT.

A MARKED INCREASE IN CELL NUMBER AND A PROLONGATION OF THE "MITOTIC-STATE" WAS OBSERVED TO BE CO-INCIDENTAL WITH THE COMPLETION OF THE THERMO-PHASE IN BOTH GRAIN VARIETIES. CHANGES IN SEGMENT LENGTH, AVERAGE CELL LENGTH, FRESH WEIGHT AND DRY WEIGHT PER SEGMENT AND PER AVERAGE CELL OF THE PRIMARY ROOT OF THESE WHEAT VARIETIES WERE ALSO SHOWN TO BE CORRELATED WITH THE COMPLETION OF VERNALIZATION.

RÉSUMÉ

L'EFFET DE LA TEMPÉRATURE DE VERNALIZATION SUR LA CROISSANCE INITIALE DE LA RACINE DU BLÉ DE PRINTEMPS (VAR. MARQUIS) ET DU BLÉ D'HIVER (VAR. RIDEAU) FUT ÉTUDIÉ AU MOYEN DE DEUX PÉRIODES D'IMBIBITION (5 ET 14 HEURES) ET D'UN TRAITEMENT AU FROID VARIANT DE 1 À 7 SEMAINES. LA DURÉE DE LA "THERMO-PHASE" (VÉRIFIÉE PAR DEUX ÉPREUVES BIOCHIMIQUES), S'AVÉRA DIFFÉRENTE SELON LA VARIÉTÉ DE GRAINE ET LA PÉRIODE D'IMBIBITION.

QUATRE SEMAINES DE RÉFRIGÉRATION DONNENT L'IMPULSION MAXIMALE À LA GERMINATION, INDÉPENDEMMENT DE LA VARIÉTÉ DE CÉRÉALE, DE LA PÉRIODE D'IMBIBITION OU DE LA DURÉE DE LA "THERMO-PHASE". UNE AUGMENTATION MARQUÉE DU NOMBRE DES CELLULES ET LA PROLONGATION DU STADE MITOTIQUE ACCOMPAGNENT L'ACHÈVEMENT DE LA "THERMO-PHASE" DANS LES DEUX VARIÉTÉS DE CÉRÉALE. LE TERME DE LA VERNALIZATION EST ASSOCIÉ À DES CHANGEMENTS DANS LA LONGUEUR DES SEGMENTS, DANS LA LONGUEUR MOYENNE DES CELLULES, DANS LE POIDS FRAIS ET LE POIDS SEC DES RACINES.

List of Code Used in The Text

K : Control seedling - exposed to Controlled Environment Cabinet Temperature only.

C.E.C. : Controlled Environment Cabinet.

C_1 : seeds vernalized one week at 2 ± 1°C.

C_2 : seeds vernalized two weeks at 2 ± 1°C.

C_3 : seeds vernalized three weeks at 2 ± 1°C.

C_4 : seeds vernalized four weeks at 2 ± 1°C.

C_5 : seeds vernalized five weeks at 2 ± 1°C.

C_6 : seeds vernalizel six weeks at 2 ± 1°C.

C_7 : seeds vernalized seven weeks at 2 ± 1°C.

M_5 : Marquis wheat (spring var.) imbibed 5 hours prior to vernalization.

R_5 : Rideau Wheat (winter var.) imbibed 5 hours prior to vernalization.

R_{14} : Rideau Wheat (winter var.) imbibed 14 hours prior to vernalization.

M_5K, R_5K, $R_{14}K$: - Control seed of Marquis and Rideau wheat, five and fourteen hour imbibed.

M_5C_{1-7}, R_5C_{1-7}, $R_{14}C_{1-7}$: Treated seed of Marquis and Rideau wheat, five and fourteen hour imbibed, vernalized from 1-7 weeks.

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PART ONE

INTRODUCTION

In temperate countries the seeds of winter cereals must be planted in the fall, or before the end of winter, for the plants to flower during the following summer. If they are planted in spring, winter cereals do not come to flower until the late fall, and do not ear until early November. This late earing makes harvesting of the wheat almost impossible because of the onset of the rain and snow of winter. Spring cereals, on the other hand, which generally can not survive the prolonged cold of winter, are sown in spring, and the cereals flower in mid-summer of the same year.

Since the last century, many scientists have studied the two different types of cereals (16,17,24,25,35). Consistently, they have found that it is the low temperatures of the winter period which hastens the subsequent flowering.

The term "vernalization" was originally coined by Lysenko 1928 (23) to describe the acceleration of the reproductive stage of growth by chilling the winter cereal seeds or seedlings. Effective chilling temperatures are in the range of $-5^{o}C$ to $+ 10^{o}C$ (16,17,35,36). The maximal response being elicited between $0^{o}C$ and $+ 3^{o}C$. Purvis noted that rye seeds or seedlings maintained at temperatures below $-6^{o}C$ decayed after planting. A neutral response was obtained from $13^{o}C$ to $15^{o}C$ and devernalization occurred in rye at temperatures higher

THAN 18°C (24).

UNDER NATURAL CONDITIONS, THE VARIOUS CEREAL SPECIES HAVE DIFFERENT CHILLING TIME REQUIREMENTS WHICH DEPEND UPON THEIR NATIVE CLIMATE (34). SEEDS MAY THUS BE PARTIALLY VERNALIZED BEFORE REAPING. BECAUSE OF THIS, THE SAME VARIETY OF WHEAT GROWN IN DIFFERENT REGIONS, MAY HAVE DIFFERENT REQUIREMENTS FOR THE DURATION OF COLD TREATMENT IN ORDER TO COMPLETE THE VERNALIZATION PROCESS.

THE EFFECTIVENESS OF CHILLING IN BOTH WINTER AND SPRING CEREALS IS DEPENDENT UPON THE WATER SUPPLY AVAILABLE TO THE SEEDS AT THE TIME OF IMBIBITION, AS WELL AS ON THE TEMPERATURE TO WHICH THE SEEDS ARE SUBSEQUENTLY EXPOSED (34). USUALLY AN OPTIMAL RESPONSE IS OBTAINED WHEN THE AMOUNT OF WATER USED IS EQUAL TO 50-60% OF THE AIR DRY WEIGHT OF THE SEED (34).

GREGORY AND PURVIS 1938 (16) NOTED THAT CHILLING AFFECTED THE MERISTEMATIC CELLS OF THE EMBRYO, BUT THE LATENT CHANGES ONLY BECAME MORPHOLOGICALLY EVIDENT DURING SUBSEQUENT GROWTH AND DEVELOPMENT.

IN STUDYING THE EARLY STAGES OF SEED GROWTH, IT IS IMPORTANT TO DIFFERENTIATE BETWEEN THE GERMINATION PROCESS AS SUCH AND SUBSEQUENT SEEDLING GROWTH. IN THIS THESIS, GERMINATION IS DEFINED AS ENCOMPASSING THOSE PROCESSES WHICH START WITH THE IMBIBITION OF THE SEED AND END WITH THE PROTRUSION OF THE ROOT THROUGH THE PERICARP. THE LATER STAGES OF GERMINATION INEVITABLY OVERLAP THE EARLY STAGES OF ROOT GROWTH. MANY DEVELOPMENTAL STAGES TAKE PLACE INSIDE THE SEED

AND PREPARE THE EMBRYO FOR SUBSEQUENT GROWTH (16). IT IS KNOWN THAT WINTER CEREALS AND SOME SPRING CEREALS ARE ABLE TO BE BROUGHT TO EARLIER FLOWERING ONLY AFTER CERTAIN METABOLIC CHANGES HAVE BEEN INDUCED BY EXPOSURE TO LOW TEMPERATURE (16). BIOCHEMICALLY, LITTLE IS KNOWN ABOUT THE METABOLIC SEQUENCE ASSOCIATED WITH VERNALIZATION.

TWO EMPIRICAL BIOCHEMICAL TESTS HAVE BEEN DEVISED FOR USE ON CEREAL EMBRYOS IN ORDER TO DETECT THE COMPLETION OF THE VERNALIZATION REQUIREMENT OF THE SEEDS. ONE OF THESE METHODS WAS DEVISED BY BASSARSKAJA (1). HE USED A STAINING REACTION BASED ON THE PRECIPITATION OF PRUSSIAN BLUE WITHIN THE EMBRYO TISSUES FOLLOWING ADDITION OF FERRIC CHLORIDE AND POTASSIUM FERROCYANIDE. RICHTER (26) USED A TECHNIQUE BASED UPON THE DISPLACEMENT OF THE ISO-ELECTRIC POINT OF THE EMBRYO TISSUES TO DETERMINE THE COMPLETION OF THE VERNALIZATION REQUIREMENT.

TEMPERATURE AFFECTS GROWTH IN VARIOUS WAYS. WORKING IN THE GENERAL FIELD OF ROOT GROWTH, WENT (34) FOUND THAT A DIURNAL VARIATION IN TEMPERATURE (CIRCA 25°C DURING THE DAY, AND 17^0 - 20^0C AT NIGHT) PROVIDE OPTIMAL TEMPERATURE CONDITIONS FOR ROOT GROWTH OF THE PLANTS STUDIED. BURSTROM (5) NOTE THAT UNDER HIGH TEMPERATURES THE FINAL LENGTH OF THE CELLS OF MANY ROOTS WAS REDUCED BECAUSE OF THE SHORTER PERIOD OF CELL ELONGATION.

IN STUDYING THE NATURE OF GROWTH AND DIFFERENTIATION OF APICAL MERISTEMS, ROOT MERISTEMS SPECIFICALLY, HAVE RECEIVED MUCH ATTENTION BY EARLY WORKERS (14, 19, 20). CHANGES IN GROWTH ARE MORE EASILY FOLLOWED HERE SINCE ROOTS ARE NOT OBSCURED OR COMPLICATED BY FOLIAR

EMERGENCES. EACH REGION MELDS SOMEWHAT INTO THE NEXT SO THAT NO CLEAR CUT LINE OF DEMARCATION IS ACTUALLY VISIBLE.

USUALLY, THE ROOT TIP IN LONGITUDINAL SECTION IS SOMEWHAT ARBITRARILY DIVIDED INTO FOUR REGIONS, NAMELY, THE ROOT CAP (0 MM. TO 0.5 MM.), THE MERISTEMATIC ZONE (0.5 TO THE 4.0 MM.), ZONE OF ELONGATION 4.0 MM. TO 10 MM.) AND THE ZONE OF DIFFERENTIATION OR MATURATION (BEYOND 10 MM.) (11,19,28). GROWTH IN A MULTICELLULAR ORGAN OR PLANT USUALLY INVOLVES AN INCREASE IN THE NUMBER OF CELLS AND/OR AN INCREASE IN THE SIZE OF ITS CONSTITUENT CELLS. THE RELATIVE CONTRIBUTION OF CELL DIVISION AND CELL EXPANSION TOWARDS LONGITUDINAL GROWTH IN THE APICES OF ROOTS HAS BEEN INVESTIGATED IN SEVERAL WAYS.

GRAY AND SCHOLES 1951 (15) FOLLOWED ROOT GROWTH BY COUNTING THE NUMBER OF CELLS IN MITOSIS AND INTERPHASE IN CONSECUTIVE ROOT TIP SECTIONS. BROWN AND RICKLESS 1949 (4) ASSESSED THE ROOT GROWTH OF THEIR EXCISED MATERIAL BY MEASURING THE ROOT AND THEN MACERATING IT IN A KNOWN VOLUME OF CHROMIC ACID. SAMPLES OF THE CELLULAR SUSPENSION WERE TAKEN, COUNTED ON A HEMOCYTOMETER SLIDE, AND FROM THIS COUNT THE TOTAL NUMBER OF CELLS CONTAINED IN KNOWN LENGTHS OF ROOT WERE COMPUTED.

IN ORDER TO ESTABLISH THE CHANGING PATTERN OF GROWTH WITH TIME, ANALYSES HAVE ALSO BEEN MADE OF CAMERA LUCIDA DRAWINGS OR OF PHOTOGRAPHIC RECORDS OF MARKED EPIDERMAL CELLS, OR OF INK MARKS ON THE SURFACE OF THE ROOTS. THIS APPROACH HAS BEEN APPLIED BY

ERICKSON AND COWORKERS (8, 9 ,10,11) AND GOODWIN AND AVERS 1956. THEY USED A FINE CAMEL HAIR BRUSH AND MARKED THE ROOTS WITH LAMP BLACK AT 0.5 MM. INTERVALS FROM THE ROOT TIPS. CONTINUOUS PHOTOGRAPHIC RECORDS OF THE SUBSEQUENT DISPLACEMENT OF THESE MARKINGS PROVIDED THE BASIC DATA FOR COMPUTING GROWTH RATES.

GROWTH HAS ALSO BEEN ASSESSED IN TERMS OF CHANGING FRESH AND DRY WEIGHTS. WORKING WITH ZEA ROOTS, COOK (6) FOUND THAT THE FRESH WEIGHT INCREASED FROM 14 MμG. PER CELL IN THE ZONE OF CELL DIVISION, (THE MERISTEMATIC ZONE), TO 88 MμG. PER CELL IN THE ZONE OF EXTENSION GROWTH. WHEN MAXIMAL CELL SIZE WAS REACHED, AN INCREASE IN DRY WEIGHT WAS ALSO OBSERVED. IN THE CASE OF ZEA, THIS INCREASE VARIED FROM 2.2 MμG. IN THE MERISTEMATIC ZONE TO 8.3 MμG. PER CELL IN THE ZONE OF ELONGATION (28).

MANY BIOCHEMICAL ANALYSES OF GROWING TISSUES HAVE ALSO BEEN FOLLOWED. SOME OF THESE HAVE DESCRIBED CHANGES IN DNA, RNA, PROTEINS (14), AMINO ACIDS (21), THIOLS (2), ENZYMES (37), AND CELL WALL CONSTITUENTS WITH GROWTH.

LITTLE INFORMATION IS AVAILABLE, HOWEVER, ON THE SPECIFIC EFFECT OF VERNALIZATION ON ROOT GROWTH. WORT 1939 (35) CURSORILY NOTED THAT VERNALIZATION WAS FOLLOWED BY MORE VIGOROUS ROOT GROWTH AS OBSERVED VISUALLY, AND BY INCREASED DRY WEIGHT MEASUREMENTS ON WHOLE ROOT SYSTEMS. WEINBERGER AND GODIN 1963 (32) INDICATED THAT IN WINTER WHEAT (VAR. RIDEAU) VERNALIZATION OF THE SEED CAUSED A

MARKED CHANGE IN THE METABOLISM OF THE SEEDLING AND THEIR WORK INDICATED AN EFFECT ON CELL DIVISION IN ROOT APICES WITH CHILLING. HOWEVER, THE EMPHASIS OF THEIR WORK WAS ON LEAF GROWTH. FROM THEIR STUDY IT APPEARED AS IF THE PRIMARY EFFECT OF THE COLD TREATMENT WAS TO GET GROWTH AND DEVELOPMENT OFF TO A MORE RAPID START.

RELATIVELY FEW CONCISE AND ANNOTATED OBSERVATIONS HAVE BEEN MADE IN THE FIELD OF ROOT GROWTH RESPONSE TO VERNALIZATION. THE MAIN OBJECTIVE OF THE PRESENT WORK WAS TO STUDY, IN DEPTH, THE EFFECT OF VERNALIZATION AND TWO IMBIBITION PERIODS ON SELECTED PARAMETERS OF ROOT GROWTH.

THIS INVESTIGATION REPRESENTS A STUDY IN THE DEVELOPMENT OF CELLS AT THE ROOT APEX, FROM THE MERISTEMATIC TO THE FULLY VACUOLATED STATE, IN ROOTS DERIVED FROM THE SEED CHILLED FROM 1-7 WEEKS AT $2 \pm 1^{o}C$.

A SPRING AND WINTER WHEAT WERE SELECTED IN ORDER TO ASCERTAIN WHETHER THERE WAS A DIFFERENCE IN RESPONSE BETWEEN THESE VARIETIES. AN ATTEMPT WAS MADE IN THIS WAY TO ESTABLISH FIRSTLY, WHETHER VERNALIZATION DOES IN FACT HAVE SOME EFFECT (WHETHER LARGE OR SMALL) ON THE EARLY GROWTH OF THESE CEREAL ROOT SYSTEMS, SECONDLY, WHETHER THE YOUNG ROOTS OF SPRING AND WINTER WHEAT VARIETIES RESPOND IN A SIMILAR WAY TO VERNALIZATION, AND FINALLY, TO DETERMINE WHETHER THE PRECONDITIONING TREATMENT OF THE SEED (IN THIS CASE THE DURATION OF THE IMBIBITION PERIOD) AFFECTED THE SUBSEQUENT ROOT GROWTH RESPONSE TO COLD.

THE SPRING AND WINTER WHEATS SELECTED WERE VARIETIES WHICH ARE MOST COMMONLY SOWN IN THIS REGION, NAMELY TRITICUM AESTIVUM VAR. MARQUIS AND VAR. RIDEAU. IN THIS WAY THE EFFECT OF VERNALIZATION ON THE INITIAL ROOT GROWTH OF TWO TYPES OF ECONOMICALLY IMPORTANT CEREAL VARIETIES WAS FOLLOWED.

PART TWO

A. MATERIALS AND METHODS

1. Treatment of Seeds and Seedlings

Marquis (spring) and Rideau (winter) wheats were used throughout the study in parallel experiments. Seed was obtained from the Department of Agriculture, Division of Forage Crops, through the courtesy of Dr. D.J.C. Friend.

Method of Seed Sowing - Five grams of medium sized seeds were weighed for each treatment. They were then evenly spaced in 9 cm. diameter black painted Petri dishes lined with Whatman No. 1 filter paper The general design was similar to the vernalization dishes used by Purvis and Gregory 1952 (24). Sowings were arranged so that determinations on treated and control roots of Marquis and Rideau wheat could be made on sixty roots every two hours over a 48 hours experimental period.

Method of Imbibition - Glass-distilled water was added to the seeds in the Petri dishes up to a total of 60 per cent of their air-dried weight. The seeds were then left to germinate at 25°C. In the case of Rideau Wheat seeds, two imbibition periods were employed, namely five and fourteen hours. For Marquis wheat seeds, a five hour imbibition period only was followed (c.f. Results p. 16).

Percentage Germination - The percentage of germination of treated and control seed was obtained over the initial 48 hour period immediately following imbibition and treatment.

Conditions of vernalization - The Petri dishes containing the imbibed seeds were stored for one to seven weeks in a refrigerator at a temperature of 2 ± 1°C. The lids of the Petri dishes were removed daily and the seeds aerated for a few seconds. Following the experimental period in the cold, subsequent growth of the primary root was followed in a controlled environment growth cabinet.

Controlled Environment Growth Cabinet - A sixteen hour day and eight hour night was maintained for all the experimental material following the stated periods of vernalization (18). Light was provided by fluorescent tubes with the addition of 35 per cent of incandescent light on a lamp-wattage basis at an intensity of 1750 c. The total output rate in the spectral region 400-720 mμ. was 0.0054 cal. $cm.^{-2}$ $min.^{-1}$ (81 microwatt. $cm.^{-2}$) per 100 ft. c. The temperature was maintained constant at 24.5 ± 0.75°C during the day and 18 ± 0.75°C at night (33). The relative humidity was maintained at 80 ± 5 per cent. Control seed was placed in the controlled environment chamber immediately following the imbibition period.

Germination Procedures - Following the imbibition period the swollen grain was carefully spread on cheese cloth covered screens fitted on top of blackened 250 ml. beakers. Each beaker contained 100 ml. of distilled water. A wick of cheese cloth was provided from this water source up to the cheese cloth screen supporting the imbibed seeds. Drying of the seeds was further prevented by

COVERING THEM WITH A LAYER OF COTTON WOOL, WETTED (BUT NOT "SOAKED") WITH DISTILLED WATER. SEEDS WERE PLACED CLOSELY TOGETHER BUT DID NOT ACTUALLY TOUCH ONE ANOTHER. BEAKERS AND SEEDS WERE THEN PLACED IN LARGE 20" X 30" BLACK PAINTED CONTAINERS AND PLACED IN THE CONTROLLED ENVIRONMENT CHAMBER AND ALLOWED TO GERMINATE.

SELECTION OF SEEDLINGS - SEEDLINGS WERE DISCARDED IF THEIR PRIMARY ROOT SHOWED ANY CURVATURE FROM THE VERTICAL. OF THE REMAINDER, ONLY THOSE SEEDLINGS WITH PRIMARY ROOTS OF 1.5 ± 0.2 CM. IN LENGTH WERE SELECTED FOR FURTHER STUDY. IN THIS WAY IT WAS ASSURED THAT ALL THE MATERIAL WOULD BE OF A SIMILAR PHYSIOLOGICAL AGE.

2. EMBRYO TESTS

THE EMBRYOS OF CONTROL AND VERNALIZED WHEAT SEED (CHILLED ONE TO SEVEN WEEKS) OF BOTH WINTER AND SPRING VARIETIES (RIDEAU AND MARQUIS) WERE TESTED IN ORDER TO ASCERTAIN THE DEGREE OF COMPLETION OF THE THERMO-PHASE ASSOCIATED WITH VERNALIZATION WITHIN THE SEED. TWO PARALLEL METHODS WERE USED; THESE WERE MINOR MODIFICATIONS OF THOSE INITIATED BY BASSARSKAJA (1) AND RICHTER (26). THESE METHODS INDICATE PROGRESSIVE CHANGES IN THE EMBRYO TISSUES OF TREATED GRAIN BY MEANS OF SERIAL ALTERATIONS IN THEIR STAINING AND ISO-ELECTRIC POINT PROPERTIES RESPECTIVELY.

SECTIONS OF CONTROL AND TREATED EMBRYOS WERE CUT AT A THICKNESS OF 75 μ USING A FREEZING MICROTOME. MEDIAN SECTIONS WERE THEN MOUNTED ON STANDARD GLASS SLIDES USING A GELATIN FIXATIVE AS ADHESIVE.

Color Test - The slides were treated with 5% ferric chloride for 3 minutes, rinsed thoroughly several times with distilled water and then immersed for 3 minutes in a 5% potassium ferrocyanide solution.

Treated in this way the control, partially vernalized, and fully vernalized seeds of both Rideau and Marquis wheat showed differences in reaction. The change in color was followed visually. Visual ratings were given by comparing a series of sections of varying color densities. Preliminary attempts to dissolve out the colors and rate them more objectively on a color meter presented some difficulties, dependent mainly on the poor solubility of Prussian blue.

Change of the Iso-Electric Point - The slides were treated for 15 minutes with McIlwain's buffer solutions of pH 3.0 to 7.0 with intervals of 0.2 pH units. Following this, sections were stained for 5 minutes in an aqueous solution formed by mixing equal volumes of a 1% solution of eosin and a 1% solution of methylene blue at the moment of staining. After staining, the slides were rinsed in distilled water and returned to the buffer solution for 6 hours. At the conclusion of the 6 hour period the pH of the buffers was determined using a Coleman glass electrode apparatus.

3. Methods of Marking and Measuring

The general technique used has been to take seven serial sections 0.5 mm. thick along 3.5 mm. of the course of a root from the

APEX TOWARDS THE BASE, AND TO DETERMINE ON DIFFERENT, BUT CORRESPONDING, GROUPS OF SECTIONS, THEIR LENGTH, THE NUMBER OF CELLS THEY CONTAIN, THEIR FRESH AND DRY WEIGHTS. MEASUREMENTS WERE MADE EVERY 2 HOURS TO A TOTAL OF 48 HOURS. FROM THESE DATA THE MEASUREMENTS PER CELL WERE OBTAINED BY DIVIDING THE APPROPRIATE VALUE FOR THE SECTION BY THE NUMBER OF CELLS IT CONTAINED. THIS PROCEDURE YIELDED A FIGURE WHICH WAS AN AVERAGE MEASURE FOR THE CELLS IN ANY PARTICULAR ZONE OF THE ROOT AND DOES NOT REPRESENT DATA RELEVANT TO ANY PARTICULAR CELL TYPE. RECOGNIZING THEIR LIMITATIONS, THESE TECHNIQUES DO AFFORD A METHOD OF RELATING LINEAR MEASUREMENTS TO MEASUREMENTS OF OTHER ASPECTS OF GROWTH AND PROVIDES A MEANS OF ASSESSING THE EFFECT OF SEED CHILLING ON SUBSEQUENT ROOT GROWTH.

Marking Procedure - THE PRIMARY ROOT OF EACH OF THE SELECTED SEEDLINGS WAS SUPPORTED ON SLIDES COVERED WITH FOUR LAYERS OF MOISTENED CHEESE CLOTH. THE SLIDES WERE THEN PLACED ON THE STAGE OF A BINOCULAR MICROSCOPE EQUIPPED WITH A MICROMETER EYE PIECE. USING A VERY FINE NYLON THREAD (5-10 μ DIAMETER) SOAKED IN INDIA INK, SEVEN MARKINGS WERE MADE AT 0.5 MM. INTERVALS FROM THE ROOT TIP BACKWARDS. SUBSEQUENTLY, EACH SEED WAS LIGHTLY BOUND AND SUPPORTED ON A CHEESE CLOTH COVERED SLIDE. EACH SLIDE WAS THEN PLACED IN A VERTICAL POSITION IN A 250 ML. BLACK-PAINTED BEAKER CONTAINING 20 ML. OF GLASS DISTILLED WATER. THE TOP OF THE BEAKER WAS LOOSELY COVERED WITH JOSEPH'S PAPER. AT NO TIME DURING THE EXPERIMENTAL PERIOD DID THE ROOTS COME INTO PHYSICAL CONTACT WITH

THE WATER LAYER, BUT AN EFFECTIVE HUMIDITY CHAMBER WAS THUS PROVIDED. FOLLOWING THIS THE BEAKERS WERE PLACED IN THE GROWTH CABINET.

Cell Counting Technique - The method used for the estimation of cell numbers was that previously established by Brown and Rickless (4). Using a sharp edged razor the experimental area of the root tip of both cereal varieties was cut into its constituent marked segments following all treatments at each experimental period. Using parallel experiments, segments were detached in this way every two hours to a total of 48 hours. Samples were labelled and were placed by segment number in separate vials containing 5% chromic acid (0.5 cc. per 10 segments). They were left to stand at room temperature for 18 to 24 hours. After treatment with the acid solution, the tissue was broken up into a fine slurry by manipulating it with a thick, slightly roughened glass rod against the sides of the vessel. The slurry of cells was mixed with the fluid and the final suspension, on which the count was to be made, was obtained by squirting the fluid rapidly, several times, through the narrow orifice of a pipette. Counts were made in a hemocytometer slide.

Segment and Average Cell Length - The change in the length of the segments was followed using a binocular microscope equipped with a micrometer eye-piece to an accuracy ± 0.075 mm. Average cell lengths were computed from the primary data on the length and the total number of cells per segment.

Segment and Average Cell Fresh Weights - Determinations of the fresh and dry weights were made on 30 segments at each period. The fresh weights of each segment were obtained after each 2 hours of growth for a total period of 48 hours. Rapid sectioning was carried out under a binocular microscope. At all times care was taken to minimize loss of water due to evaporation from these small segments. Average cell fresh weights were computed.

Segment and Average Cell Dry Weight - Dry weights were obtained after heating the segments in an oven for 24 hours at 95 ± 1°C on small aluminum discs. Weights were taken to an accuracy of ± 0.01 mg. on an analytical balance after equilibrating with atmospheric humidity. The accuracy of the method has been examined by comparing these results with others obtained by a freeze - drying method. The results from the two methods did not differ significantly. An estimate of the change in average cell dry weight was also calculated.

Statistical Data - Most of the data presented in Part 2 were subjected to an Analysis of variance. Wherever the F value was found to be significant at the 5% level, the Duncan multiple range test (7) was used to locate the significant difference at this level.

B. RESULTS

1. Germination and Early Root Growth

The Imbibition Period - Marquis and Rideau wheat seeds were allowed to imbibe water at a level of 50 per cent of their air dry weight at 25°C (34). After 5 hours of imbibition the Marquis (spring) wheat seeds (M_5) were fully swollen, prolonging the imbibition period further resulted in the continued emergence of the primary root. Rideau (winter) cereal seeds after 5 hours imbibition (R_5) under the same conditions of water and temperature were still very wrinkled in appearance. Further prolonging the imbibition period to 14 hours (R_{14}) produced an appearance in the grain similar to that obtained for Marquis seed after 5 hours treatment. Extending the imbibition period still further resulted in the emergence of the primary root. Physiologically then, a five hour imbibition period in Marquis seed (M_5) under the stated conditions paralleled those stages of germination observed in Rideau seed after 14 hours (R_{14}). In both cases the caryopses at this stage was milky, the embryo fully hydrated, and prolonging the imbibition periods further resulted in the emergence of the primary root. Because of this, two parallel imbibition periods were used for Rideau wheat, namely 5 and 14 hours (R_5 and R_{14}) and only one five hour period for Marquis (M_5).

Percentage Germination - The percentage germination of control seed of spring (Marquis) and winter (Rideau) wheat following all

TREATMENTS WAS OBTAINED. GERMINATION WAS ASSESSED TO BE COMPLETED WHEN THE RADICLE HAD PIERCED THE PERICARP. THE RESULT OF TREATMENT ON GERMINATION IS SHOWN IN TABLE I.

TABLE I

THE VARIATION OF PERCENTAGE GERMINATION OF MARQUIS AND RIDEAU WHEAT WITH IMBIBITION, VERNALIZATION AND SEED VARIETY.

DATA REPRESENT TRIPLICATE DETERMINATIONS OF 20 SEEDS TO A TOTAL OF 60.

SEED VARIETY	VERNALIZATION (WEEKS)							
	0	1	2	3	4	5	6	7
M_5	92	90	92	92	91	92	92	91
R_5	93	94	92	92	91	93	91	91
R_{14}	91	90	92	90	90	91	90	91

IT IS EVIDENT THAT APPROXIMATELY 90-93 PER CENT GERMINATION WAS OBTAINED UNDER ALL CONDITIONS OF TREATMENT. NEITHER THE IMBIBITION PERIOD, NOR THE DURATION OF THE COLD TREATMENT AFFECTED THE GERMINATION CAPACITY OF THE SEEDS.

RATE OF GROWTH OF THE PRIMARY ROOT - UNLIKE PERCENTAGE GERMINATION, THE RATE OF GROWTH OF THE PRIMARY ROOT OF EACH VARIETY OF SEED

FOLLOWING RUPTURE OF THE PERICARP WAS DEPENDENT UPON THE IMBIBITION PERIOD AND THE DURATION OF VERNALIZATION. THE TIME REQUIRED FOR THE SEEDS, UNDER ALL TREATMENTS, TO REACH 1.5 CM. IN LENGTH IS GIVEN IN TABLE 2. IN ALL CASES SIXTY SEEDS WERE OBSERVED (TRIPLICATE DETERMINATIONS ON TWENTY SEEDS.)

TABLE 2

MARQUIS WHEAT (M_5), RIDEAU WHEAT (R_5) AND (R_{14}). VARIABLE SCHEDULES TO REACH 1.5 CM IN LENGTH WITH TWO IMBIBITION PERIODS AND VERNALIZATION.

DUNCAN'S TEST (5% LEVEL)

VERNALIZATION (WEEKS)	TIME (HOURS)		
	R_5	M_5	R_{14}
0	44.0 ± 0.5	40.5 ± 0.5	28.0 ± 0.5
1	R_5 29.5 ± 0.5	R_{14} 28.0 ± 1.0	M_5 26.5 ± 0.5
2	R_5 28.0 ± 0.5	R_{14} 27.0 ± 0.5	M_5 24.0 ± 0.5
3	R_5 25.0 ± 0.5	R_{14} 24.0 ± 0.8	M_5 19.0 ± 0.4
4	R_{14} 24.0 ± 0.5	R_5 23.0 ± 0.5	M_5 16.0 ± 0.7
5	R_5 24.0 ± 0.4	R_{14} 23.0 ± 1.0	M_5 17.0 ± 0.8
6	R_{14} 24.0 ± 0.5	R_5 23.0 ± 0.7	M_5 16.0 ± 0.8
7	R_{14} 23.0 ± 1.0	R_5 22.0 ± 0.8	M_5 18.0 ± 0.5

CHILLING ELICITED A SIMILAR PATTERN IN THE TIMES TAKEN FOR THE PRIMARY ROOTS OF FIVE HOUR IMBIBED SPRING AND WINTER WHEAT TO REACH 1.5 ± 0.2 CM. IN LENGTH, NAMELY, $C_7=C_6=C_5=C_4=C_3 < C_2=C_1 < K$. THIS SEQUENTIAL RESPONSE DID NOT HOLD IN THE CASE OF THE FOURTEEN HOUR IMBIBED RIDEAU SERIES WHERE $K=C_1 > C_2 > C_3 - C_7$. THE PRIMARY ROOT OF THE CONTROL SEEDS IN THIS LATER SERIES ATTAINED THE LENGTH OF 1.5 ± 0.2 CM. IN ONLY 28 HOURS AS AGAINST 44 AND 40 HOURS IN THE OTHER RIDEAU AND MARQUIS SERIES.

THE RATE OF THE EARLY ROOT GROWTH OF THE RADICLE WAS THUS SHOWN TO BE HIGHLY DEPENDENT UPON THE IMBIBITION PERIOD. CHILLING MODIFIED THIS PRIMARY RESPONSE.

2. Diagnosis of the Vernalized State

THE EARLY ADVANCE IN DEVELOPMENT OF A GERMINATING SEED IS NOT ALWAYS EVIDENCED BY MORPHOLOGICAL CHANGES. THIS IS PARTICULARLY TRUE IN THE CASE OF VERNALIZED CEREAL SEED WHICH IS MORPHOLOGICALLY INDISTINGUISHABLE FROM UNTREATED CONTROL GRAIN. THE DATA ON ROOT EMERGENCE AS PRESENTED IN TABLE 2 INDICATED THAT 3-7 WEEKS OF CHILLING WAS OPTIMAL FOR THE EARLY ROOT GROWTH OF BOTH SPRING AND WINTER VARIETIES OF WHEAT. A DIAGNOSIS OF THE VERNALIZED STATE OF THESE SEEDS WAS THEREFORE UNDERTAKEN USING A MODIFICATION OF THE METHODS EMPLOYED BY BASSARSKAJA (1) AND RICHTER (26).

The Ferric Chloride - Potassium Ferrocyanide Color Test - THE METHOD DETAILED PREVIOUSLY (p. 10) WAS EMPLOYED ON MARQUIS (M_5) AND RIDEAU (R_5 AND R_{14}) WHEAT SEEDS. TREATED IN THIS WAY THE

VERNALIZED AND UNVERNALIZED SEEDS SHOWED DIFFERENCES IN REACTION. AS THE SEEDS PASSED TOWARDS COMPLETION OF VERNALIZATION THE COLOR OF THE GROWING POINT CHANGED FROM YELLOW TO GREEN WITH AREAS OF YELLOW, AND FINALLY TO A DARK BLUE. THE BLUE COLOR WAS OBTAINED WHEN VERNALIZATION(VERIFIED BY PARALLEL GROWTH EXPERIMENTS) WAS COMPLETED. TISSUES OTHER THAN THE GROWING POINT STAINED BLUE FROM THE BEGINNING. THESE CHANGES ARE DETAILED IN TABLE 3, A.B.C.

TABLE 3

MARQUIS WHEAT (M_5), RIDEAU WHEAT (R_5 AND R_{14}). VISUAL RATING OF THE CHANGE OF COLOR OF THE GROWING POINT WITH IMBIBITION, VERNALIZATION AND SEED VARIETY.

A) MARQUIS WHEAT (M_5)

	TREATMENT (WEEKS)						
COLOR	M_5K	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6
Y	+	+					
YG	+	+	+				
G		+	+	+	+		
GB			+	+	++	+++	+
B		+	+	++	++	+++	++++

B) RIDEAU WHEAT (R_5)

COLOR	R_5K	R_5C_1	R_5C_2	R_5C_3	R_5C_4	R_5C_5	R_5C_6
Y	+++	+	+				
YG		+	++	++			
G			+	+			
GB				+++	++++	+	+
B					+++	+++	++++

C) RIDEAU WHEAT (R_{14})

COLOR	$R_{14}K$	$R_{14}C_1$	$R_{14}C_2$	$R_{14}C_3$	$R_{14}C_4$	$R_{14}C_5$	$R_{14}C_6$
Y	++	+					
YG		++	+				
G			+	+			
GB			+	++	+++		
B				+	++	+++	+++

Y: YELLOW; YG: YELLOW GREEN; G: GREEN; GB: GREEN BLUE; B: BLUE.
+: VISUAL RATINGS OF COLOR DENSITY.

THE COLOR TEST RELIES ON A CHANGE IN REACTIVITY OF CEREAL EMBRYO TISSUE TOWARDS FERRIC CHLORIDE AND POTASSIUM FERROCYANIDE DURING THE COURSE OF COMPLETION OF VERNALIZATION. FULLY VERNALIZED TISSUE ALLOWS DEPOSITION OF PRUSSIAN BLUE IN THE REGION OF THE GROWING POINTS. IN THIS SERIES, IT IS APPARENT THAT THE MARQUIS (SPRING) WHEAT USED HERE HAD A CHILLING REQUIREMENT OF AT LEAST ONE WEEK IN ORDER TO COMPLETE VERNALIZATION. THE DURATION OF THE CHILLING PERIOD TO COMPLETE THIS PHASE IN RIDEAU WHEAT APPEARED TO BE INFLUENCED BY THE PRIOR PERIOD OF SEED IMBIBITION. SEEDS IMBIBED FOR 5 AND FOURTEEN HOURS REQUIRED FOUR AND THREE WEEKS RESPECTIVELY OF CHILLING FOR COMPLETION OF THEIR VERNALIZATION REQUIREMENT AS EVILENCED BY THE FIRST APPEARANCE OF WHOLLY BLUE AREAS IN THE EMBRYO.

THE CHANGE IN COLOR WAS FOLLOWED VISUALLY, VISUAL RATINGS WERE GIVEN BY COMPARING A SERIES OF SECTIONS OF VARYING COLOR DENSITIES. PRELIMINARY ATTEMPTS TO DISSOLVE OUT THE COLORS AND RATE THEM MORE OBJECTIVELY ON A COLORIMETER PRESENTED SOME DIFFICULTIES, DEPENDENT MAINLY ON THE POOR SOLUBILITY OF PRUSSIAN BLUE.

PARALLEL EXPERIMENTS WERE UNDERTAKEN IN ORDER TO VERIFY THESE FINDINGS ON THE VERNALIZATION REQUIREMENT OF THE GRAIN. THE TEST EMPLOYED WAS THAT DEVISED BY RICHTER (43). THIS METHOD IS DEPENDENT UPON SERIAL ISO-ELECTRIC POINT CHANGES OF SEED TISSUES AS VERNALIZATION ADVANCES TO COMPLETION.

Change of Iso-electric Point - During the course of exposure to cold treatment it was observed that as the thermophase of vernalization advanced to completion the pH reaction of the tissue progressively changed. This change was evidenced by an actual change in pH measurements and by a visual change in the color of the tissue. At pH 5.32 sections from unvernalized seeds stained blue when treated with eosin and methylene blue but at the same pH sections obtained from cold treated seed stained pink. During the course of vernalization the pH at which the sections stained blue dropped. On completion of vernalization the embryos in all cases (M_5, R_5, R_{14}) stained blue at pH 4.88. It thus appears as if the iso-electric point of the embryo tissues changed from pH 5.32 to pH 4.88 during the course of vernalization.

The results for the treated wheats are shown in Table 4, A.B.C.

TABLE 4

MARQUIS WHEAT (M_5), RIDEAU WHEAT (R_5) AND (R_{14}). CHANGE OF ISO-ELECTRIC POINT WITH IMBIBITION AND VERNALIZATION.

A. MARQUIS WHEAT (M_5)

VERNALIZATION (WEEKS)	0	1	2	3	4	5	6	7
pH	5.32	4.88	4.88	4.88	4.88	4.88	4.88	4.88

B. RIDEAU WHEAT (R_5)

VERNALIZATION (WEEKS)	0	1	2	3	4	5	6	7
pH	5.32	5.16	5.14	4.92	4.88	4.88	4.88	4.88

C. RIDEAU WHEAT (R_{14})

VERNALIZATION (WEEKS)	0	1	2	3	4	5	6	7
pH	5.32	5.16	5.14	4.92	4.90	4.88	4.88	4.88

THEY INDICATE THAT VERNALIZATION WAS COMPLETE AFTER 1 WEEK IN MARQUIS (M_5), AND 4 AND 5 WEEKS RESPECTIVELY IN THE RIDEAU SERIES R_5 AND R_{14}. THESE RESULTS, EXCEPT IN THE CASE OF R_{14}, ARE COMPARABLE TO THOSE OBTAINED USING THE FERRIC CHLORIDE-POTASSIUM FERROCYANIDE METHOD (C.F. TABLE 3).

IN ORDER TO DIFFERENTIATE BETWEEN PATTERNS OF ROOT GROWTH OVERLAPPING THE LATER STAGES OF GERMINATION, AND THE PROCESSES OF ROOT GROWTH PER SE, FURTHER STUDIES WERE UNDERTAKEN SOLELY ON ROOTS THAT HAD ATTAINED 1.5 ± 0.2 CM. IN LENGTH AT THE BEGINNING OF THE EXPERIMENTAL PERIOD.

3. Measures of Growth with Time and with Distance from the Root Apex

Increase in Cell Number with Time

Control Series

THE DATA IN TABLE 5 AND FIGURE 1 SHOW THE CHANGE IN THE TOTAL NUMBER OF CELLS IN EACH SUCCESSIVE 0.5 MM. SECTION OF CONTROL ROOTS WITH TIME. THE DATA INDICATE THAT MOST SEGMENTS OF ALL SERIES CONTAIN COMPARABLE NUMBERS OF CELL IN EACH SUCCESSIVE SEGMENT.

Vernalized Series

MARQUIS WHEAT (M_5):- CELL COUNTS PER SEGMENT WITH TIME, OBTAINED FROM OPTIMALLY VERNALIZED MARQUIS WHEAT AND COMPARATIVE DATA FROM THE RIDEAU SERIES IS GIVEN IN TABLE 6.

THERE WAS A SPECTACULAR INCREASE IN THE NUMBER OF CELLS IN ALL SEGMENTS OF MARQUIS WHEAT AFTER ONE WEEK OF CHILLING. WITH FEW EXCEPTIONS THE INCREASE OVER THE FIRST 18 HOUR GROWTH PERIOD WAS AT LEAST A 100% OVER THAT OF CONTROL SEGMENTS OBTAINED FROM NON-

TABLE 5 (Part I)

Number of cells X10^{-2} of each segment of the primary root of Marquis (M_5K) Rideau (R_5K $R_{14}K$) wheat with time, imbibition, vernalization and seed variety. Control Data.

Duncan's test (5% level)

Segment	Experimental period (hours							
	2		4		6		8	
1	M_5K	4.56	R_5K	4.78	R_5K	7.11	R_5K	7.11
	R_5K	3.11	$R_{14}K$	4.72	$R_{14}K$	4.83	$R_{14}K$	5.
	$R_{14}K$	2.89	$M_{14}K$	2.39	M_5K	3.27	M_5K	4.22
2	$R_{14}K$	10.11	$R_{14}K$	7.72	R_5K	14.39	R_5K	14.50
	M_5K	6.50	R_5K	6.72	$R_{14}K$	12.61	$R_{14}K$	13.22
	R_5K	6.22	M_5K	3.44	M_5K	7.44	M_5K	8.89
3	$R_{14}K$	8.28	R_5K	9.84	R_5K	14.78	R_5K	15.50
	M_5K	7.17	$R_{14}K$	9.56	$R_{14}K$	12.50	$R_{14}K$	13.00
	R_5K	6.89	M_5K	5.22	M_5K	9.22	M_5K	10.44
4	$R_{14}K$	3.50	R_5K	4.84	R_5K	8.22	R_5K	8.50
	R_5K	3.39	M_5K	4.22	$R_{14}K$	6.94	$R_{14}K$	7.11
	M_5K	1.17	$R_{14}K$	4.17	M_5K	5.06	M_5K	5.78
5	$R_{14}K$	5.11	$R_{14}K$	5.78	R_5K	5.83	R_5K	6.11
	M_5K	5.00	M_5K	5.44	$R_{14}K$	4.61	$R_{14}K$	4.89
	R_5K	4.18	R_5K	4.83	M_5K	4.44	$M_{14}K$	4.89
6	$R_{14}K$	2.33	R_5K	2.67	R_5K	3.67	R_5K	3.79
	R_5K	1.78	$R_{14}K$	2.22	$R_{14}K$	2.39	$R_{14}K$	2.50
	M_5K	1.34	M_5K	1.28	M_5K	2.28	M_5K	2.33
	$R_{14}K$	1.94	$R5K$	2.22	R_5K	2.83	$R5K$	3.00
	$R5k$	1.61	$R_{14}K$	2.22	M_5K	1.67	$R_{14}K$	2.44
	$M5K$	1.56	$M5K$	1.67	$R_{14}K$	1.39	M_5K	1.79

TABLE 5 (Part II)

Number of cells X 10^{-2} of each segment of the primary root Marquis (M_5K) and Rideau (R_5K and $R_{14}K$) wheat with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Experimental period (hours)			
	10	12	14	16
1	R_5K 7.33	R_5K 7.44	R_5K 7.44	R_5K 7.50
	$R_{14}K$ 5.89	$R_{14}K$ 6.11	M_5K 6.89	$R_{14}K$ 7.22
	M_5K 5.00	R_5K 6.00	$R_{14}K$ 6.50	M_5K 6.79
2	R_5K 14.79	R_5K 15.00	R_5K 15.50	R_5K 14.79
	$R_{14}K$ 13.79	$R_{14}K$ 14.00	$R_{14}K$ 14.79	$R_{14}K$ 14.22
	M_5K 9.78	M_5K 10.00	M_5K 10.89	M_5K 12.00
3	R_5K 17.00	R_5K 16.11	R_5K 15.44	R_5K 14.50
	$R_{14}K$ 13.50	$R_{14}K$ 14.11	$R_{14}K$ 13.67	$R_{14}K$ 13.33
	M_5K 12.50	M_5K 13.78	M_5K 13.50	M_5K 13.11
4	R_5K 8.89	R_5K 8.11	$R_{14}K$ 8.44	R_5K 8.00
	$R_{14}K$ 7.79	R_5K 8.11	M_5K 8.22	$R_{14}K$ 8.00
	M_5K 6.11	M_5K 7.00	R_5K 7.50	M_5K 7.50
5	R_5K 6.79	R_5K 7.50	R_5K 6.11	R_5K 5.67
	$R_{14}K$ 5.11	$R_{14}K$ 5.68	M_5K 5.11	$R_{14}K$ 4.79
	M_5K 5.00	M_5K 4.67	$R_{14}K$ 4.50	M_5K 4.50
6	R_5K 4.11	R_5K 4.33	R_5K 4.00	R_5K 3.50
	$R_{14}K$ 2.79	$R_{14}K$ 3.00	M_5K 2.68	$R_{14}K$ 2.50
	M_5K 2.50	M_5K 2.79	$R_{14}K$ 2.67	M_5K 2.50
7	R_5K 3.22	R_5K 3.50	R_5K 3.11	R_5K 2.79
	$R_{14}K$ 2.11	$R_{14}K$ 2.10	M_5K 1.89	$R_{14}K$ 1.79
	M_5K 1.90	M_5K 2.00	$R_{14}K$ 1.79	M_5K 1.71

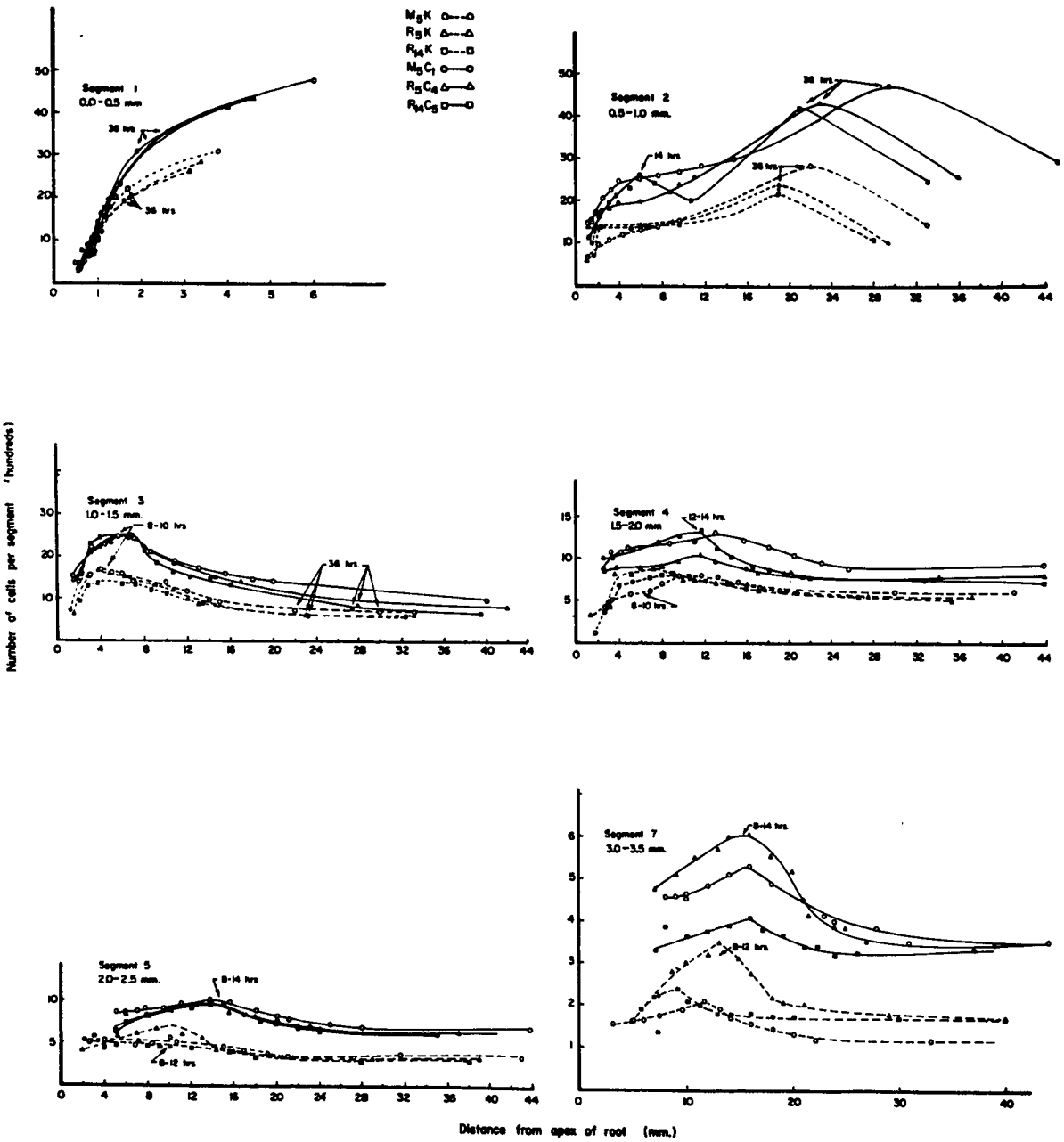
TABLE 5 (Part III)

Number of cells X10^{-2} of each segment of the primary root Marquis (M_5K) and Rideau (R_5K and $R_{14}K$) wheat with time, imbibition, vernalization and seed variety.

Duncan's Test (5% level)

Segment	Experimental period (hours)			
	18	24	36	48
1	M_5K 8.22	R_5K 12.22	M_5K 22.11	M_5K 23.11
	R_5K 7.33	M_5K 12.11	R_5K 20.11	R_5K 28.79
	$R_{14}K$ 7.22	$R_{14}K$ 12.00	$R_{14}K$ 19.11	$R_{14}K$ 26.50
2	R_5K 14.33	M_5K 15.89	M_5K 28.89	M_5K 14.50
	$R_{14}K$ 13.39	R_5K 15.33	R_5K 24.11	R_5K 17.33
	M_5K 13.22	$R_{14}K$ 14.79	$R_{14}K$ 22.11	$R_{14}K$ 11.00
3	R_5K 13.78	M_5K 10.00	M_5K 7.78	M_5K 7.78
	$R_{14}K$ 12.50	R_5K 9.79	R_5K 6.50	R_5K 6.50
	M_5K 12.11	$R_{14}K$ 9.78	$R_{14}K$ 6.22	$R_{14}K$ 6.00
4	M_5K 7.89	M_5K 6.72	M_5K 6.50	M_5K 6.44
	$R_{14}K$ 7.50	R_5K 6.56	R_5K 5.78	R_5K 5.50
	R_5K 7.33	$R_{14}K$ 6.11	$R_{14}K$ 5.80	$R_{14}K$ 5.11
5	M_5K 4.56	R_5K 4.11	M_5K 3.80	M_5K 3.44
	$R_{14}K$ 4.44	$R_{14}K$ 3.44	R_5K 3.11	R_5K 3.11
	R_5K 4.33	M_5K 3.22	$R_{14}K$ 3.00	$R_{14}K$ 3.00
6	R_5K 3.06	R_5K 2.89	R_5K 2.11	R_5K 2.00
	$R_{14}K$ 2.50	$R_{14}K$ 2.11	$R_{14}K$ 2.00	$R_{14}K$ 2.00
	M_5K 2.39	M_5K 1.78	M_5K 1.71	M_5K 1.79
7	R_5K 2.22	R_5K 2.00	R_5K 1.79	$R_{14}K$ 1.78
	$R_{14}K$ 2.00	$R_{14}K$ 1.89	$R_{14}K$ 1.79	R_5K 1.00
	M_5K 1.59	M_5K 1.22	M_5K 1.11	M_5K 1.22

FIGURE 1



NUMBER OF CELLS PER SEGMENT AT SUCCESSIVE INTERVALS FROM THE APEX.

TABLE 6 (Part I)

Marquis Wheat (M_5) Rideau Wheat (R_5) and (R_{14}). The cell number X 10^2 of each segment of the Primary Root with time, imbibition and vernalization. Control data on Marquis Wheat included (M_5K) Duncan's test (5% level)

Segment	Experimental period (hours)							
	2		4		6		8	
1	M_5C_1	11.61	M_5C_1	5.17	M_5C_1	5.18	M_5C_1	7.11
	M_5K	4.56	R_5C_1	3.78	R_5C_1	4.78	R_5C_1	6.50
	R_5C_1	2.22	M_5K	2.39	$R_{14}C_1$	3.33	$R_{14}C_1$	4.22
	$R_{14}C_1$	2.11	$R_{14}C_1$	2.06	M_5K	3.27	M_5K	4.22
2	M_5C_1	14.78	M_5C_1	11.72	M_5C_1	14.72	M_5C_1	17.22
	$R_{14}C_1$	6.67	$R_{14}C_1$	5.72	R_5C_1	13.17	R_5C_1	14.00
	M_5K	6.50	R_5C_1	4.00	$R_{14}C_1$	9.83	$R_{14}C_1$	12.22
	R_5C_1	5.22	M_5K	3.44	M_5K	7.44	M_5K	8.89
3	M_5C_1	15.56	M_5C_1	12.56	M_5C_1	22.57	M_5C_1	23.78
	M_5K	7.17	$R_{14}C_1$	7.22	R_5C_1	13.61	R_5C_1	14.11
	$R_{14}C_1$	7.11	R_5C_1	6.61	$R_{14}C_1$	10.17	$R_{14}C_1$	12.11
	R_5C_1	5.56	M_5K	5.22	M_5K	9.22	M_5K	10.44
4	M_5C_1	8.61	M_5C_1	10.89	M_5C_1	10.89	M_5C_1	11.22
	R_5C_1	5.00	M_5K	4.22	R_5C_1	8.11	R_5C_1	8.00
	$R_{14}C_1$	2.89	R_5C_1	3.72	M_5K	5.06	$R_{14}C_1$	6.11
	M_5K	1.17	$R_{14}C_1$	3.00	$R_{14}C_1$	5.00	M_5K	5.78
5	M_5C_1	8.83	M_5C_1	8.78	M_5C_1	8.78	M_5C_1	9.00
	M_5K	5.00	M_5K	5.44	R_5C_1	4.78	R_5C_1	5.11
	$R_{14}C_1$	4.11	$R_{14}C_1$	4.11	M_5K	4.44	$R_{14}C_1$	6.11
	R_5C_1	3.06	R_5C_1	3.37	$R_{14}C_1$	3.89	$R_{14}C_1$	3.79
6	M_5C_1	4.00	M_5C_1	6.94	M_5C_1	6.94	M_5C_1	7.11
	$R_{14}C_1$	1.44	R_5C_1	2.11	R_5C_1	2.39	R_5C_1	3.00
	M_5K	1.39	M_5K	1.28	M_5K	2.28	M_5K	2.33
	R_5C_1	1.11	$R_{14}C_1$	1.22	$R_{14}C_1$	1.89	$R_{14}C_1$	1.66
7	M_5C_1	4.56	M_5C_1	4.59	M_5C_1	4.61	M_5C_1	4.89
	M_5K	1.56	M_5K	1.67	M_5K	1.67	R_5C_1	1.79
	$R_{14}C_1$	1.44	$R_{14}C_1$	1.11	R_5C_1	1.28	M_5K	1.79
	R_5C_1	1.11	R_5C_1	1.10	$R_{14}C_1$	1.00	$R_{14}C_1$	1.50

TABLE 6 (Part II)

Marquis Wheat (M_5) Rideau Wheat (R_5) and (R_{14}). The cell number X 10^{-2} of each segment of the Primary Root with time, imbibition and vernalization. Control data on Marquis Wheat included (M_5K). Duncan's test (5% level)

Segment	Experimental period (hour)							
	10		12		14		16	
1	M_5C_1	9.00	M_5C_1	10.28	M_5C_1	11.78	M_5C_1	13.50
	R_5C_1	6.44	R_5C_1	6.89	R_5C_1	7.00	R_5C_1	7.22
	M_5K	5.00	M_5K	6.11	M_5K	6.89	M_5K	7.22
	$R_{14}K$	.67	$R_{14}C_1$	5.11	$R_{14}C_1$	5.27	$R_{14}C_1$	5.50
2	M_5C_1	20.11	M_5C_1	22.50	M_5C_1	24.67	M_5C_1	25.78
	R_5C_1	13.50	R_5C_1	14.11	R_5C_1	13.79	R_5C_1	13.50
	$R_{14}C_1$	12.11	$R_{14}C_1$	13.79	$R_{14}C_1$	13.11	$R_{14}C_1$	13.50
	M_5K	9.78	M_5K	10.00	M_5K	10.89	M_5K	12.00
3	M_5C_1	25.89	M_5C_1	24.11	M_5C_1	21.44	M_5C_1	19.11
	R_5C_1	16.00	R_5C_1	15.50	R_5C_1	14.33	R_5C_1	13.79
	$R_{14}C_1$	12.50	M_5K	13.78	M_5K	13.50	M_5K	13.33
	M_5C_1	12.50	$R_{14}C_1$	12.79	$R_{14}C_1$	12.11	$R_{14}C_1$	11.39
4	M_5C_1	11.78	M_5C_1	12.00	M_5C_1	13.11	M_5C_1	12.44
	R_5C_1	7.50	R_5C_1	7.00	M_5K	8.22	M_5K	8.00
	$R_{14}C_1$	6.11	M_5K	7.00	$R_{14}C_1$	7.22	R_5C_1	6.79
	M_5C_1	6.11	$R_{14}C_1$	7.00	R_5C_1	6.79	$R_{14}C_1$	6.18
5	M_5C_1	9.79	M_5C_1	10.11	M_5C_1	9.78	M_5C_1	9.00
	R_5C_1	5.44	R_5C_1	6.22	R_5C_1	5.22	M_5K	4.79
	M_5K	5.00	M_5K	5.68	M_5K	5.11	R_5C_1	4.22
	$R_{14}C_1$	4.22	$R_{14}C_1$	3.79	$R_{14}C_1$	3.11	$R_{14}C_1$	3.22
6	M_5C_1	7.50	M_5C_1	7.78	M_5C_1	7.20	M_5C_1	6.79
	R_5C_1	3.50	R_5C_1	3.22	R_5C_1	3.22	R_5C_1	2.79
	M_5K	2.50	M_5K	2.79	M_5K	2.68	M_5K	2.50
	$R_{14}C_1$	1.79	$R_{14}C_1$	2.00	$R_{14}C_1$	1.50	$R_{14}C_1$	1.11
7	M_5C_1	5.11	M_5C_1	5.33	M_5C_1	4.89	M_5C_1	4.50
	R_5C_1	2.22	R_5C_1	2.50	R_5C_1	2.22	R_5C_1	1.79
	M_5K	1.90	M_5K	2.10	M_5K	1.89	M_5K	1.71
	$R_{14}C_1$	1.79	$R_{14}C_1$	.50	$R_{14}C_1$	1.11	$R_{14}C_1$	1.22

TABLE 6 (Part III)

Marquis Wheat (M_5) Rideau Wheat (R_5) and (R_{14}). The cell number X 10^2 of each segment of the Primary Root with time, imbibition and vernalization. Control data on Marquis Wheat included (M_5K). Duncan's test (5% level)

Segment	Experimental period (hour)			
	18	24	36	48
1	M_5C_1 15.33	M_5C_1 23.11	M_5C_1 35.50	M_5C_1 48.44
	M_5K 8.22	M_5K 12.11	M_5K 22.11	M_5K 31.11
	$R_{14}C_1$ 6.11	R_5C_1 10.00	R_5C_1 18.50	R_5C_1 26.50
	R_5C_1 4.84	$R_{14}C_1$ 9.89	$R_{14}C_1$ 18.00	$R_{14}C_1$ 24.44
2	M_5C_1 26.06	M_5C_1 30.11	M_5C_1 48.50	M_5C_1 29.11
	R_5C_1 73.44	R_5C_1 16.99	M_5K 28.89	M_5K 14.50
	M_5K 13.22	M_5K 15.89	R_5C_1 21.00	R_5C_1 10.00
	$R_{14}C_1$ 11.22	$R_{14}K$ 15.79	$R_{14}C_1$ 20.50	$R_{14}C_1$ 9.67
3	M_5C_1 17.50	M_5C_1 14.44	M_5C_1 9.89	M_5C_1 9.79
	R_5C_1 12.72	M_5K 10.00	M_5K 7.78	M_5K 7.78
	M_5K 12.11	R_5C_1 7.79	R_5C_1 5.79	R_5C_1 5.50
	$R_{14}C_1$ 10.22	$R_{14}C_1$ 7.79	$R_{14}C_1$ 5.11	$R_{14}C_1$ 5.11
4	M_5C_1 11.61	M_5C_1 8.78	M_5C_1 9.44	M_5C_1 9.50
	M_5K 7.89	M_5K 6.22	M_5K 6.50	M_5K 6.44
	R_5C_1 6.44	R_5C_1 5.11	R_5C_1 5.50	R_5C_1 4.50
	$R_{14}C_1$ 5.89	$R_{14}C_1$ 5.00	$R_{14}C_1$ 5.11	$R_{14}C_1$ 4.44
5	M_5C_1 8.28	M_5C_1 6.79	M_5C_1 7.11	M_5C_1 7.00
	M_5K 4.56	M_5K 3.22	M_5K 3.80	M_5K 3.44
	R_5C_1 3.77	R_5C_1 3.22	R_5C_1 2.44	R_5C_1 2.50
	$R_{14}C_1$ 3.50	$R_{14}C_1$ 2.56	$R_{14}C_1$ 2.44	$R_{14}C_1$ 2.22
6	M_5C_1 6.28	M_5C_1 4.11	M_5C_1 4.22	M_5C_1 5.11
	R_5C_1 2.78	R_5C_1 2.22	M_5K 1.71	M_5K 1.79
	M_5K 2.39	M_5K 1.78	R_5C_1 1.50	R_5C_1 1.50
	$R_{14}C_1$ 1.89	$R_{14}C_1$ 1.11	$R_{14}C_1$ 1.50	$R_{14}C_1$ 1.50
7	M_5C_1 4.11	M_5C_1 3.56	M_5C_1 4.11	M_5C_1 4.11
	R_5C_1 1.78	R_5C_1 1.77	M_5K 1.22	M_5K 1.22
	M_5K 1.59	$R_{14}C_1$ 1.50	$R_{14}C_1$ 1.22	$R_{14}C_1$ 1.22
	$R_{14}C_1$ 1.50	M_5K 1.22	R_5C_1 1.11	R_5C_1 1.11

VERNALIZED SEED.

THE STIMULATION IN CELL DIVISION GROWTH AS SHOWN BY THE HIGHER CELL COUNT WAS ESPECIALLY EVIDENT IN SEGMENTS 1 AND 2. THE DATA FOR SEGMENTS 1-5 AND 7 IS PLOTTED IN FIGURE 1. IT CAN BE SEEN THAT THE LOG PHASE OF CELL DIVISION GROWTH WAS CONTINUED FOR A LONGER PERIOD OF TIME IN THE FIRST TWO SEGMENTS RESULTING IN A SUBSTANTIALLY HIGHER CELL COUNT.

DATA RELATING THE CHANGE IN CELL COUNT PER SEGMENT WITH TIME, FOR CHILLING PERIODS OF 1-4 WEEKS ARE GIVEN IN TABLE A_{1-12} IN THE APPENDIX SECTION. CHILLING STIMULATED THE CELL DIVISION PHASE OF GROWTH, EVEN IN THOSE SEGMENTS MOST DISTANT FROM THE APEX. THE TREND WAS USUALLY OBSERVED THAT $C_1 > C_2 > C_3 > C_4 > K$.

RIDEAU WHEAT (R_5):- THE CHANGE IN CELL NUMBER FOR ALL SEGMENTS OF OPTIMALLY VERNALIZED RIDEAU WHEAT (R_5) WITH TIME AND COMPARATIVE DATA FROM THE OTHER SERIES ARE GIVEN IN TABLE 7. STIMULATION OF THE CELL DIVISION PHASE OF GROWTH IN THE RANGE OF 50-200 PER CENT IS ALSO EVIDENT IN ALL SEGMENTS OF THIS SERIES. HOWEVER, UNLIKE THE MARQUIS SERIES, HIGH RATES OF CELL DIVISION WERE MAINLY CONFINED TO THE FIRST FOUR HOURS OF GROWTH. IN SEGMENTS NUMBER 5-7 WHERE THE CELLS ARE USUALLY TYPIFIED AS BEING IN THE LATER STAGES OF ELONGATION, THERE WAS AN 80-200 FOLD INCREASE IN THE TOTAL NUMBER OF CELLS AT EACH PERIOD UP TO 24 HOURS, AFTER WHICH A MORE OR LESS CONSTANT VALUE WAS OBTAINED.

TABLE 7 (Part I)

Marquis Wheat (M_5), Rideau Wheat (R_5) and (R_{14}).

Number of cells X 10^{-2} of each segment of the primary Root with time, imbibition and vernalization. Duncan test lines placed vertically. Control data on Rideau Wheat included (R_5K).

Duncan's test (5% level)

Segment	Experimental period (hours)			
	2	4	6	8
1	M_5C_4 9.18 R_5C_4 9.17 R_5K 3.11 $R_{14}C_4$ 2.83	R_5C_4 11.61 R_5K 4.78 M_5C_4 4.33 $R_{14}C_4$ 4.11	R_5C_4 12.61 R_5K 7.11 $R_{14}C_4$ 4.78 M_5C_4 4.28	R_5C_4 8.00 R_5K 7.11 M_5C_4 5.28 $R_{14}C_4$ 5.00
2	R_5C_4 14.78 M_5C_4 9.17 $R_{14}C_4$ 7.67 R_5K 6.22	R_5C_4 15.83 M_5C_4 7.44 R_5K 6.72 $R_{14}C_4$ 6.72	R_5C_4 16.72 R_5K 14.39 $R_{14}C_4$ 12.61 M_5C_4 9.17	R_5C_4 17.22 R_5K 14.50 $R_{14}C_4$ 13.00 M_5C_4 10.50
3	R_5C_4 15.11 M_5C_4 9.17 $R_{14}C_4$ 8.22 R_5K 6.89	R_5C_4 16.50 $R_{14}C_4$ 8.89 R_5K 8.83 M_5C_4 6.39	R_5C_4 21.22 R_5K 14.78 $R_{14}C_4$ 11.94 M_5C_4 11.67	R_5C_4 22.79 R_5K 15.00 M_5C_4 13.11 $R_{14}C_4$ 12.79
4	R_5C_4 8.74 M_5C_4 6.72 $R_{14}C_4$ 3.39 R_5K 3.39	R_5C_4 8.77 M_5C_4 6.78 R_5K 4.84 $R_{14}C_4$ 4.22	R_5C_4 8.94 R_5K 8.22 M_5C_4 7.61 $R_{14}C_4$ 6.39	R_5C_4 9.11 R_5K 8.50 M_5C_4 8.50 $R_{14}C_4$ 7.00
5	R_5C_4 6.72 M_5C_4 5.39 $R_{14}C_4$ 5.00 R_5K 4.18	R_5C_4 8.89 M_5C_4 5.83 $R_{14}C_4$ 5.22 R_5K 4.83	R_5C_4 8.44 M_5C_4 6.28 R_5K 5.54 $R_{14}C_4$ 4.44	R_5C_4 9.00 M_5C_4 6.89 R_5K 6.11 $R_{14}C_4$ 4.50
6	R_5C_4 5.66 $R_{14}C_4$ 2.11 R_5K 1.78 M_5C_4 1.72	R_5C_4 7.34 R_5K 2.67 M_5C_4 2.42 $R_{14}C_4$ 2.00	R_5C_4 7.40 M_5C_4 4.39 R_5K 3.67 $R_{14}C_4$ 2.89	R_5C_4 7.78 M_5C_4 4.79 R_5K 3.79 $R_{14}C_4$ 2.22
7	R_5C_4 4.78 M_5C_4 1.80 $R_{14}C_4$ 1.61 R_5K 1.56	R_5C_4 5.11 R_5K 2.22 M_5C_4 2.11 $R_{14}C_4$ 2.00	R_5C_4 5.50 M_5C_4 2.50 R_5K 1.67 $R_{14}C_4$ 1.22	R_5C_4 5.70 R_5K 3.00 M_5C_4 2.78 $R_{14}C_4$ 2.22

TABLE 7 (Part II)

Marquis Wheat (M_5), Rideau Wheat (R_5) and (R_{14}).

Number of cells X 10-2 of each segment of the primary Root with time, imbibition and vernalization.

Control data on Rideau Wheat included (R_5K). Duncan's test (5% level).

Segment	Experimental period (hours)							
	10		12		14		16	
1	R_5C_4	8.11	R_5C_4	9.79	R_5C_4	11.22	R_5C_4	12.78
	R_5K	7.33	R_5K	7.44	M_5C_4	8.44	M_5C_4	9.89
	M_5C_4	6.28	M_5C_4	7.22	R_5K	7.44	R_5K	7.50
	$R_{14}C_4$	5.50	$R_{14}C_4$	5.79	$R_{14}C_4$	6.22	$R_{14}C_4$	6.50
2	R_5C_4	17.77	R_5C	18.50	R_5C_4	19.11	R_5C_4	19.79
	R_5K	14.79	R_5K^4	15.00	R_5K	15.50	M_5C_4	15.78
	$R_{14}C_4$	13.50	$R_{14}C_4$	14.00	M_5C_4	14.89	R_5K	14.79
	M_5C_4	12.00	M_5C_4	13.50	$R_{14}C_4$	14.00	$R_{14}C_4$	14.11
3	R_5C_4	23.57	R_5C_4	25.11	R_5C_4	22.79	R_5C_4	18.44
	R_5K	17.00	R_5K	16.11	M_5C_4	18.79	M_5C_4	16.22
	M_5C_4	15.22	M_5C_4	16.00	R_5K	15.44	R_5K^4	14.50
	$R_{14}C_4$	13.11	$R_{14}C_4$	14.20	$R_{14}C_4$	13.50	$R_{14}C_4$	12.50
4	R_5C_4	9.79	R_5C_4	10.50	M_5C_4	10.50	$M5C_4$	10.00
	R_5K	8.89	M_5C_4	9.11	R_5C_4	9.79	R_5C_4	9.00
	M_5C_4	8.50	R_5K	8.11	$R_{14}C_4$	8.11	$R_{14}C_4$	7.89
	$R_{14}C_4$	7.50	$R_{14}C_4$	7.79	R_5K	7.50	R_5K	7.50
5	R_5C_4	9.50	R_5C_4	10.00	R_5C_4	8.79	R_5C_4	8.11
	M_5C_4	7.11	M_5C_4	7.80	M_5C_4	7.79	M_5C_4	7.79
	R_5K	6.79	R_5K	7.50	R_5K	6.11	R_5K	5.67
	$R_{14}C_4$	5.00	$R_{14}C_4$	4.50	$R_{14}C_4$	4.11	$R_{14}C_4$	4.22
6	R_5C_4	7.79	R_5C_4	7.11	R_5C_4	6.79	R_5C_4	6.22
	M_5C_4	5.11	M_5C_4	5.44	M_5C_4	5.11	M_5C_4	5.00
	R_5K	4.11	R_5K	4.33	R_5K	4.00	R_5K	3.50
	$R_{14}C_4$	2.60	$R_{14}C_4$	2.79	$R_{14}C_4$	2.44	$R_{14}C_4$	2.22
7	$R5C_4$	6.00	R_5C_4	6.11	R_5C_4	5.50	R_5C_4	5.22
	R_5K	3.22	M_5C_4	3.67	M_5C_4	3.72	M_5C_4	3.50
	M_5C_4	3.00	R_5K	3.50	R_5K	3.11	R_5K	2.79
	$R_{14}C_4$	2.00	$R_{14}C_4$	1.79	$R_{14}C_4$	1.79	$R_{14}C_4$	1.60

TABLE 7 (Part III)

Marquis Wheat (M_5), Rideau Wheat (R_5) and (R_{14}).

Number of cells X 10^{-2} of each segment of the primary root with time, imbibition and vernalization.

Control data on Rideau Wheat included (R_5K).

Duncan's test (5% level)

Segment	Experimental period (hours)			
	18	24	36	48
1	R_5C_4 16.11 M_5C_4 11.28 R_5K^4 7.33 $R_{14}C_4$ 7.00	R_5C_4 20.11 M_5C_4 18.89 R_5K^4 12.22 $R_{14}C_4$ 10.56	R_5C_4 32.11 M_5C^4 31.22 R_5K^4 20.11 $R_{14}C_4$ 19.00	R_5C_4 44.50 M_5C_4 40.50 R_5K^4 28.79 $R_{14}C_4$ 26.00
2	R_5C_4 20.89 M_5C_4 16.44 R_5K^4 14.33 $R_{14}C_4$ 13.22	R_5C_4 26.50 M_5C_4 20.22 R_5K^4 15.33 $R_{14}C_5$ 15.11	M_5C_4 44.89 R_5C^4 44.44 R_5K^4 24.11 $R_{14}C_4$ 21.79	M_5C_4 26.79 R_5C^4 26.11 R_5K^4 11.33 $R_{14}C_4$ 10.50
3	R_5C_4 15.44 M_5C_4 14.17 R_5K^4 13.78 $R_{14}C_4$ 12.41	R_5C_4 14.50 M_5C_4 13.79 R_5K^4 9.79 $R_{14}C_4$ 9.22	M_5C_4 8.50 R_5C^4 8.22 R_5K^4 6.50 $R_{14}C_4$ 6.00	M_5C_4 8.44 R_5C^4 8.11 R_5K^4 6.50 $R_{14}C_4$ 5.79
4	M_5C_4 9.17 R_5C^4 8.56 R_5K^4 7.33 $R_{14}C_4$ 7.22	R_5C_4 7.79 M_5C_4 7.11 R_5K^4 6.56 $R_{14}C_4$ 5.79	M_5C_4 8.88 R_5C^4 8.11 R_5K^4 5.79 $R_{14}C_4$ 4.79	M_5C_4 8.67 R_5C^4 7.79 R_5K^4 5.50 $R_{14}C_4$ 5.00
5	M_5C_4 7.72 R_5C^4 7.44 R_5K^4 4.83 $R_{14}C_4$ 4.22	R_5C_4 6.79 M_5C_4 6.00 R_5K^4 4.11 $R_{14}C_4$ 3.22	R_5C_4 6.79 M_5C^4 6.22 R_5K^4 3.11 $R_{14}C_4$ 2.79	R_5C_4 6.50 M_5C^4 6.11 R_5K^4 3.11 $R_{14}C_4$ 2.79
6	R_5C_4 5.94 M_5C^4 4.89 R_5K^4 3.06 $R_{14}C_4$ 2.45	R_5C_4 4.00 R_5K^4 2.89 M_5C^4 2.79 $R_{14}C_4$ 2.00	R_5C_4 3.79 M_5C^4 2.50 R_5K^4 2.11 $R_{14}C_4$ 2.00	R_5C_4 3.50 M_5C^4 2.44 R_5K^4 1.79 $R_{14}C_4$ 1.79
7	R_5C_4 4.11 M_5C_4 3.72 R_5K^4 2.22 $R_{14}C_4$ 1.89	R_5C_4 3.50 M_5C_4 2.44 R_5K^4 2.00 $R_{14}C_5$ 1.72	R_5C_4 3.50 M_5C^4 2.44 R_5K^4 1.79 $R_{14}C_4$ 1.50	R_5C_4 3.11 M_5C_4 2.44 $R_{14}C_4$ 1.67 R_5K 1.50

DATA RELATING THE CHANGE IN CELL COUNT PER SEGMENT WITH TIME, FOR ALL OTHER CHILLING PERIODS MAY BE FOUND IN TABLE B_{1-12} IN THE APPENDIX SECTION. AT ALL TIMES, IN ALL THE SEGMENTS, A CLEAR PICTURE OF STIMULATION WAS OBSERVED TO BE AS FOLLOWS $R_5C_4=R_5C_5=R_5C_6>R_5K=R_5C_3=R_5C_2=R_5C_1$. ALTHOUGH NO STATISTICAL DIFFERENCES WERE OBSERVED BETWEEN MEMBERS OF EACH GROUP, THE CONSISTENT ORDER OF STIMULATION OBSERVED THROUGHOUT MIGHT INDICATE A GENERAL TREND. IN ANY CASE IT WAS APPARENT THAT 4-6 WEEKS OF CHILLING RESULTED IN SIGNIFICANTLY HIGHER CELL COUNTS PER SEGMENT OVER THOSE OF CONTROL AND 1-3 WEEK CHILLED GRAIN.

RIDEAU WHEAT R_{14}:- IN TABLE 8 IS FOUND THE COMPARATIVE DATA ON THE SECOND SERIES OF RIDEAU WHEAT (R_{14}) FOLLOWING FIVE WEEKS CHILLING AND SUBSEQUENT GROWTH. CELL COUNT DATA ON MARQUIS WHEAT WAS NOT OBTAINED AT THIS CHILLING PERIOD. VERNALIZATION SIGNIFICANTLY STIMULATED AN INCREASE IN CELL DIVISION GROWTH IN ALL SEGMENTS AT ALL PERIODS OVER UNTREATED CONTROL ROOTS. HOWEVER, IT WAS ONLY IN SEGMENTS 3,4 AND 5 THAT CONSISTENTLY HIGHER CELL COUNTS WERE OBTAINED AT ALL PERIODS IN THE R_{14} SERIES AS COMPARED WITH THE OTHER RIDEAU SERIES.

DATA RELATING THE CHANGE IN CELL COUNT PER SEGMENT WITH TIME FOR ALL TESTED CHILLING PERIODS (I.E. 1-6 WEEKS) ARE GIVEN IN TABLE C_{1-12} IN THE APPENDIX SECTION. APART FROM SEGMENTS 2 AND 3 FOLLOWING 2 HOURS OF GROWTH, CHILLING STIMULATED INCREASED CELL DIVISION GROWTH IN THE ORDER $C_5=C_6>K=C_4=C_3=C_2=C_1$.

TABLE 8 (Part I)

Rideau Wheat (R_5) and (R_{14})

Number of cells X 10^{-2} of each segment of the primary root with time, imbibition and vernalization.

Control data on Rideau Wheat included ($R_{14}K$)

Duncan's test (5% level)

Segment	Experimental period (hours)			
	2	4	6	8
1	R_5C_5 8.73 $R_{14}C_5$ 4.44 $R_{14}K$ 2.89	R_5C_5 10.78 $R_{14}C_5$ 7.83 $R_{14}K$ 4.72	R_5C_5 12.56 $R_{14}C_5$ 7.83 $R_{14}K$ 4.83	R_5C_5 8.22 $R_{14}C_5$ 7.79 $R_{14}K$ 5.22
2	R_5C_5 14.39 $R_{14}C_5$ 11.67 $R_{14}K$ 10.11	R_5C_5 14.28 $R_{14}C_5$ 11.78 $R_{14}K$ 7.72	R_5C_5 16.11 $R_{14}C_5$ 13.00 $R_{14}K$ 12.61	R_5C_5 17.11 $R_{14}C_5$ 15.11 $R_{14}K$ 13.22
3	$R_{14}C_5$ 15.33 R_5C_5 14.56 $R_{14}K$ 8.28	$R_{14}C_5$ 15.89 R_5C_5 14.61 $R_{14}K$ 9.56	$R_{14}C_5$ 23.33 R_5C_5 20.33 $R_{14}K$ 12.50	$R_{14}C_5$ 24.00 R_5C_5 21.50 $R_{14}K$ 13.00
4	$R_{14}C_5$ 10.11 R_5C_5 8.78 $R_{14}K$ 3.50	$R_{14}C_5$ 10.56 R_5C_5 7.22 $R_{14}K$ 4.17	$R_{14}C_5$ 11.39 R_5C_5 8.44 $R_{14}K$ 6.94	$R_{14}C_5$ 12.00 R_5C_5 8.79 $R_{14}K$ 7.11
5	$R_{14}C_5$ 6.89 R_5C_5 6.33 $R_{14}K$ 5.11	R_5C_5 8.78 $R_{14}C_5$ 7.61 $R_{14}K$ 5.78	$R_{14}C_5$ 8.72 R_5C_5 8.17 $R_{14}K$ 4.61	$R_{14}C_5$ 9.00 R_5C_5 8.79 $R_{14}K$ 4.89
6	$R_{14}C_5$ 5.22 R_5C_5 4.67 $R_{14}K$ 2.33	R_5C_5 6.17 $R_{14}C_5$ 5.29 $R_{14}K$ 2.22	R_5C_5 7.67 $R_{14}C_5$ 5.44 $R_{14}K$ 2.39	R_5C_5 7.61 $R_{14}C_5$ 5.79 $R_{14}K$ 2.50
7	R_5C_5 4.22 $R_{14}C_5$ 3.33 $R_{14}K$ 1.94	R_5C_5 5.00 $R_{14}C_5$ 3.89 $R_{14}K$ 2.22	R_5C_5 5.44 $R_{14}C_5$ 3.56 $R_{14}K$ 1.39	R_5C_5 5.44 $R_{14}C_5$ 3.79 $R_{14}K$ 2.44

TABLE 8 (Part II)

Rideau Wheat (R_5) and (R_{14})
Number of cells X 10^{-2} of each segment of the primary root with time, imbibition and vernalization.
Control data on Rideau wheat included ($R_{14}K$)

Duncan's test (5% level)

Segment	Experimental period (hours)			
	10	12	14	16
1	$R_{14}C_5$ 8.89 R_5C_5 8.00 $R_{14}K$ 5.89	$R_{14}C_5$ 9.50 R_5C_5 9.44 $R_{14}K$ 6.00	R_5C_5 11.00 $R_{14}C_5$ 10.78 $R_{14}K$ 6.50	R_5C_5 12.50 $R_{14}C_5$ 12.00 $R_{14}K$ 6.79
2	$R_{14}C_5$ 17.50 R_5C_5 17.11 $R_{14}K$ 13.79	$R_{14}C_5$ 19.56 R_5C_5 18.00 $R_{14}K$ 14.50	R_5C_5 21.22 $R_{14}C_5$ 18.50 $R_{14}K$ 14.79	$R_{14}C_5$ 23.11 R_5C_5 19.00 $R_{14}K$ 14.22
3	$R_{14}C_5$ 24.50 R_5C_5 22.79 $R_{14}K$ 13.50	$R_{14}C_5$ 25.11 R_5C_5 24.79 $R_{14}K$ 14.11	R_5C_5 21.79 $R_{14}C_5$ 21.68 $R_{14}K$ 13.67	$R_{14}C_5$ 18.11 R_5C_5 17.79 $R_{14}K$ 13.11
4	$R_{14}C_5$ 12.79 R_5C_5 9.50 $R_{14}K$ 7.79	$R_{14}C_5$ 13.50 R_5C_5 10.11 $R_{14}K$ 8.11	$R_{14}C_5$ 11.11 R_5C_5 9.50 $R_{14}K$ 8.44	$R_{14}C_5$ 10.22 R_5C_5 8.79 $R_{14}K$ 8.00
5	$R_{14}C_5$ 9.22 R_5C_5 9.11 $R_{14}K$ 5.11	$R_{14}C_5$ 9.79 R_5C_5 9.79 $R_{14}K$ 4.67	$R_{14}C_5$ 9.50 R_5C_5 8.50 $R_{14}K$ 4.50	$R_{14}C_5$ 8.67 R_5C_5 8.00 $R_{14}K$ 4.50
6	R_5C_5 7.79 $R_{14}C_5$ 6.11 $R_{14}K$ 2.79	R_5C_5 7.00 $R_{14}C_5$ 6.22 $R_{14}K$ 3.00	R_5C_5 6.67 $R_{14}C_5$ 5.60 $R_{14}K$ 2.67	R_5C_5 6.11 $R_{14}C_5$ 5.44 $R_{14}K$ 2.50
7	R_5C_5 5.79 $R_{14}C_5$ 3.90 $R_{14}K$ 2.11	R_5C_5 6.00 $R_{14}C_5$ 4.11 $R_{14}K$ 2.00	R_5C_5 5.00 $R_{14}C_5$ 3.79 $R_{14}K$ 1.79	R_5C_5 5.00 $R_{14}C_5$ 3.67 $R_{14}K$ 1.79

TABLE 8 (Part III)

Rideau Wheat (R_5) and (R_{14})
Number of cells X 10^{-2} of each segment of the primary root with time, imbibition and vernalization.

Control data on Rideau Wheat included ($R_{14}K$)

Duncan's test (5% level)

Segment	Experimental period (hours)			
	18	24	36	48
1	R_5C_5 15.00 $R_{14}C_5$ 13.33 $R_{14}K$ 7.22	R_5C_5 19.11 $R_{14}C_5$ 19.00 $R_{14}K$ 12.00	R_5C_5 31.50 $R_{14}C_5$ 31.11 $R_{14}K$ 19.11	R_5C_5 43.50 $R_{14}C_5$ 42.22 $R_{14}K$ 26.50
2	$R_{14}C_5$ 26.00 R_5C_5 19.67 $R_{14}K$ 13.39	R_5C_5 21.50 $R_{14}C_5$ 20.50 $R_{14}K$ 14.79	$R_{14}C_5$ 42.44 R_5C_5 42.22 $R_{14}K$ 22.11	R_5C_5 25.50 $R_{14}C_5$ 25.11 $R_{14}K$ 11.00
3	$R_{14}C_5$ 16.61 R_5C_5 15.22 $R_{14}K$ 12.50	$R_{14}C_5$ 14.11 R_5C_5 14.11 $R_{14}K$ 9.78	R_5C_5 8.00 $R_{14}C_5$ 7.79 $R_{14}K$ 6.22	R_5C_5 7.79 $R_{14}C_5$ 7.11 $R_{14}K$ 6.00
4	$R_{14}C_5$ 9.00 R_5C_5 8.44 $R_{14}K$ 7.50	R_5C_5 8.11 $R_{14}C_5$ 8.00 $R_{14}K$ 6.11	R_5C_5 8.11 $R_{14}C_5$ 7.79 $R_{14}K$ 5.60	R_5C_5 7.50 $R_{14}C_5$ 7.11 $R_{14}K$ 5.11
5	$R_{14}C_5$ 7.33 R_5C_5 7.22 $R_{14}K$ 4.44	$R_{14}C_5$ 6.89 R_5C_5 6.79 $R_{14}K$ 3.44	$R_{14}C_5$ 6.67 R_5C_5 6.50 $R_{14}K$ 3.00	$R_{14}C_5$ 6.40 R_5C_5 6.11 $R_{14}K$ 3.00
6	R_5C_5 5.28 $R_{14}C_5$ 5.23 $R_{14}K$ 2.50	$R_{14}C_5$ 4.00 R_5C_5 3.79 $R_{14}K$ 2.11	$R_{14}C_5$ 3.67 R_5C_5 3.50 $R_{14}K$ 2.00	$R_{14}C_5$ 3.22 R_5C_5 3.11 $R_{14}K$ 2.00
7	R_5C_5 4.00 $R_{14}C_5$ 3.44 $R_{14}K$ 2.00	$R_{14}C_5$ 3.33 R_5C_5 3.22 $R_{14}K$ 1.89	$R_{14}C_5$ 3.44 R_5C_5 3.11 $R_{14}K$ 1.79	$R_{14}C_5$ 3.00 R_5C_5 3.00 $R_{14}K$ 1.78

COMPARATIVE CELL COUNT DATA:- FOR PURPOSES OF COMPARISON, CELL COUNTS PER SEGMENT AT EACH 2 HOUR PERIOD OBTAINED FOLLOWING OPTIMAL CONDITIONS OF STIMULATION FOR THE THREE WHEAT SERIES ARE GROUPED IN TABLE 9.

IN ALL CASES AND AT ALL PERIODS, A 100-200 PER CENT INCREASE IN CELL COUNT PER SEGMENT WAS OBTAINED FOLLOWING OPTIMAL PERIODS OF VERNALIZATION. CELL COUNTS PER SEGMENT OBTAINED FROM THE OPTIMALLY VERNALIZED SERIES WERE SUBSTANTIALLY ALIKE, WHERE SIGNIFICANT DIFFERENCES WERE OBSERVED THE LEVEL OF DIFFERENCE WAS SLIGHT.

THE NUMBER OF CELLS FOUND IN SEGMENT 7 OF ALL SERIES FOLLOWING VERNALIZATION WAS COMPARABLE TO THOSE OBTAINED IN SEGMENT 5 IN THE NON-TREATED CONTROLS. THAT IS, VERNALIZATION STIMULATED A CONTINUANCE OF CELL DIVISION GROWTH IN THOSE SEGMENTS WHICH WOULD OTHERWISE HAVE PASSED OUT OF THIS GROWTH PHASE.

INCREASE IN CELL NUMBER WITH DISTANCE FROM THE ROOT APEX

THE DATA IN TABLE 10, AND FIGURE 2, SHOW THE TOTAL NUMBER OF CELLS IN SUCCESSIVE 0.5 MM. SECTIONS OF CONTROL AND OPTIMALLY VERNALIZED MARQUIS AND RIDEAU WHEAT. IN ALL CASES THE CELL NUMBER INCREASED RAPIDLY FROM THE ROOT APEX TO APPROXIMATELY 1 MM. THIS WAS FOLLOWED BY A RAPID DECREASE TO ABOUT 2 MM. AND A SLOWER DECREASE THEREAFTER TO 3-4 MM. WHEN A MORE OR LESS CONSTANT VALUE WAS MAINTAINED TO 9 MMS. FROM THE APEX, THIS REGION REPRESENTING

TABLE 9 (Part I)

Marquis Wheat (M_5) Rideau Wheat (R_5) and (R_{14}) Comparative Data - Cell counts at the control and maximum condition of stimulation of the cell division phase of growth. Duncan's test (5% level). **Cell count X 10^{-2}**

Segment	Experimental period (hours) 2		4		6		8	
1	M_5C_1	11.61	R_5C_4	11.61	R_5C_4	12.61	$R_{14}C_5$	8.22
	R_5C_4	9.17	$R_{14}C_5$	7.83	$R_{14}C_5$	7.83	R_5C_4	8.11
	M_5K	4.56	M_5C_1	5.17	R_5K	7.11	M_5C_1	7.11
	$R_{14}C_5$	4.44	R_5K	4.78	M_5C_1	5.18	R_5K	7.11
	R_5K	3.11	$R_{14}K$	4.72	$R_{14}K$	4.83	$R_{14}K$	5.22
	$R_{14}K$	2.89	M_5K	2.39	M_5K	3.27	M_5K	4.22
2	M_5C_1	14.78	R_5C_4	15.83	R_5C_4	16.72	M_5C_1	17.22
	R_5C_4	14.78	$R_{14}C_5$	11.78	M_5C_1	14.72	R_5C_4	17.22
	$R_{14}C_5$	11.17	M_5C_1	11.72	R_5K	14.39	$R_{14}C_5$	15.11
	$R_{14}K$	10.11	$R_{14}K$	7.72	$R_{14}C_5$	13.00	R_5K_1	14.50
	M_5K	6.50	R_5K	6.72	$R_{14}K$	12.61	$R_{14}K$	13.22
	R_5K	6.22	M_5K	3.44	M_5K	7.44	M_5K	8.89
3	M_5C_1	15.56	R_5C_4	16.50	$R_{14}C_5$	23.33	$R_{14}C_5$	24.11
	$R_{14}C_5$	15.33	$R_{14}C_5$	15.89	M_5C_1	22.57	M_5C_1	23.78
	R_5C_4	15.11	M_5C_1	12.56	R_5C_4	21.22	R_5C_4	22.79
	$R_{14}K$	8.28	$R_{14}K$	9.56	R_5K	14.78	R_5K	15.50
	M_5K	7.17	R_5K	8.83	$R_{14}K$	12.50	$R_{14}K$	13.00
	R_5K	6.89	M_5K	5.22	M_5K	9.22	M_5K	10.44
4	$R_{14}C_5$	10.11	M_5C_1	10.89	$R_{14}C_5$	11.39	$R_{14}C_5$	12.00
	M_5C_1	8.61	$R_{14}C_5$	10.56	M_5C_1	10.89	M_5C_1	11.22
	R_5C_4	8.74	R_5C_4	8.78	R_5C_4	8.94	R_5C_4	9.11
	$R_{14}K$	3.50	R_5K	4.88	R_5K	8.22	R_5K	8.50
	R_5K	3.39	M_5K	4.22	$R_{14}K$	6.94	$R_{14}K$	7.11
	M_5K	1.17	$R_{14}K$	4.17	M_5K	5.06	M_5K	5.78
5	M_5C_1	8.83	R_5C_4	8.89	M_5C_1	8.78	M_5C_1	9.00
	$R_{14}C_5$	6.89	M_5C_1	8.78	$R_{14}C_5$	8.77	R_5C_4	9.00
	R_5C_4	6.72	$R_{14}C_5$	7.61	R_5C_4	8.44	$R_{14}C_5$	9.00
	$R_{14}K$	5.11	$R_{14}K$	5.78	R_5K	5.83	R_5K	6.11
	M_5K	5.00	M_5K	5.44	$R_{14}K$	4.61	$R_{14}K$	4.89
	R_5K	4.18	R_5K	4.83	M_5K	4.44	M_5K	4.89
7	R_5C_4	4.78	R_5C_4	5.11	R_5C_4	5.50	R_5C_4	5.70
	M_5C_1	4.56	M_5C_1	4.59	M_5C_1	4.61	M_5C_1	4.89
	$R_{14}C_5$	3.33	$R_{14}C_5$	3.89	$R_{14}C_5$	3.55	$R_{14}C_5$	3.79
	$R_{14}K$	1.94	R_5K	2.22	R_5K	2.83	R_5K	3.00
	R_5K	1.61	$R_{14}K$	2.22	M_5K	1.67	$R_{14}K$	2.44
	M_5K	1.56	M_5K	1.67	R_5K	1.39	M_5K	1.79

Duncan test lines placed vertically to facilitate compression of the data.

TABLE 9 (Part II)

Marquis Wheat (M_5) Rideau Wheat (R_5) and (R_{14}) Comparative Data - Cell counts at the control and maximum condition of stimulation of the cell division phase of growth. Duncan's test (5% level). **Cell count X 10^{-2}**

Segment	Experimental period (hours) 10	12	14	16
1	M_5C_1 9.00 $R_{14}C_5$ 8.89 R_5C_4 8.11 R_5K 7.33 $R_{14}K$ 5.89 M_5K 5.00	M_5C_1 10.25 R_5C_4 9.79 $R_{14}C_5$ 9.50 R_4K 7.44 M_5K 6.11 $R_{14}K$ 6.00	M_5C_1 11.78 R_5C_4 11.22 $R_{14}C_5$ 10.78 R_5K 7.44 M_5K 6.89 $R_{14}K$ 6.50	M_5C_1 13.50 R_5C_4 12.78 $R_{14}C_5$ 12.00 R_5K 7.50 M_5K 7.00 $R_{14}K$ 6.79
2	M_5C_1 20.11 R_5C_4 17.79 $R_{14}C_5$ 17.50 R_5K 14.79 $R_{14}K$ 13.79 M_5K 9.78	M_5C_1 22.50 $R_{14}C_5$ 19.56 R_5C_4 18.50 R_5K 15.00 $R_{14}K$ 14.50 M_5K 14.00	M_5C_1 24.67 $R_{14}C_5$ 21.22 R_5C_4 19.11 R_5K 15.50 $R_{14}K$ 14.79 M_5K 10.89	M_5C_1 25.78 $R_{14}C_5$ 23.11 R_5C_4 19.79 R_5K 14.79 $R_{14}K$ 14.22 M_5K 12.00
3	M_5C_1 25.89 $R_{14}C_5$ 24.50 R_5C_4 23.57 R_5K 17.00 $R_{14}K$ 13.50 M_5K 12.50	R_5C_1 25.11 $R_{14}C_4$ 25.11 M_5C_5 24.11 R_5K 16.11 $R_{14}K$ 14.11 M_5K 13.78	R_5C_4 22.79 $R_{14}C_5$ 21.68 M_5C_1 21.44 R_5K 15.44 $R_{14}K$ 13.67 M_5K 13.50	M_5C_1 19.11 R_5C_4 18.44 $R_{14}C_5$ 18.11 R_4K 14.50 M_5K 13.33 $R_{14}K$ 13.11
4	$R_{14}C_5$ 12.79 M_5C_1 11.78 R_5C_4 9.79 R_5K 8.89 $R_{14}K$ 7.79 M_5K 6.11	$R_{14}C_5$ 13.50 M_5C_1 12.00 R_5C_4 10.50 R_5K 8.11 $R_{14}K$ 8.11 M_5K 7.00	M_5C_1 13.11 $R_{14}C_5$ 11.11 R_5C_4 9.79 $R_{14}K$ 8.44 M_5K 8.22 R_5K 7.50	M_5C_1 12.44 $R_{14}C_5$ 10.22 R_5C_4 9.00 M_5K 8.00 $R_{14}K$ 8.00 R_5K 7.50
5	M_5C_1 9.79 R_5C_4 9.50 $R_{14}C_5$ 9.22 R_5K 6.79 $R_{14}K$ 5.11 M_5K 5.00	M_5C_1 10.11 R_5C_4 10.00 $R_{14}C_5$ 9.79 R_5K 7.50 M_5K 5.68 $R_{14}K$ 4.67	M_5C_1 9.79 $R_{14}C_5$ 9.50 R_5C_4 8.79 R_4K 6.11 M_5K 5.11 R_5K 5.00	M_5C_1 9.00 $R_{14}C_5$ 8.67 R_5C_4 8.11 R_5K 5.67 M_5K 4.79 $R_{14}K$ 4.50
7	R_5C_4 6.00 M_5C_1 5.11 $R_{14}C_5$ 3.90 R_5K 3.22 $R_{14}K$ 2.91 M_5K 1.90	R_5C_4 6.11 M_5C_1 5.33 $R_{14}C_5$ 4.11 R_5K 3.50 M_5K 2.10 $R_{14}K$ 2.00	R_5C_4 5.50 M_5C_1 4.89 $R_{14}C_5$ 3.79 R_5K 3.11 M_5K 1.89 $R_{14}K$ 1.79	R_5C_4 5.22 M_5C_1 4.50 $R_{14}C_5$ 3.67 R_5K 2.79 $R_{14}K$ 1.79 M_5K 1.71

TABLE 9 (Part III)

Marquis Wheat (M_5) Rideau Wheat (R_5) and (R_{14}) Comparative Data - Cell counts at the control and maximum condition of stimulation of the cell division phase of growth. Duncan's test (5% level). **Cell count X 10^{-2}**

Segment	Experimental period (hours) 18	24	36	48
1	M_5C_1 15.33 R_5C_4 14.11 $R_{14}C_5$ 13.33 M_5K 8.22 R_5K 7.33 $R_{14}K$ 7.22	M_5C_1 23.11 R_5C_4 20.11 $R_{14}C_5$ 19.00 R_5K 12.22 M_5K 12.11 $R_{14}K$ 12.00	M_5C_1 35.50 R_5C_4 32.11 $R_{14}C_5$ 31.11 M_5K 22.11 R_5K 20.11 $R_{14}K$ 19.11	M_5C_1 48.44 R_5C_4 44.50 $R_{14}C_5$ 42.22 M_5K 31.11 R_5K 28.79 $R_{14}K$ 26.50
2	M_5C_1 26.06 $R_{14}C_5$ 26.00 R_5C_4 25.89 R_5K 14.33 $R_{14}K$ 13.39 M_5K 13.22	M_5C_1 30.11 R_5C_4 26.50 $R_{14}C_5$ 20.50 M_5K 15.89 R_5K 15.33 $R_{14}K$ 14.79	M_5C_1 48.50 R_5C_4 44.44 $R_{14}C_5$ 42.44 M_5K 28.89 R_5K 24.11 $R_{14}K$ 22.11	M_5C_1 29.11 R_5C_4 26.11 $R_{14}C_5$ 25.11 M_5K 14.50 $R_{14}K$ 11.33 $R_{14}K$ 11.00
3	M_5C_1 17.50 $R_{14}C_5$ 16.61 R_5C_4 15.44 R_5K 13.78 $R_{14}K$ 12.50 M_5K 12.11	R_5C_4 14.50 M_5C_1 14.44 $R_{14}C_5$ 14.11 M_5K 10.00 R_5K 9.79 $R_{14}K$ 9.79	M_5C_1 9.89 R_5C_4 8.22 $R_{14}C_5$ 7.79 M_5K 7.78 R_5K 6.50 $R_{14}K$ 6.22	M_5C_1 9.79 R_5C_4 8.11 $R_{14}C_5$ 7.11 M_5C_1 6.78 R_5C_4 6.50 $R_{14}C_5$ 6.00
4	M_5C_1 11.61 R_5C_4 9.17 $R_{14}C_5$ 8.96 M_5K 7.89 $R_{14}K$ 7.50 R_5K 7.33	M_5C_1 8.78 $R_{14}C_5$ 8.00 R_5C_4 7.79 R_5K 6.56 M_5K 6.22 $R_{14}K$ 6.11	M_5C_1 9.44 R_5C_4 8.11 $R_{14}C_5$ 7.79 M_5K 6.50 R_5K 5.78 $R_{14}K$ 5.60	M_5C_1 9.50 R_5C_4 7.79 $R_{14}C_5$ 7.11 M_5K 6.44 R_5K 5.50 $R_{14}K$ 5.11
5	M_5C_1 8.28 R_5C_4 7.72 $R_{14}C_5$ 7.44 M_5K 4.56 $R_{14}K$ 4.44 R_5K 4.33	$R_{14}C_5$ 6.89 M_5C_1 6.79 R_5C_4 6.79 R_5K 4.11 $R_{14}K$ 3.44 M_5K 3.22	M_5C_1 7.11 R_5C_4 6.79 $R_{14}C_5$ 6.67 M_5K 3.80 R_5K 3.11 $R_{14}K$ 3.00	M_5C_1 7.00 R_5C_4 6.50 $R_{14}C_5$ 6.40 M_5K 3.44 R_5K 3.11 $R_{14}K$ 3.00
7	M_5C_1 4.11 R_5C_4 4.11 $R_{14}C_5$ 3.44 R_5K 3.22 $R_{14}K$ 2.00 M_5K 1.89	M_5C_1 3.56 R_5C_4 3.50 $R_{14}C_5$ 3.33 R_5K 2.00 $R_{14}K$ 1.89 M_5K 1.22	M_5C_1 4.11 R_5C_4 3.50 $R_{14}C_5$ 3.44 R_5K 1.79 $R_{14}K$ 1.79 M_5K 1.11	M_5C_1 4.11 R_5C_4 3.11 $R_{14}C_5$ 3.00 $R_{14}K$ 1.79 R_5K 1.50 M_5K 1.22

TABLE 10

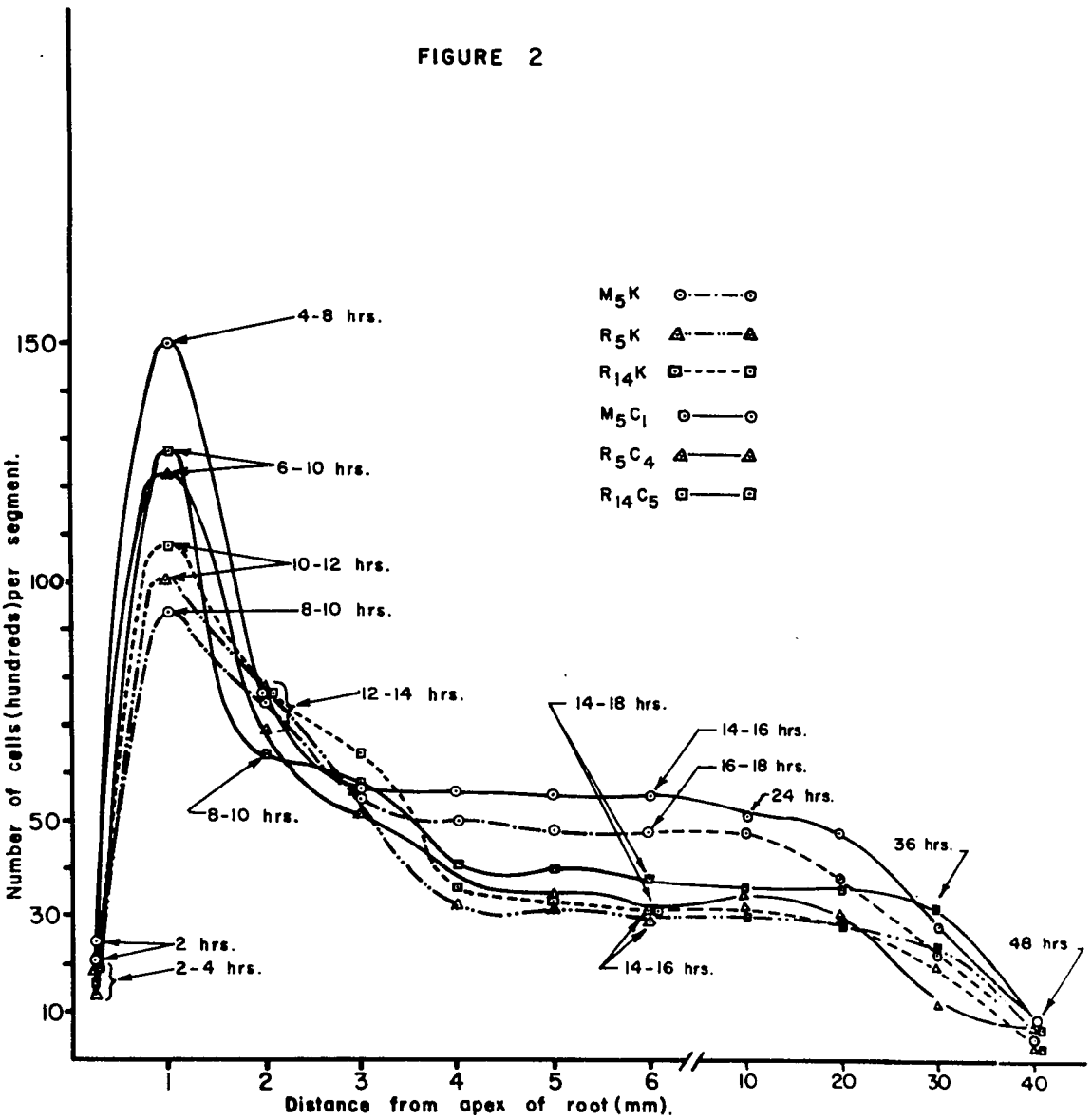
Marquis Wheat (M_5) Rideau Wheat (R_5) and (R_{14}).

Variation in total cell count with distance from root apex at optimally vernalized periods. Cell counts X 10^{-2}

Duncan's test (5% level)

Distance from apex of root (mm)	Vernalization (weeks)					
0.5	M_5K	M_5C_1	$R_{14}C_5$	R_5C_4	$R_{14}K$	R_5K
	25.50	21.96	19.51	18.39	17.69	14.44
1.0	M_5C_1	$R_{14}C_5$	R_5C_4	$R_{14}K$	R_5K	M_5K
	153.95	128.38	123.27	108.16	101.21	94.16
2.0	$R_{14}K$	R_5K	M_5K	M_5C_1	R_5C_4	$R_{14}C_5$
	77.72	77.50	75.22	74.06	69.26	63.83
3.0	$R_{14}K$	$R_{14}C_5$	M_5K	R_5K	M_5C_1	R_5C_4
	64.35	58.33	57.33	56.66	55.96	51.50
4.0	M_5C_1	M_5K	$R_{14}C_5$	R_5C_4	$R_{14}K$	R_5K
	59.34	50.00	40.83	40.34	36.26	33.38
5.0	M_5C_1	M_5K	$R_{14}C_5$	R_5C_4	$R_{14}K$	R_5K
	57.14	48.33	40.00	35.00	34.61	31.40
6.0	M_5C_1	M_5K	$R_{14}C_5$	$R_{14}K$	R_5C_4	R_5K
	56.51	47.5	38.00	31.20	31.00	28.00
10.0	M_5C_1	M_5K	$R_{14}C_5$	R_5C_4	R_5K	$R_{14}K$
	50.60	47.07	36.22	34.89	32.22	30.89
20.0	M_5C_1	M_5K	$R_{14}C_5$	R_5C_4	R_5K	$R_{14}K$
	48.50	38.07	36.10	31.82	29.62	29.35
30.0	$R_{14}C_5$	M_5C_1	$R_{14}K$	M_5K	R_5K	R_5C_4
	32.81	28.3	24.00	22.50	19.62	11.50
40.0	M_5C_1	R_5C_4	$R_{14}C_5$	M_5K	R_5K	$R_{14}K$
	8.50	8.11	7.11	5.79	3.50	3.00

FIGURE 2



Variation in total cell count with distance from root apex.

OBSERVATIONS MADE AFTER 16 HOURS OF GROWTH. FOLLOWING THIS, A SLOW DECREASE IN TOTAL CELL NUMBER TOOK PLACE OVER THE NEXT 16 HOURS REPRESENTING A REGION 20-30 MM. FROM THE ROOT APEX, AND THIS WAS FOLLOWED BY A MORE OR LESS RAPID DECLINE IN THE REGION 30-40 MM. FROM THE APEX AFTER 48 HOURS OF GROWTH. THE OUTSTANDING FEATURE HERE IS THE EFFECT OF IMBIBITION, SEED VARIETY AND VERNALIZATION ON THE BASIC CURVE.

Control Series

OVER THE 1-3 MM. ROOT TIP REGION, STIMULATION OF CELL DIVISION, AS EVIDENCED BY INCREASED TOTAL CELL COUNTS, WAS ELICITED AS THE SERIES, $R_{14}K > R_5K > M_5K$. HOWEVER OVER THE SUCCEEDING 3-6 MM. REGION THE GREATEST NUMBER OF CELLS WAS FOUND IN MARQUIS SPRING WHEAT.

Vernalized Series

FOLLOWING VERNALIZATION, THE GENERALIZED PATTERN OF CELL DIVISION GROWTH WAS SIMILAR TO UNTREATED CONTROLS BUT SIGNIFICANTLY HIGHER LEVELS WERE OBTAINED IN ALL CASES ALONG THE COURSE OF THE ROOT.

Increase in Length with Time

Root Length

AT EACH 2 HOUR PERIOD TO 48 HOURS THE CHANGING TOTAL LENGTH OF THE ORIGINALLY MARKED 3.5 MM. ROOT TIP REGION WAS OBSERVED AT ALL CHILLING PERIODS. THIS DATA IS PRESENTED IN TABLE II. IT REPRESENTS THE SUMMATION OF THE CHANGING LENGTH OF EACH OF THE SEVEN ORIGINALLY MARKED 0.5 MM. PORTIONS OF THE ROOT TIP. IN ORDER TO

TABLE 11 (part I)

Marquis Wheat (M_5). Rideau Wheat (R_5) and (R_{14}). Increase in total length in mms. of originally marked 3.5 mm. root tip with time, imbibition and vernalization. Duncan's test (5% level).

Vernalization (weeks)	Experimental period (hours) 2	4	6	8
0	M_5K 4.28	$R_{14}K$ 6.04	$R_{14}K$ 7.28	$R_{14}K$ 8.69
	R_5K 4.35	M_5K 5.68	M_5K 6.88	M_5K 8.68
	$R_{14}K$ 4.55	R_5K 5.61	R_5K 6.87	R_5K 8.61
1	M_5C_1 5.10	M_5C_1 7.46	M_5C_1 9.23	M_5C_1 11.82
	$R_{14}C_1$ 4.46	$R_{14}C_1$ 5.57	$R_{14}C_1$ 6.60	R_5C_1 7.95
	R_5C_1 4.16	R_5C_1 5.23	R_5C_1 6.33	$R_{14}C_1$ 7.87
2	M_5C_2 5.05	M_5C_2 7.40	M_5C_2 9.93	M_5C_2 12.29
	$R_{14}C_2$ 4.50	$R_{14}C_2$ 5.69	R_5C_2 6.75	R_5C_2 8.09
	R_5C_2 4.19	R_5C_2 5.31	$R_{14}C_2$ 6.44	$R_{14}C_2$ 8.06
3	M_5C_3 4.92	M_5C_3 6.91	M_5C_3 9.11	M_5C_3 11.63
	$R_{14}C_3$ 4.53	$R_{14}C_3$ 5.75	$R_{14}C_3$ 6.87	R_5C_3 8.30
	R_5C_3 4.26	R_5C_3 5.43	R_5C_3 6.60	$R_{14}C_3$ 8.21
4	R_5C_4 5.05	R_5C_4 7.74	R_5C_4 10.53	R_5C_4 12.85
	M_5C_4 4.81	M_5C_4 6.65	M_5C_4 8.70	M_5C_4 11.21
	$R_{14}C_4$ 4.61	$R_{14}C_4$ 5.94	$R_{14}C_4$ 7.15	$R_{14}C_4$ 8.52
5	$R_{14}C_5$ 5.08	$R_{14}C_5$ 7.28	R_5C_5 9.83	R_5C_5 12.04
	R_5C_5 4.87	R_5C_5 7.13	$R_{14}C_5$ 9.82	$R_{14}C_5$ 11.94
	M_5C_5 4.72	M_5C_5 6.36	M_5C_5 8.30	M_5C_5 10.76
6	$R_{14}C_6$ 4.92	$R_{14}C_6$ 6.97	$R_{14}C_6$ 9.33	$R_{14}C_6$ 11.41
	M_5C_6 4.64	R_5C_6 6.65	R_5C_6 8.78	R_5C_6 10.95
	R_5C_6 4.56	M_5C_6 6.16	M_5C_6 7.97	M_5C_6 10.39
7	$R_{14}C_7$ 4.77	R_5C_7 6.61	$R_{14}C_7$ 8.83	$R_{14}C_7$ 10.87
	M_5C_7 4.61	$R_{14}C_7$ 6.59	R_5C_7 8.66	R_5C_7 10.80
	R_5C_7 4.60	M_5C_7 6.02	M_5C_7 7.70	M_5C_7 10.01

TABLE 11 (Part II)

Marquis Wheat (M_5). Rideau Wheat (R_5)and (R_{14}). Increase in total length in mms. of originally marked 3.5 mm. root tip with time, imbibition and vernalization. Duncan's test (5% level).

Vernalization (weeks)	Experimental period (hours) 10	12	14	16
0	M_5K 10.42 R_5K 10.37 $R_{14}K$ 10.24	M_5K 11.91 R_5K 11.91 $R_{14}K$ 11.60	M_5K 13.41 R_5K 13.19 $R_{14}K$ 12.80	M_5K 15.30 R_5K 14.62 $R_{14}K$ 14.13
1	M_5C_1 14.17 R_5C_1 9.64 $R_{14}C_1$ 9.30	M_5C_1 16.40 R_5C_1 11.11 $R_{14}C_1$ 10.32	M_5C_1 18.36 R_5C_1 12.33 $R_{14}C_1$ 11.70	M_5C_1 20.95 R_5C_1 13.68 $R_{14}C_1$ 12.91
2	M_5C_2 14.61 R_5C_3 9.80 $R_{14}C_2$ 9.50	M_5C_2 16.83 R_5C_2 11.30 $R_{14}C_2$ 10.79	M_5C_2 18.81 R_5C_2 12.53 $R_{14}C_2$ 12.01	M_5C_2 21.35 R_5C_2 13.91 $R_{14}C_2$ 13.16
3	M_5C_3 13.94 R_5C_3 10.03 $R_{14}C_3$ 9.68	M_5C_3 16.13 R_5C_3 11.55 $R_{14}C_3$ 10.98	M_5C_3 17.64 R_5C_3 12.80 $R_{14}C_3$ 12.22	M_5C_3 20.16 R_5C_3 14.21 $R_{14}C_3$ 13.49
4	R_5C_4 14.19 M_5C_4 13.50 $R_{14}C_4$ 10.03	R_5C_4 16.17 M_5C_4 15.66 $R_{14}C_4$ 11.37	R_5C_4 17.88 M_5C_4 17.54 $R_{14}C_4$ 12.65	M_5C_4 20.04 R_5C_4 19.65 $R_{14}C_4$ 13.96
5	R_5C_5 14.26 $R_{14}C_5$ 14.13 M_5C_5 13.02	R_5C_5 16.22 $R_{14}C_5$ 16.10 M_5C_5 15.15	R_5C_5 17.91 $R_{14}C_5$ 17.67 M_5C_5 17.00	R_5C_5 19.66 M_5C_5 19.47 $R_{14}C_5$ 19.22
6	R_5C_6 13.15 $R_{14}C_6$ 13.14 M_5C_6 12.64	$R_{14}C_6$ 15.48 R_5C_6 15.08 M_5C_6 14.74	$R_{14}C_6$ 17.04 R_5C_6 16.74 M_5C_6 16.57	M_5C_6 19.02 $R_{14}C_6$ 18.57 R_5C_6 18.48
7	$R_{14}C_7$ 12.99 R_5C_7 12.98 M_5C_7 12.29	$R_{14}C_7$ 14.86 R_5C_7 14.52 M_5C_7 14.38	$R_{14}C_7$ 16.43 M_5C_7 16.18 R_5C_7 16.17	M_5C_7 18.61 $R_{14}C_7$ 17.95 R_5C_7 17.88

TABLE 11 (Part III)

Marquis Wheat (M_5). Rideau Wheat (R_5) and (R_{14}). Increase in total length in mms. of originally marked 3.5 mm. root tip with time, imbibition and vernalization. Duncan's test (5% level).

Vernalization (weeks)	Experimental period (hours)			
	18	24	36	48
0	M_5K 17.31 R_5K 16.29 $R_{14}K$ 15.58	M_5K 23.26 R_5K 20.82 $R_{14}K$ 20.60	M_5K 34.50 R_5K 30.64 $R_{14}K$ 30.03	M_5K 44.80 R_5K 40.44 $R_{14}K$ 39.26
1	M_5C_1 23.49 R_5C_1 15.29 $R_{14}C_1$ 14.41	M_5C_1 30.93 R_5C_1 19.70 $R_{14}C_1$ 18.53	M_5C_1 46.05 R_5C_1 29.35 $R_{14}C_1$ 27.70	M_5C_1 65.97 R_5C_1 38.76 $R_{14}C_1$ 36.59
2	M_5C_2 23.87 R_5C_2 15.54 $R_{14}C_2$ 14.73	M_5C_2 31.13 R_5C_2 19.98 $R_{14}C_2$ 18.92	M_5C_2 45.97 R_5C_2 29.71 $R_{14}C_2$ 28.13	M_5C_2 65.51 R_5C_2 39.23 $R_{14}C_2$ 37.07
3	M_5C_3 22.65 R_5C_3 15.85 $R_{14}C_3$ 15.00	M_5C_3 29.92 R_5C_3 20.33 $R_{14}C_3$ 19.73	M_5C_3 44.63 R_5C_3 30.14 $R_{14}C_3$ 28.55	M_5C_3 60.18 R_5C_3 39.68 $R_{14}C_3$ 37.53
4	M_5C_4 22.50 R_5C_4 21.78 $R_{14}C_4$ 15.48	M_5C_4 29.67 R_5C_4 27.11 $R_{14}C_4$ 19.78	M_5C_4 44.08 R_5C_4 39.12 $R_{14}C_4$ 29.14	M_5C_4 59.47 R_5C_4 52.49 $R_{14}C_4$ 38.30
5	M_5C_5 21.98 R_5C_5 21.65 $R_{14}C_5$ 20.94	M_5C_5 29.00 R_5C_5 27.03 $R_{14}C_5$ 25.95	M_5C_5 43.29 R_5C_5 39.25 $R_{14}C_5$ 37.16	M_5C_5 58.58 R_5C_5 52.54 $R_{14}C_5$ 49.07
6	M_5C_6 21.48 R_5C_6 20.43 $R_{14}C_6$ 20.29	M_5C_6 28.46 R_5C_6 25.78 $R_{14}C_6$ 25.25	M_5C_6 42.58 R_5C_6 37.64 $R_{14}C_6$ 36.37	M_5C_6 57.82 R_5C_6 51.30 $R_{14}C_6$ 47.21
7	M_5C_7 20.95 R_5C_7 19.81 $R_{14}C_7$ 19.65	M_5C_7 27.80 R_5C_7 25.12 $R_{14}C_7$ 24.58	M_5C_7 41.71 R_5C_7 36.94 $R_{14}C_7$ 35.68	M_5C_7 56.89 R_5C_7 50.10 $R_{14}C_7$ 47.45

COMPRESS THE DATA, DUNCAN TEST SIGNIFICANCE LINES WERE PLACED VERTICALLY.

FIGURE 3 GRAPHICALLY PRESENTS THIS ELONGATION GROWTH DATA PERTAINING SOLELY TO THE OPTIMAL PERIODS OF VERNALIZATION.

CONTROL SERIES

APART FROM THE 4-8 HOUR GROWTH PERIOD, ROOTS DERIVED FROM MARQUIS SPRING WHEAT SHOWED AN ACCELERATED RATE OF ELONGATION GROWTH WHICH BECAME STATISTICALLY SIGNIFICANT AFTER 18 HOURS OF GROWTH. GENERALLY, THE ORDER OF ELONGATION GROWTH IN THESE THREE SERIES FOLLOWED THE TREND $M_5K > R_5K > R_{14}K$.

VERNALIZED SERIES

AT ALL EXPERIMENTAL PERIODS, ONE TO THREE WEEKS OF PRIOR SEED CHILLING EVOKED AN ACCELERATED ELONGATION GROWTH RESPONSE OF THE PRIMARY ROOTS OF MARQUIS WHEAT. PROLONGING THE VERNALIZATION PERIOD TO 4 WEEKS RESULTED IN A HIGHER STIMULATED RESPONSE IN RIDEAU WINTER WHEAT (R_5) DURING THE FIRST 14 HOURS OF GROWTH, AFTER WHICH A GREATER RESPONSE WAS OBTAINED IN THE MARQUIS SERIES. FURTHER CHILLING (5-7 WEEKS) EVOKED A SIMILAR PATTERN OF RESPONSE IN THE OTHER RIDEAU SERIES (R_{14}) WHERE STIMULATED ELONGATION GROWTH WAS OBSERVED OVER THE FIRST 14 HOURS OF GROWTH, FOLLOWED BY A GREATER RESPONSE IN SPRING WHEAT TO 48 HOURS.

SEGMENT LENGTH

THE DATA REFERRING THE GROWTH VERNALIZATION RESPONSE OF EACH INDIVIDUALLY CONSECUTIVE SEGMENT OF MARQUIS ROOTS IS GIVEN IN TABLE D_{1-7} IN THE APPENDIX SECTION. THE RESPONSE TREND TO THE DURATION OF PRIOR CHILLING IN ALL CASES WAS AS $C_1 > C_2 > C_3 > C_4 > C_5 > C_6 > C_7 > K$.

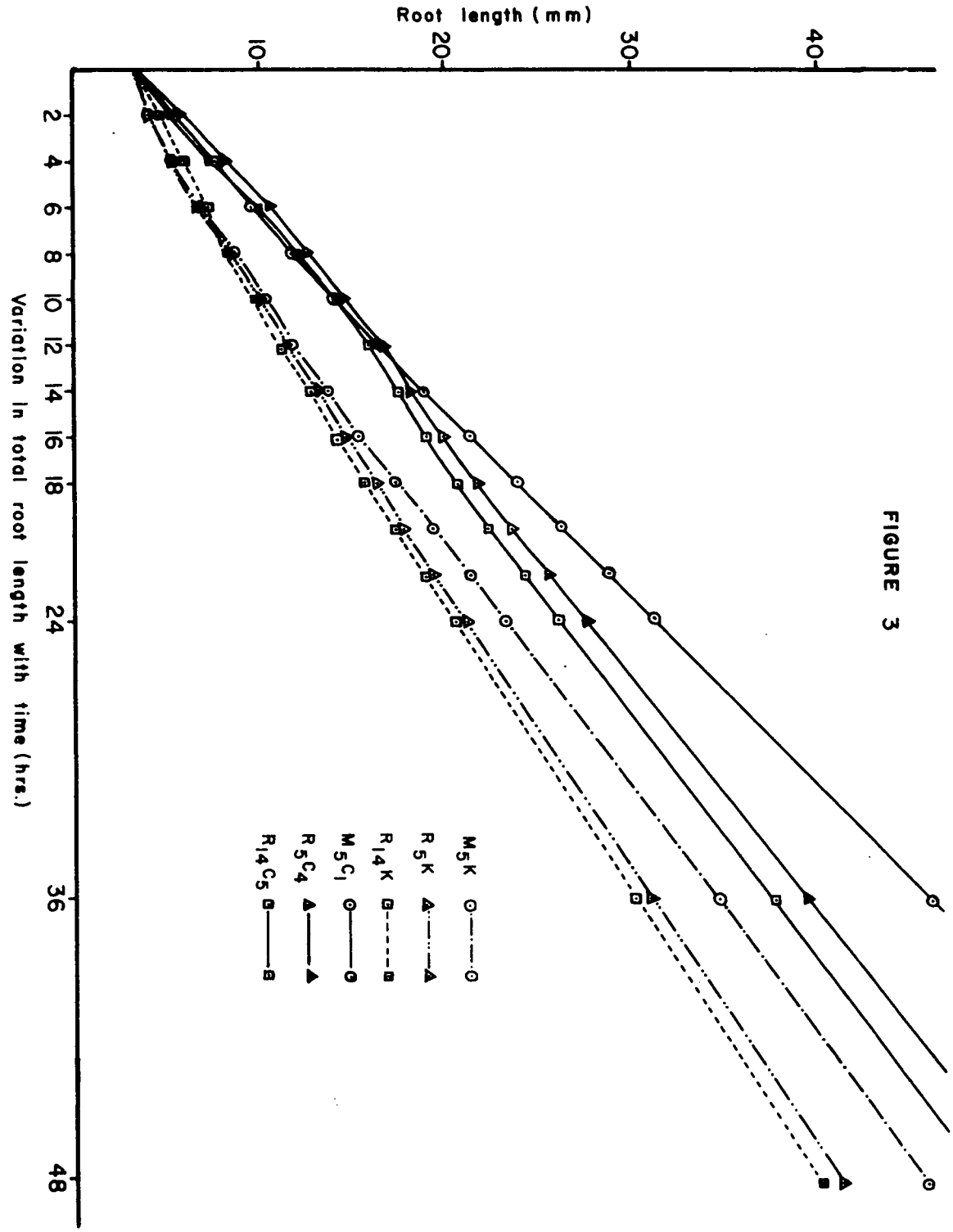

Root length (mm)
10
20
30
40
2
4
6
8
10
12
14
16
18
24
36
48
Variation in total root length with time (hrs.)
M5K
R5K
R14K
M5C1
R5C4
R14C5

FIGURE 3

COMPARABLE DATA ON THE RIDEAU 5-HOUR-IMBIBED SERIES ARE GIVEN IN TABLE E_{1-7} IN THE APPENDIX SECTION. THE SEQUENTIAL RESPONSE HERE WAS OF THE ORDER $C_4=C_5=C_6=C_7>K=C_3=C_2=C_1$.

IN THE CASE OF THE RIDEAU 14 HOUR IMBIBED SERIES THE DATA ON SEGMENT RESPONSE WITH TIME AND VERNALIZATION ARE GIVEN IN TABLE F_{1-7} IN THE APPENDIX SECTION. IN MOST CASES THE RESPONSE WAS OBSERVED TO FOLLOW THE SERIES $R_5=R_6=R_7>K=C_4=C_3=C_2=C_1$

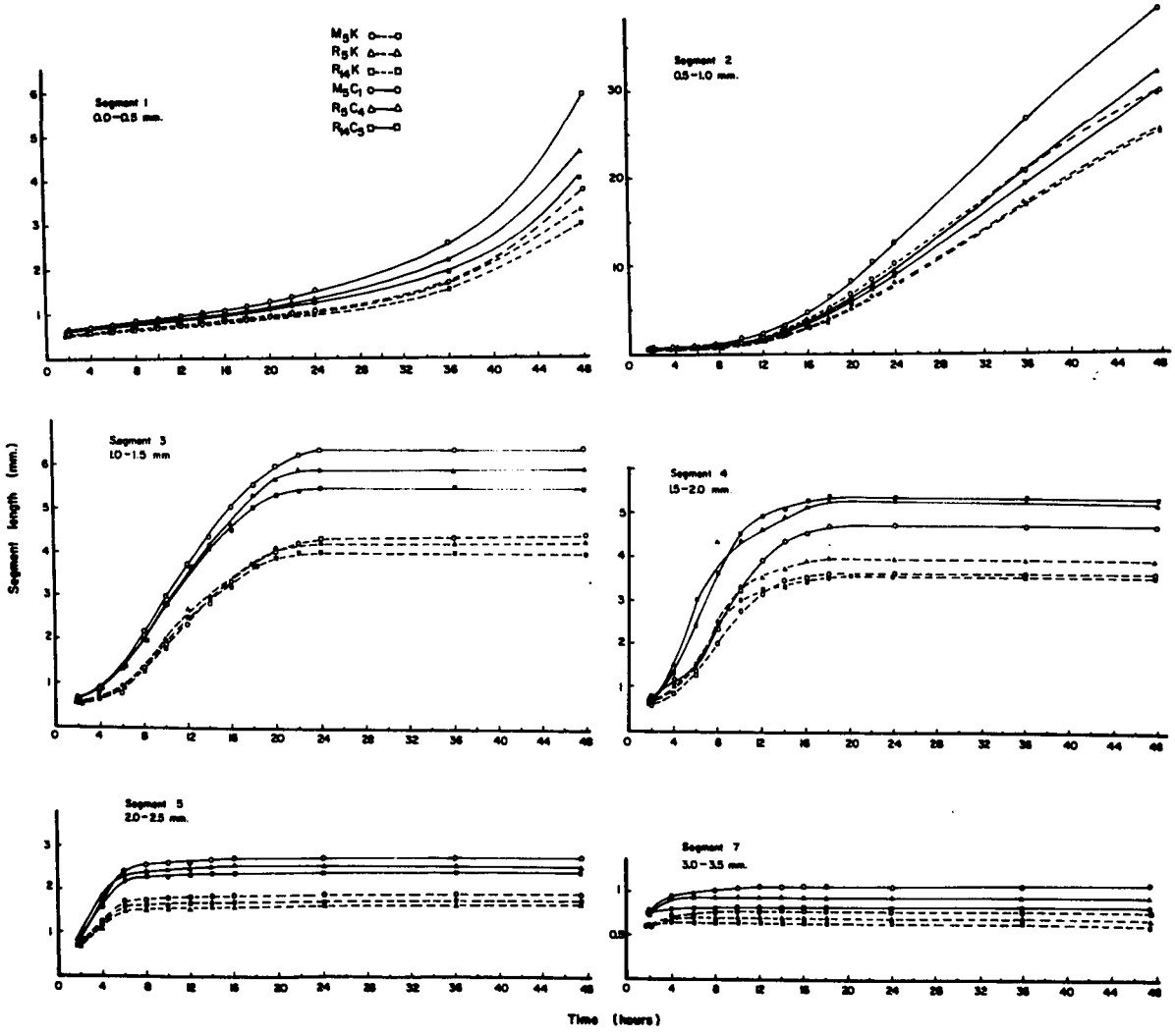
IT WAS THUS APPARENT THAT THERE OBTAINED A SIMILAR SEQUENTIAL RESPONSE TO THE CHILLING PERIODS FOR CELL DIVISION GROWTH AS WELL AS FOR ELONGATION GROWTH.

THE CHANGE IN SEGMENT LENGTH WITH TIME AT OPTIMAL PERIODS OF VERNALIZATION IS GIVEN IN FIGURE 4. IN SEGMENTS 1-6 CHILLING EVOKED AN INCREASE IN SEGMENT ELONGATION OVER THAT OBTAINED FOR CONTROL SEGMENTS WITHOUT ALTERING THE TYPICAL GROWTH CURVES. THIS PATTERN PARALLELS THE CELL DIVISION STIMULATED GROWTH RESPONSE DETAILED PREVIOUSLY (P. 38-41).

AVERAGE CELL LENGTH

THE DATA RELATING CHANGE IN AVERAGE CELL LENGTH WITH TIME WAS ALSO DETERMINED FOR ALL SERIES AND IS FOUND IN TABLE 12. AT MOST PERIODS THERE WAS A GREATER INCREASE IN THE AVERAGE CELL LENGTH OF CELLS DERIVED FROM SEGMENTS OF UNTREATED SEED. NO GENERALIZED PATTERN OF RESPONSE APPEARED TO BE EVOKED BY SEED VARIETY, THE TWO IMBIBITION PERIODS OR THE DURATION OF VERNALIZATION.

FIGURE 4



VARIATION IN SEGMENT LENGTH WITH TIME.

TABLE 12

MARQUIS WHEAT (M_5), RIDEAU WHEAT (R_5) AND (R_{14})

CHANGE IN AVERAGE CELL LENGTH (UMM) IN EACH SEGMENT OF THE PRIMARY ROOT WITH TIME.

DUNCAN'S TEST (5% LEVEL)

SEGMENT	EXPERIMENTAL PERIOD (HOURS)											
	4		12		18		24		36		48	
1	M_5K	23.9	$R_{14}K$	12.6	$R_{14}C_5$	12.5	$R_{14}K$	9.0	R_5K	8.7	M_5C_1	12.4
	M_5C_1	13.3	M_5K	11.9	R_5K	12.4	R_5K	9.0	$R_{14}K$	8.2	R_5K	11.7
	$R_{14}K$	12.5	R_5K	10.3	M_5K	10.9	M_5K	9.0	M_5K	7.7	$R_{14}K$	11.5
	R_5K	12.3	$R_{14}C_5$	9.3	$R_{14}C_5$	7.9	$R_{14}C_5$	8.7	M_5C_1	7.3	R_5C_{14}	10.3
	$R_{14}C_5$	8.3	R_5C_4	9.3	M_5C_1	7.8	R_5C_4	8.7	R_5C_4	6.8	M_5K	9.7
	R_5C_4	5.7	M_5C_1	9.1	R_5C_4	6.8	M_5C_1	6.5	$R_{14}C_5$	6.1	$R_{14}C_5$	9.6
2	M_5K	12.5	M_5K	18.6	M_5K	39.2	M_5K	65.3	$R_{14}K$	78.0	$R_{14}K$	227.4
	R_5K	9.2	R_5C_4	11.2	R_5K	29.5	$R_{14}K$	56.2	M_5K	72.6	R_5K	225.0
	$R_{14}K$	8.3	$R_{14}K$	11.1	$R_{14}K$	29.3	R_5K	53.1	R_5K	71.9	M_5K	206.8
	$R_{14}C_5$	6.1	R_5K	11.0	M_5C_1	24.9	$R_{14}C_5$	44.1	M_5C_1	55.3	M_5C_1	134.5
	M_5C_1	5.4	M_5C_1	10.5	R_5C_4	24.4	M_5C_1	42.5	R_5C_4	46.9	R_5C_4	121.9
	R_5C_4	4.4	$R_{14}C_5$	10.1	$R_{14}C_5$	18.2	R_5C_4	36.5	$R_{14}C_5$	46.2	$R_{14}C_5$	116.9
3	M_5K	12.3	$R_{14}K$	17.8	R_5C_4	34.3	M_5C_1	44.3	M_5C_1	115.2	M_5C_1	116.4
	$R_{14}K$	8.2	M_5K	17.1	M_5C_1	31.9	R_5K	43.5	R_5C_4	72.1	$R_{14}C_5$	77.5
	R_5K	7.1	R_5K	16.8	M_5K	30.9	M_5K	43.0	$R_{14}C_5$	70.7	R_5C_4	73.1
	M_5C_1	6.7	M_5C_1	15.5	$R_{14}C_5$	30.6	$R_{14}K$	41.5	R_5K	65.5	$R_{14}K$	67.7
	$R_{14}C_5$	5.6	R_5C_4	14.9	$R_{14}K$	29.9	R_5C_4	40.9	$R_{14}K$	65.3	R_5K	65.5
	R_5C_4	5.6	$R_{14}C_5$	14.8	R_5K	27.9	$R_{14}C_5$	39.0	M_5K	55.3	M_5K	55.3
4	$R_{14}K$	27.3	M_5K	45.2	R_5C_4	62.0	$R_{14}C_5$	58.6	$R_{14}C_5$	70.5	$R_{14}C_5$	77.2
	R_5K	21.8	R_5C_4	44.4	$R_{14}C_5$	60.4	R_5C_4	58.1	R_5K	70.2	R_5K	73.8
	M_5K	20.4	R_5K	44.1	R_5K	55.4	R_5K	61.9	R_5C_4	65.4	$R_{14}K$	71.1
	R_5C_4	17.6	$R_{14}K$	40.4	$R_{14}K$	47.8	$R_{14}K$	59.4	$R_{14}K$	62.6	R_5C_4	68.1
	$R_{14}C_5$	12.6	$R_{14}C_5$	36.3	M_5K	46.1	M_5K	54.1	M_5K	56.0	M_5K	56.3
	M_5C_1	10.9	M_5C_1	32.9	M_5C_1	40.7	M_5C_1	53.9	M_5C_1	50.1	M_5C_1	49.8
5	M_5K	23.5	$R_{14}K$	36.9	M_5K	41.3	M_5K	58.4	$R_{14}K$	58.0	$R_{14}K$	58.0
	R_5K	23.2	M_5K	32.2	$R_{14}K$	39.1	$R_{14}C_5$	50.5	R_5K	52.8	M_5K	54.6
	$R_{14}C_5$	21.4	M_5C_1	26.4	R_5K	37.9	M_5C_1	40.6	M_5K	49.5	R_5K	52.8
	R_5C_4	21.0	R_5C_4	25.1	R_5C_4	34.7	R_5K	40.0	M_5C_1	38.7	R_5C_4	39.8
	$R_{14}K$	20.7	$R_{14}C_5$	33.3	M_5C_1	33.3	R_5C_4	38.1	R_5C_4	38.1	M_5C_1	39.4
	M_5C_1	20.1	R_5K	21.2	$R_{14}C_5$	31.1	$R_{14}C_5$	34.9	$R_{14}C_5$	38.1	$R_{14}C_5$	37.6

Increase in Length with Distance from the Root Apex

Average Cell Length

The variation in average cell length at increasing distances from the apex at optimal periods of vernalization was also determined and is shown in Table 13 and Figure 5. Vernalization appeared to depress average cell elongation growth in the region of 0-20 mm. Actually, however, because of stimulated growth by cell division as noted above, a significantly greater number of cells was found in this region. Therefore, the apparently depressant effect of vernalization on average cell elongation is actually an erroneous implication, as evidenced by the greater average cell lengths obtained in all the vernalized series over their control following 36 hours of growth, at a region 30 mms. from the apex.

Increase in Fresh Weight with Time

Segment Weight

The change in the fresh weight of each successive 0.5 mm. segment derived from the roots of control and optimally vernalized Marquis and Rideau wheats was observed at three time periods and is shown in Table 14. Each value represents the mean of thirty determinations (triplicate determinations on 10 roots.) Duncan's test significance lines were placed vertically in order to accommodate the total data in one table. The fresh weights were observed to increase coincidentally with segment elongation growth.

TABLE 13

Marquis Wheat (M_5) Rideau Wheat (R_5) and (R_{14}).

Variation in cell length (μm) with distance from root apex at optimally vernalized periods.

Duncan's test (5% level)

Distance from apex of root (μm)	Vernalization (weeks)					
0.5	M_5K	M_5C_1	$R_{14}K$	R_5K	$R_{14}C_5$	R_5C_4
	21.0	13.3	12.5	12.3	8.3	5.7
1	M_5K	R_5K	$R_{14}K$	M_5C_1	R_5C_4	$R_{14}C_5$
	12.4	10.7	8.4	7.1	7.0	6.2
2	M_5K	$R_{14}K$	R_5K	M_5C_1	R_5C_4	$R_{14}C_5$
	13.0	9.6	7.9	6.7	6.2	5.9
3	M_5K	R_5K	$R_{14}K$	M_5C_1	$R_{14}C_5$	R_5C_4
	19.5	16.7	10.8	10.7	10.1	8.0
4	M_5K	R_5K	$R_{14}K$	R_5C_1	M_5C_1	$R_{14}C_5$
	23.5	23.2	22.1	14.4	14.0	11.1
5	M_5K	$R_{14}K$	R_5K	R_5C_4	M_5C_1	$R_{14}C_5$
	29.0	25.0	23.1	14.4	14.0	14.0
6	M_5K	$R_{14}K$	R_5K	R_5C_4	$R_{14}C_5$	M_5C_1
	39.2	28.0	25.0	22.6	19.8	14.0
10	M_5K	$R_{14}K$	M_5C_1	R_5K	$R_{14}C_5$	R_5C_4
	43.0	[illegible]	42.0	37.2	37.0	35.4
15	M_5K	M_5C_1	R_5K	$R_{14}K$	$R_{14}C_5$	R_5C_4
	54.0	49.0	45.0	44.0	44.0	41.0
20	M_5K	R_5K	M_5C_1	R_5C_4	$R_{14}K$	$R_{14}C_5$
	65.0	55.9	55.0	51.7	50.0	48.9

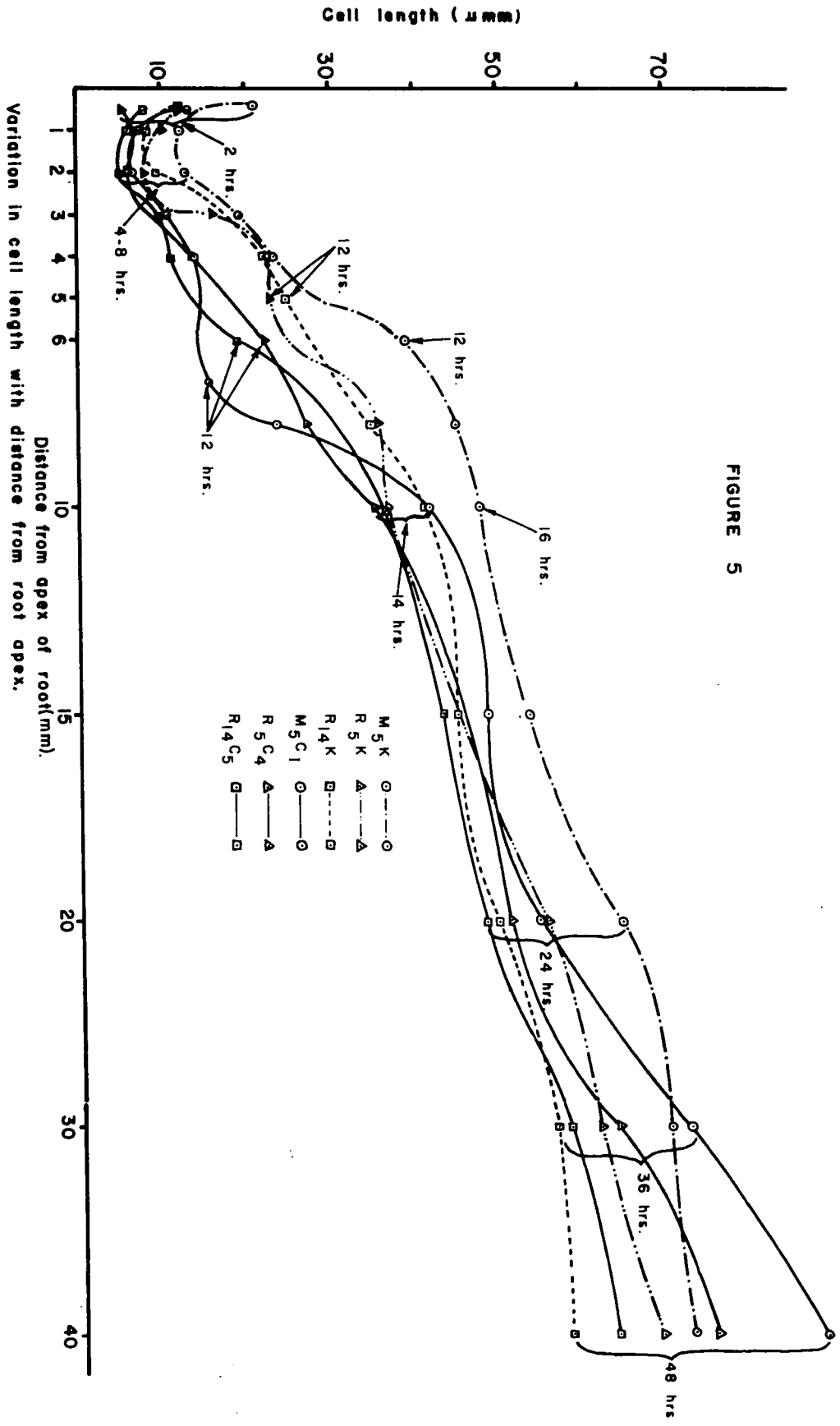


FIGURE 5

Variation in cell length with distance from root apex.

TABLE 14 (Part I)

Variation in Fresh weight mg. per 10 roots of each segment with time, wheat variety, imbibition, vernalization.

Triplicate determinations to a total of 30 segments per period.
Duncan's test (5% level)

Time (hours)	segment 1		2		3		4	
24	M_5C_1	43.5±9	M_5C_1	266.5±17	M_5C_1	264.3±18	M_5K	153.2±19
	R_5K	35.5±7	R_5C_4	220.1±14	M_5K	225.6±19	$R_{14}K$	127.0±18
	$R_{14}C_5$	30.6±6	$R_{14}C_5$	154.1±11	R_5C_4	217.2±11	M_5C_1	122.1±18
	M_5K	29.6±5	M_5K	144.4±5	R_5K	198.2±10	R_5C_4	120.1±16
	R_5C_4	27.9±5	R_5K	130.0±7	$R_{14}C_5$	194.9±9	$R_{14}C_5$	115.5±10
	$R_{14}K$	20.1±5	$R_{14}K$	87.9±5	$R_{14}K$	182.5±5	R_5K	93.5±11
36	$R_{14}C_5$	65.6±14	$R_{14}C_5$	458.8±79	M_5C_1	365.5±28	M_5C_1	194.5±15
	R_5K	63.4±10	R_5K	438.0±75	R_5K	325.6±25	R_5K	175.3±15
	R_5C_4	58.6±9	R_5C_4	401.0±24	R_5C_4	318.8±18	$R_{14}K$	139.8±15
	$R_{14}K$	54.5±9	M_5K	390.5±12	$R_{14}C_5$	280.4±18	M_5K	135.1±11
	M_5K	53.1±7	M_5C_1	357.5±22	M_5K	251.2±17	R_5C_4	133.5±11
	M_5C_1	49.7±6	$R_{14}K$	333.6±20	$R_{14}K$	227.7±15	$R_{14}C_5$	94.9±9
48	M_5C_1	390.2±62	M_5C_1	743.8±65	$R_{14}C_5$	530.1±41	R_5C_4	212.1±47
	R_5C_4	220.0±45	R_5C_4	683.9±49	M_5C_1	440.4±32	M_5C_1	167.4±41
	$R_{14}C_5$	181.7±37	$R_{14}C_5$	514.9±45	M_5K	353.4±30	$R_{14}C_5$	147.2±34
	$R_{14}K$	102.1±32	$R_{14}K$	487.5±44	R_5C_4	340.2±30	M_5K	139.7±31
	M_5K	81.0±30	M_5K	421.3±37	$R_{14}K$	265.1±25	R_5K	113.8±26
	R_5K	71.1±26	R_5K	394.3±27	R_5K	213.1±19	$R_{14}K$	93.5±15

TABLE 14 (Part II)

Variation in Fresh weight mg. per 10 roots of each segment with time, imbibition, vernalization and seed variety.

Triplicate determinations to a total of 30 segments per period.

Duncan's test (5% level)

Time (hours)	Segment 5		Segment 6		Segment 7	
24	M_5K	80.1±24	M_5C_1	26.6±13	M_5C_1	22.2±7
	M_5C_1	71.6±17	M_5K	26.2±13	M_5K	13.0±6
	R_5C_4	49.9±14	R_5C_4	20.7±8	$R_{14}C_5$	10.5±5
	$R_{14}C_5$	47.5±14	$R_{14}K$	16.8±8	R_5C_4	10.1±5
	$R_{14}K$	44.2±14	$R_{14}C_5$	16.6±8	$R_{14}K$	10.0±5
	R_5K	31.3±12	R_5K	9.9±4	R_5K	3.7±4
36	M_5C_1	90.0±14	M_5C_1	30.3±12	M_5K	22.8±8
	M_5K	68.3±10	M_5K	30.0±12	R_5K	21.3±8
	R_5K	60.2±9	R_5C_4	27.5±8	M_5C_1	19.0±5
	R_5C_4	59.4±8	$R_{14}K$	25.9±8	$R_{14}C_5$	17.9±5
	$R_{14}K$	56.2±8	R_5K	20.3±7	$R_{14}K$	14.1±4
	$R_{14}C_5$	43.7±7	$R_{14}C_5$	11.9±4	R_5C_4	12.2±4
48	$R_{14}C_5$	69.6±13	R_5C_4	45.8±8	M_5C_1	20.5±8
	M_5K	68.1±9	M_5C_1	37.4±8	R_5C_4	19.4±8
	M_5C_1	66.7±9	M_5K	25.5±7	$R_{14}C_5$	16.6±5
	R_5C_4	55.8±9	$R_{14}C_5$	25.0±7	M_5K	14.3±5
	$R_{14}K$	34.0±4	R_5K	15.7±6	R_5K	13.5±4
	R_5K	33.5±4	$R_{14}K$	11.5±4	$R_{14}K$	6.0±2

Average Cell Fresh Weight

Average cell fresh weight measurements are given in Table 15 and Figure 6.

Control Series

In the control series the average fresh weight per cell increased rapidly during the first 36 hours of growth, and this corresponded to a region approximately 30 mm. from the root apex. Following this phase a slower increase in average cell fresh weight was obtained in the $N_5K_4R_{14}K$ series, whereas a decrease was observed in the R_5K series.

Vernalized Series

In the three vernalized series, it was noted that the onset of increase in average cell fresh weight occurred at a region more distant from the apex than observed for the untreated control series. Once initiated, the increase in fresh weight was rapid and attained levels at least 100 fold over control.

The "lag" in average cell fresh weight increase in the cells of optimally vernalized seed corresponded to the delay of the onset of elongation growth. The highest value was obtained in Marquis wheat at the 48 hour growth period representing a region more distant from the apex than obtained in the Rideau series. This difference may be correlated with the increase in average cell length growth at this period as noted previously (c.f. Figure 5).

TABLE 15

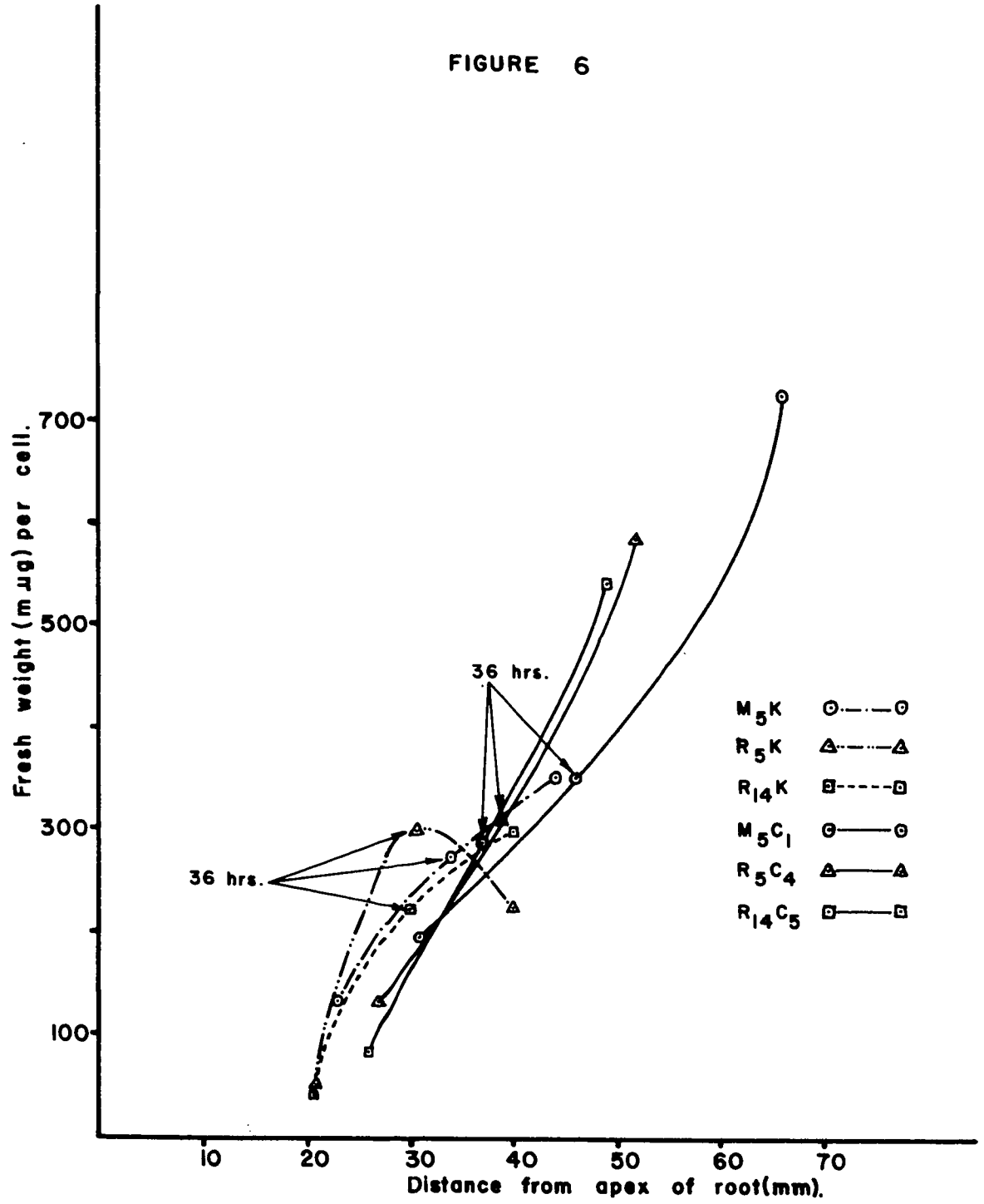
Marquis wheat (M_5), Rideau wheat (R_5) and (R_{14})

Change in average cell fresh weight (mug) in each segment of the primary root with time, imbibition, vernalization and seed variety.

Duncan's Test (5% level)

Segment	Experimental period (hours)					
	24		36		48	
1	R_5K	29.09	R_5K	31.54	M_5C_1	30.61
	M_5K	24.46	$P_{14}K$	28.53	R_5C_4	49.43
	M_5C_1	13.83	M_5K	24.02	$R_{14}C_5$	43.05
	$R_{14}K$	16.75	$R_{14}C_5$	21.09	$R_{14}K$	38.52
	$R_{14}C_5$	16.10	R_5C_4	18.25	M_5K	26.04
	R_5C_4	13.88	M_5C_1	14.00	R_5K	24.68
2	M_5K	90.81	R_5K	121.74	$R_{14}K$	443.18
	M_5C_1	88.73	$P_{14}K$	150.95	R_5K	348.33
	R_5K	84.96	M_5K	136.12	M_5K	290.55
	R_5C_4	83.05	$R_{14}C_5$	108.20	R_5C_4	262.03
	$R_{14}C_5$	75.17	R_5C_4	90.31	M_5C_1	255.60
	$R_{14}K$	59.39	M_5C_1	73.71	$R_{14}C_5$	205.17
3	M_5K	225.64	R_5K	500.92	M_5K	453.07
	R_5K	202.24	R_5C_4	388.78	M_5C_1	449.38
	$R_{14}K$	156.32	M_5C_1	369.19	$R_{14}C_5$	446.61
	M_5C_1	183.54	$R_{14}K$	367.25	$R_{14}K$	441.83
	R_5C_4	149.79	$R_{14}C_5$	359.43	R_5C_4	420.00
	$R_{14}C_5$	138.22	M_5K	322.05	R_5K	327.84
4		228.65	R_5K	302.24	R_5C_4	271.92
	$R_{14}K$	208.19	$R_{14}K$	249.64	M_5K	213.28
	R_5C_4	153.97	M_5K	207.84	$R_{14}C_5$	207.32
	$R_{14}C_5$	144.37	M_5C_1	206.91	R_5K	200.90
	R_5K	141.66	R_5C_4	164.81	$R_{14}K$	183.33
	M_5C_1	138.75	$R_{14}C_5$	121.66	M_5C_1	176.21
5	M_5K	250.31	R_5K	190.19	M_5K	200.27
	$R_{14}K$	130.00	$R_{14}K$	137.33	$R_{14}K$	113.33
	R_5K	76.34	M_5K	179.73	$R_{14}C_5$	108.75
	M_5C_1	75.83	M_5C_1	126.76	R_5K	108.06
	R_5C_4	73.38	R_5C_4	87.35	R_5C_4	85.34
	$P_{14}C_5$	68.84	$R_{14}C_5$	65.22	M_5C_1	80.61

FIGURE 6



Variation in cell fresh weight with distance from root apex.

Increase in Dry Weight with Time

Segment Weight

Dry weight determinations on all delineated segments was obtained after 24, 36 and 48 hours of growth for the control and optimally vernalized series (i.e. N_5C_1, R_5C_4 and $R_{14}C_5$). This data is presented in Table 16. Vertical Duncan test significance lines were again used in order to facilitate compression of the data.

Few statistically significant differences in the change of dry weight of optimally vernalized and control segments were observed. Where real differences were present they could generally be correlated with significantly higher levels of cell division and/or segment elongation growth as in the case of N_5C_1 segments 3 and 4 after 36 hours of growth, and segment 1 of the same series following 48 hours of growth (c.f. Tables 9 and 11). The relationship did not hold in the case of segment 3 $R_{14}C_5$, at the 36 hour growth period.

Average Cell Dry Weight

The change in average cell dry weight after 24, 36 and 48 hours of growth is given in Table 17 where vertical Duncan test significance lines were used.

Apart from the cells found in segment 3 and 4 of the N_5C_1 series at 36 hours, vernalization appeared to depress an increase in average cell dry weight. This apparently depressant effect, could be closely correlated with the changes in average cell length (p. 50). A similar erroneous implication could have been obtained if this parameter of growth had been studied alone, and out

TABLE 16 (Part I)

Variation in Dry Weight mg. per 10 roots of each segment with time, imbibition and vernalization and seed variety. Triplicate determination to a total of 30 segments per period.

Duncan's test (5% level)

Time (hours)	Segment 1		Segment 2		Segment 3		Segment 4	
24	M_5K	10.8±6	M_5C_1	17.0±4	M_5C_1	16.1±4	M_5K	14.0±2
	R_5K	6.8±5	M_5K	13.9±4	M_5K	14.6±3	R_5K	10.5±2
	R_5C_4	5.1±5	R_5K	11.0±3	R_5K	14.3±3	$R_{14}K$	8.7±2
	M_5C_1	4.5±4	$R_{14}C_5$	10.9±3	$R_{14}C_5$	12.8±2	$R_{14}C_5$	8.4±2
	$R_{14}K$	3.0±4	$R_{14}K$	8.6±3	R_5C_4	12.1±2	M_5C_1	5.9±1
	$R_{14}C_5$	1.6±3	R_5C_4	6.7±2	$R_{14}K$	10.8±1	R_5C_4	5.4±1
36	$R_{14}C_5$	14.7±5	$R_{14}C_5$	34.0±11	M_5C_1	39.0±6	M_5C_1	28.1±4
	R_5K	9.0±3	M_5K	21.9±7	R_5K	20.8±5	R_5K	11.7±3
	M_5K	8.6±3	R_5K	21.0±7	M_5K	20.2±5	R_5C_4	10.8±3
	R_5C_4	6.0±2	R_5C_4	20.6±7	R_5C_4	18.6±4	M_5K	10.5±3
	$R_{14}K$	4.8±2	$R_{14}K$	20.0±5	$R_{14}K$	13.8±3	$R_{14}K$	10.2±3
	M_5C_1	4.3±2	M_5C_1	15.1±3	$R_{14}C_5$	11.6±3	$R_{14}C_5$	8.1±2
48	M_5C_1	22.0±4	R_5C_4	42.4±15	$R_{14}C_5$	26.4±5	R_5C_4	11.0±3
	R_5C_4	16.1±4	M_5C_1	31.1±11	R_5C_4	21.9±5	$R_{14}C_5$	9.5±3
	$R_{14}C_5$	8.1±3	R_5K	26.5±11	M_5K	21.9±5	M_5K	9.5±3
	$R_{14}K$	8.0±3	$R_{14}K$	24.9±9	M_5C_1	20.8±4	$R_{14}K$	8.6±2
	R_5K	7.7±2	M_5K	23.6±7	$R_{14}K$	16.4±4	R_5K	7.7±2
	M_5K	7.6±2	$R_{14}C_5$	21.8±5	R_5K	15.0±4	M_5C_1	7.3±2

TABLE-16 (Part II)

Variation in Dry Weight mg. per 10 roots of each segment with time, imbibition, vernalization and seed variety. Triplicate determination to a total of 30 segments per period.

Duncan's test (5% level)

Time (hours)	Segment 5		Segment 6		Segment 7	
24	M_5K	9.1±6	M_5K	6.8±4	M_5K	6.4±4
	R_5K	5.8±5	R_5K	5.9±4	$R_{14}C_5$	3.1±2
	R_5C_4	3.5±4	$R_{14}C_5$	3.5±2	R_5K	2.0±2
	$R_{14}K$	3.3±4	R_5C_4	3.4±2	M_5C_1	1.5±2
	M_5C_1	3.1±4	$R_{14}K$	3.1±2	$R_{14}K$	1.5±2
	$R_{14}C_5$	2.3±4	M_5C_1	1.9±1	R_5C_4	1.0±2
36	R_5K	7.6±3	M_5K	4.7±2	M_5K	5.7±2
	M_5K	5.9±3	R_5C_4	4.5±2	M_5C_1	3.0±1
	R_4C_5	5.3±3	R_5K	4.4±2	$R_{14}K$	2.9±1
	$R_{14}K$	5.1±3	M_5C_1	4.3±2	$R_{14}C$	2.9±1
	M_5C_1	2.8±1	$R_{14}K$	4.0±2	R_5K	2.7±1
	$R_{14}C_5$	2.5±1	$R_{14}C_5$	2.5±1	R_5C_4	2.7±1
48	$R_{14}C_5$	7.1±3	$R_{14}C_5$	4.0±2	$R_{14}C_5$	3.7±2
	M_5K	5.1±3	R_5C_4	2.6±1	$R_{14}K$	2.5±1
	M_5C_1	4.6±2	$R_{14}K$	2.5±1	M_5C_1	2.1±1
	R_5C_4	4.4±2	M_5C_1	2.5±1	R_5K	2.0±1
	$R_{14}K$	4.2±2	R_5K	2.4±1	M_5K	1.7±1
	R_5K	4.1±2	M_5K	2.2±1	R_5C_4	1.0±1

TABLE 17

Marquis Wheat (M_5), Rideau Wheat (R_5) and (R_{14}).

Change in average cell dry weight (mug) in each segment of the primary root with time, imbibition, vernalization and seed variety.

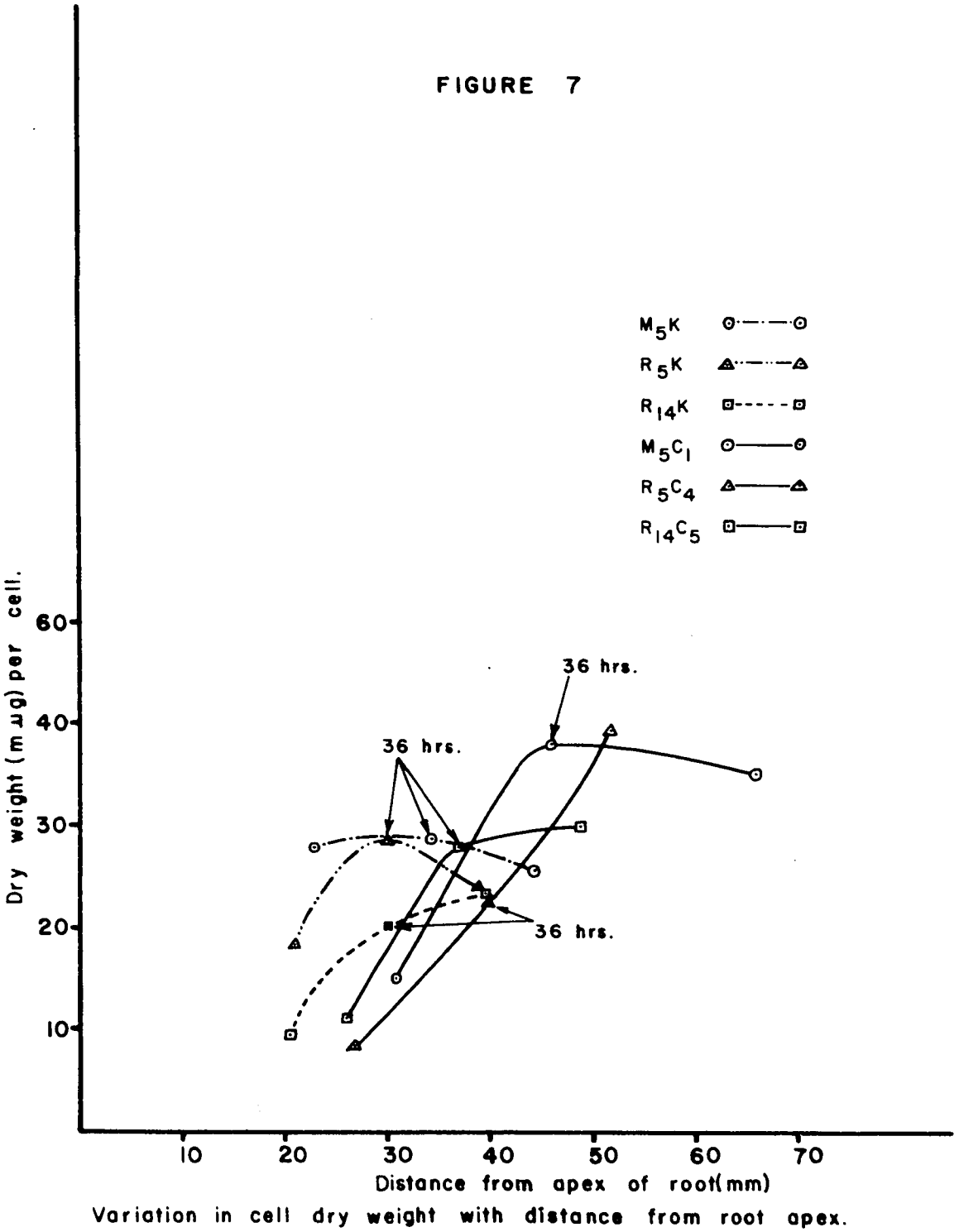
Duncan's test (5% level)

Segment	Experimental period (hours)		
	24	36	48
1	M_5K 8.92 R_5K 4.57 R_5C_4 2.53 $R_{14}K$ 2.50 M_5C 1.94 $R_{14}C$ 0.84	$R_{14}K$ 4.72 R_5K 4.47 M_5K 3.89 $R_{14}K$ 2.51 R_5C_4 1.86 M_5C 1.21	M_5C_1 4.54 R_5C_4 3.61 $R_{14}K$ 3.01 R_5K 2.67 M_5K 2.44 $R_{14}C_5$ 1.91
2	M_5K 8.74 R_5K 7.18 $R_{14}K$ 5.81 M_5C_1 5.64 $R_{14}C_5$ 5.31 R_5C_4 2.52	$R_{14}K$ 9.04 R_5K 8.71 $R_{14}C_5$ 8.01 M_5K 7.57 R_5C_4 4.63 M_5C_1 3.11	R_5K 23.65 $R_{14}K$ 22.63 M_5K 16.27 R_5C_4 16.24 M_5C_1 10.28 $R_{14}C_5$ 8.68
3	M_5K 14.60 R_5K 14.59 M_5C_1 11.18 $R_{14}K$ 19.02 $R_{14}C_5$ 9.07 R_5C_4 8.34	M_5C_1 39.69 R_5K 32.00 M_5K 25.89 R_5C_4 22.68 $R_{14}K$ 22.25 $R_{14}C_5$ 14.87	$R_{14}C_5$ 37.18 R_5K 33.69 M_5K 28.07 $R_{14}K$ 27.33 R_5C_4 27.03 M_5C_1 21.22
4	M_5K 20.89 R_5K 15.90 $R_{14}K$ 14.26 $R_{14}C_5$ 10.62 R_5C_4 6.92 M_5C_1 6.70	M_5C_1 29.89 R_5K 20.17 $R_{14}K$ 18.21 M_5K 16.15 R_5C_4 13.33 $R_{14}C_5$ 10.38	$R_{14}K$ 16.86 M_5K 14.84 R_5C_4 14.10 R_5K 14.00 $R_{14}C_5$ 13.38 M_5C_1 7.68
5	M_5K 28.43 R_5K 14.14 $R_{14}K$ 9.70 R_5C_4 5.14 M_5C_1 4.55 $R_{14}C_5$ 3.62	R_5K 24.51 $R_{14}K$ 17.00 M_5K 15.52 R_5C_4 7.79 M_5C_1 3.94 $R_{14}C_5$ 3.73	M_5K 15.00 $R_{14}K$ 14.00 R_5K 13.22 $R_{14}C_5$ 11.09 R_5C_4 6.76 M_5C_1 6.57

OF CONTEXT WITH THE DYNAMIC PHASES OF CELL DIVISION AND CELL ELONGATION GROWTH.

THE CHANGE IN AVERAGE CELL DRY WEIGHT OVER THE 24-48 HOURS GROWTH PERIOD IS ALSO SHOWN IN FIGURE 7. IT IS INTERESTING TO NOTE HERE THE TIMES AT WHICH DRY WEIGHT CHANGES OCCURRED, AS WELL AS THE GENERAL SHAPE OF THE CURVES. IN THE CONTROL SERIES, OPTIMAL AVERAGE CELL DRY WEIGHTS WERE OBTAINED AT A REGION 25-35 MM. FROM THE ROOT APEX, AND THIS WAS ALWAYS CO-INCIDENT WITH THE 36 HOUR GROWTH PERIOD. IN THE VERNALIZED SERIES, APART FROM THE EXCEPTIONAL CASE OF THE RIDEAU FIVE-HOUR-IMBIBED SERIES (R_5), THE PEAK VALUES PER CELL WERE ALSO OBTAINED AFTER 36 HOURS OF GROWTH, BUT THIS REPRESENTED AREAS MORE DISTANT FROM THE APEX. AGAIN, A CLOSE CORRELATION PERTAINED BETWEEN THE DELAYED ONSET OF ELONGATION GROWTH IN THE VERNALIZED SERIES AND THE ACCELERATED ONSET OF INCREASE IN AVERAGE CELL FRESH WEIGHT.

FIGURE 7



Variation in cell dry weight with distance from root apex.

DISCUSSION

In a lecture to the Society of American Naturalists in 1956 (29) Thimann stressed the fact that ultimately, if not directly, most studies on growth and development in plants are based on some very general characteristic, such as increase in cell number, length, fresh or dry weight. Such increments represent an integration of a large series of different reactions throughout the plant. If changes in the environment were to affect all these processes equally, this would be reflected in equal changes in the various parameters of growth, and the plant would be unaltered. As is well known, this is never the case, Changes in the environment have differential effects on a multiplicity of processes which ultimately affect one or more of the facets of growth.

It is an important feature of this series that observations have been made on the effect of chilling on germination, and on the later growth of the root. Evidently, these two growth processes have physiologically different requirements for chilling. It would appear as if a germination inhibitor present in the seed of Rideau wheat were leached out, or hydrated to a non-inhibiting form after 14 hours of imbibition, and that one week exposure to chilling temperature affected the same change in seed of Rideau and Marquis wheat given a lesser imbibition period. That the decrease in inhibitor was very rapid at first but that its disappearance was only complete after 3 weeks of chilling is evident from Table 2.

OBSERVATIONS ALSO COVERED THE EFFECT OF CHILLING ON THE DEVELOPMENT OF THE CELL FROM THE MERISTEMATIC TO THE FULLY VACUOLATED STATE. ANATOMICAL OBSERVATIONS SHOW THAT WITHIN THE FIRST 1.0 MM. THE CELLS ARE ALL MERISTEMATIC EXCEPT FOR ROOT CAP CELLS. ALL SUCCEEDING REGIONS CONTAIN AN EVER INCREASING NUMBER OF VACUOLATED CELLS WHICH DO NOT DIVIDE.

IT HAS GENERALLY BEEN ACCEPTED THAT APICAL MERISTEMS ARE THE SITE OF "PERCEPTION" OF A LOW TEMPERATURE STIMULUS (16,17,35,36). THE RECENT WORK OF WELLENSIEK STRONGLY SUPPORTS THE CONTENTION THAT VERNALIZATION PROCEEDS VIA DIVIDING CELLS ONLY. THIS IS FURTHER SUPPORTED BY THE ORIGINAL EMPIRICAL OBSERVATIONS OF LYSENKO THAT SEED VERNALIZATION TAKES PLACE ONLY IN GRAIN IN WHICH GERMINATION HAS BEEN INITIATED, TO SOME DEGREE, BY PRIOR EXPOSURE TO WATER. SCHWABE'S WORK (27) HAS INDICATED THAT THE VERNALIZATION STIMULUS DOES NOT REMAIN ALWAYS CONCENTRATED IN THE TERMINAL APICES OF THE PLANT.

IT IS AXIOMATIC, OF COURSE, AND AT THE FOUNDATION OF ANY UNDERSTANDING OF VERNALIZATION, THAT THE AFTER-EFFECT OF CHILLING MUST BE TRANSMITTED THROUGH CONTINUING CELL GENERATIONS, AFFECTING MANY ASPECTS OF GROWTH AND DEVELOPMENT AND EVENTUALLY AFFECTING THE TIME OF REPRODUCTIVE MATURITY.

GRIF SHOWED THAT WINTER RYE COULD BE VERNALIZED AT $-4^{\circ}C$ AND PRESENTED CYTOLOGICAL EVIDENCE TO INDICATE THAT ALTHOUGH MITOTIC ACTIVITY WAS STOPPED AT $-2^{\circ}C$, VERNALIZATION PROCEEDED NORMALLY (18). HE FURTHER REPORTED THAT SWOLLEN IMBIBED SEEDS IN WHICH PHASES OF

ACTIVE MITOSIS WERE NOT YET VISIBLE COULD BE VERNALIZED AT TEMPERATURES BELOW 0°C. FROM THIS GRIF CONCLUDED THAT THE OVERALL PROCESS OF VERNALIZATION IS INDEPENDENT OF MITOTIC ACTIVITY BEFORE FREEZING. MORE PRECISE CYTOLOGICAL STUDIES ON PLANTS KEPT AT TEMPERATURES BELOW 0°C IS REQUIRED BEFORE A DEFINITE AND IRREFUTABLE CONCLUSION CAN BE REACHED AS TO WHETHER DIVIDING CELLS HAVE TO BE PRESENT OR NOT FOR THE VERNALIZATION PROCESS TO PROCEED. MY OWN WORK TO DATE HAS ADDED NOTHING TO THIS CONTROVERSY EITHER WAY. FUTURE WORK, IT IS HOPED, WILL CLARIFY THE POSITION WITH RESPECT TO MARQUIS AND RIDEAU WHEATS.

THE STRIKING EFFECT OF VERNALIZATION ON ROOT GROWTH WAS RELATED TO THE PROLONGATION AND STIMULATION OF THE CELL DIVISION PHASE OF GROWTH. THE STIMULATION TO ACCELERATED DIVISION WAS EVIDENCED BY SPECTACULAR INCREASES IN CELL NUMBER AS SEEN IN FIGURE 2. THE EXTENT OF THIS ACTIVITY IS HIGHLIGHTED BY COMPARING CELL COUNTS DERIVED FROM UNTREATED CONTROL WITH THOSE OBTAINED FROM THE ROOTS OF THE OPTIMALLY VERNALIZED WHEATS. IN OPTIMALLY VERNALIZED GRAIN, EVEN THOSE SEGMENTS NORMALLY TYPIFIED AS CONTAINING MATURE CELLS.RETAINED A HIGH CAPACITY FOR CONTINUED CELL DIVISION. THIS WORK CLEARLY INDICATES THAT VERNALIZATION STIMULATED INCREASED CELL DIVISION GROWTH, SO THAT MORE CELLS WERE INVOLVED IN MITOSIS IN ANY GIVEN REGION ALONG THE MEASURED COURSE OF THE ROOT. OVER THE LATER PART OF THE EXPERIMENTAL PERIOD (36-48 HOURS), STIMULATED CELL ELONGATION GROWTH ALSO BECAME EVIDENT. CORRELATED WITH THIS, THERE

WAS AN INCREASE IN AVERAGE CELL DRY WEIGHT IN SEGMENTS 2 AND 3 AND A DECREASE IN SEGMENTS 4 AND 5, INDICATING AN ACCUMULATION OF METABOLITES PRIOR TO THE ONSET OF CELL ELONGATION GROWTH WHEN A UTILIZATION AND DEPLETION OF THIS METABOLIC STORE WAS OBSERVED. A DEPLETION OF DRY WEIGHT IN SEGMENT 1 COULD BE CORRELATED WITH VACUOLATION OF ROOT CAP INITIALS IN THIS SEGMENT.

THE PROGRESSIVE CHANGES IN FRESH WEIGHT MEASUREMENTS COULD AT ALL TIMES BE CORRELATED WITH THE PHASE OF CELL ELONGATION GROWTH. IN THIS WAY THE AVERAGE ROOT CELL FRESH WEIGHTS DERIVED FROM THE CONTROL SERIES ALWAYS SHOWED AN ACCELERATED INCREMENT OVER THE VERNALIZED SERIES. THIS DIFFERENCE COULD BE DIRECTLY CORRELATED, ON THE ONE HAND, WITH THE EARLIER ONSET OF ELONGATION GROWTH IN CELLS OF CONTROL ROOTS, AND ON THE OTHER, WITH THE DELAYED ONSET OF ELONGATION GROWTH DUE TO THE PROLONGATION OF ACTIVE MITOSIS IN ROOT TIP CELLS OF THE VERNALIZED WHEATS.

THE PROGRESSIVE INCREASE IN CELL NUMBER, COUPLED WITH SOME STIMULATION ON THE ELONGATING GROWTH PHASE OF THE NEWLY FORMED CELLS, TOGETHER WITH CONCOMITANT FRESH AND DRY WEIGHT CHANGES, ENABLED THE FULLY VERNALIZED SEED TO PRODUCE ROOTS WHICH GREW MORE QUICKLY. THIS RAPID GROWTH THEN SERVED TO PRODUCE A SEEDLING WITH A BETTER, MORE DEEPLY ENTHENCHED ROOT SYSTEM, AND IN THIS WAY, PROVIDED A MORE RAPID SUPPLY OF NUTRIENTS TO THE DEVELOPING SEEDLING. THE BOOST IN THE SHOOT SYSTEM GROWTH AS DETAILED BY WEINBERGER AND GODIN (32) WAS THEREFORE PRECEEDED BY A MORE RAPID GROWTH IN THE ROOT

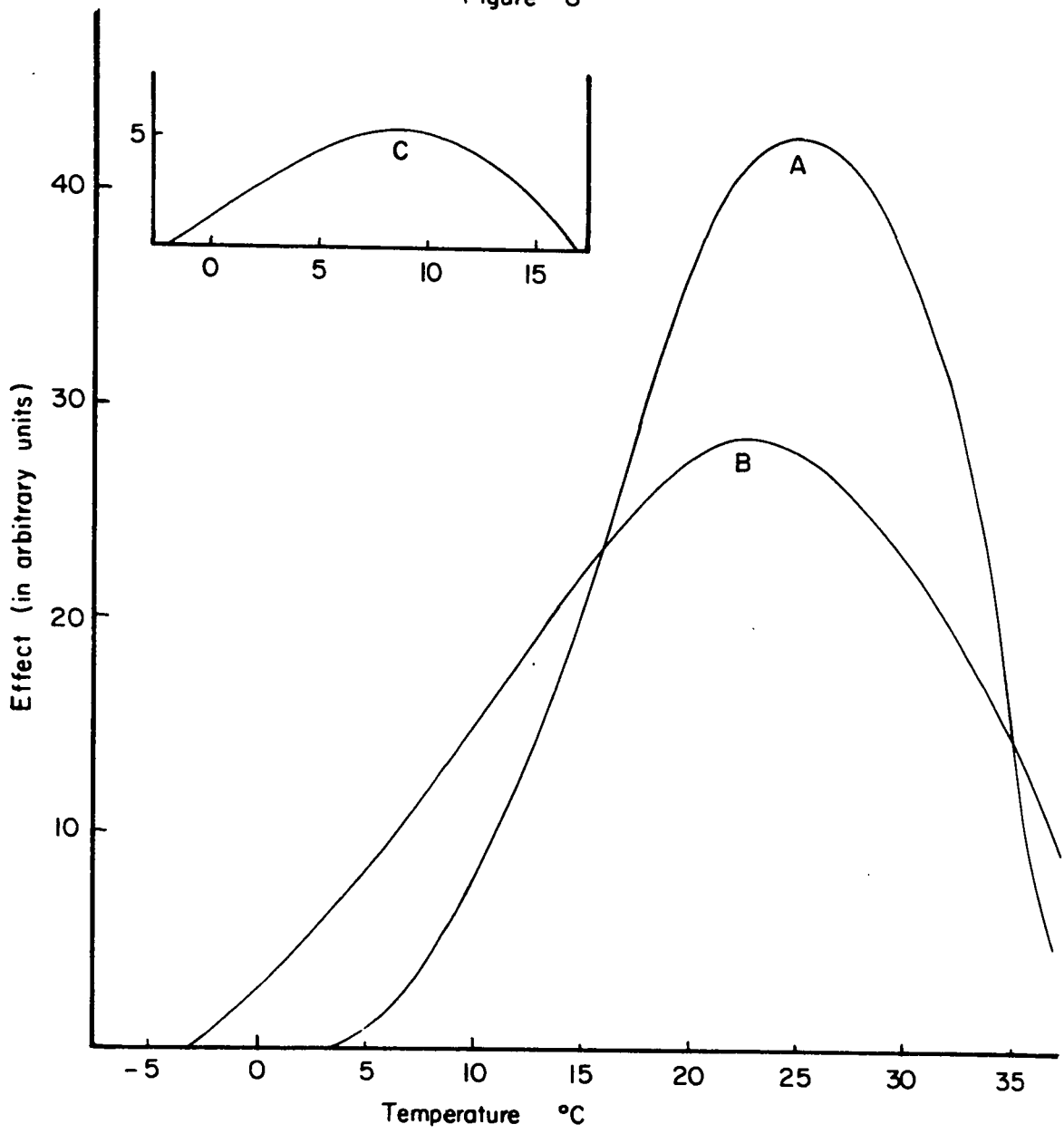
SYSTEM DUE TO THE CONTINUED STIMULATION OF MITOSIS AND ASSOCIATED PARAMETERS OF GROWTH.

LITTLE IS KNOWN OF THE BIOCHEMICAL IMPLICATIONS AND CHANGES WHICH ARE BROUGHT ABOUT BY VERNALIZATION. IT IS IMPLICIT IN THE BIOCHEMICAL TESTS UTILIZED HERE, AND IN THE SUBSEQUENT CHANGES IN THE PATTERN OF GROWTH, THAT VERY FUNDAMENTAL PROCESSES ARE INVOLVED.

MY OWN DATA TEND TO CONFIRM THIS, CLEARLY SHOWING THAT THE EFFECT OF VERNALIZATION IS ALSO TRANSMITTED TO PARTS SOME DISTANCE FROM THE APEX. IT IS EASY TO VISUALIZE TOO, THAT MANY INHERENT CHANGES MIGHT HAVE BEEN EVOKED BY VERNALIZATION, AND THAT SOME OF THESE WOULD ONLY FIND EXPRESSION AT A LATER STAGE OF DEVELOPMENT.

IT IS FAIRLY GENERALLY HELD THAT THE PROCESS OF VERNALIZATION IS DEPENDENT ON THE PRODUCTION OF A SINGLE END PRODUCT SOMETIMES CALLED VERNALIN. HOWEVER, IT WOULD SEEM UNLIKELY THAT THIS CAN DEPEND UPON A SINGLE ENZYME REACTION WITH A TEMPERATURE OPTIMUM AS LOW AS 0° TO 4°C. IT WOULD SEEM MORE PROBABLE THAT THE OPTIMUM IS SO LOW BECAUSE IT IS DETERMINED BY A COMPETITION BETWEEN TWO OR MORE REACTIONS WITH DIFFERENT TEMPERATURE RESPONSES. THE UNUSUALLY LOW OPTIMUM TEMPERATURE AND THE FLAT SHAPE OF THE RESPONSE CURVE IN RYE (12) SUGGEST THAT THE VERNALIZATION RESPONSE IS DUE TO A COMPETITION BETWEEN TWO REACTIONS, WHICH, PERHAPS, REQUIRE THE SAME SUBSTRATE AND WHICH MAY OPPOSE THEIR PRODUCTS; BOTH HAVING MORE NORMAL TEMPERATURE OPTIMA THAN THEIR RESULTANT. FIGURE 8 ILLUSTRATES THE POINT. THE OBSERVED RESPONSES MAY THEN BE DUE TO AN OVERLAP OF THE TWO

Figure 8



A scheme for vernalization. Curve B is the response to temperature of the promoting process; Curve A that of a second, opposing process, perhaps competing for the same substrate; Curve C, the outcome of these two, the actual vernalization response.

PORTIONS OF THE CURVES.

IT MAY BE THAT THE ENZYME (OR ENZYMES) RESPONSIBLE FOR THE VERNALIZATION EFFECT IS ONE WHICH GAINS ACCESS TO THE SUBSTRATE ONLY AT LOW TEMPERATURES BECAUSE ANOTHER REACTION, (OR SERIES OF REACTIONS), COMPETING WITH IT FOR THE SAME SUBSTRATE, IS SLOWED DOWN TO A GREATER EXTENT BY THE LOWERED TEMPERATURE. OR MORE SIMPLY, ONE MIGHT SPECULATE THAT THE COLD TREATMENT LEADS TO THE PRODUCTION OR ACTIVATION OF A NEW ENZYME SYSTEM; THE ACTIVATION OF WHICH IS SWITCHED ON OR OFF AS EITHER THE CELLULAR OR EXTRA-CELLULAR ENVIRONMENT CHANGES. WORK CARRIED OUT BY TOMATI IN JAPAN (30,31), BUT AS YET UNCONFIRMED, SUGGESTS THAT NUCLEOTIDES ARE INVOLVED, PROBABLY URIDYLIC ACID (UMP) OR UMP-LIKE SUBSTANCES. GRZESIUK AND J. KULKA (21) NOTED THAT VERNALIZED GRAIN EMBRYOS DIFFERED CONSIDERABLY FROM THE EMBRYOS OF UNVERNALIZED GRAIN IN THE QUANTITY OF ASPARTIC ACID AND GLUTAMIC ACIDS. THIS DIFFERENCE WAS NOT VISIBLE IN THE ENDOSPERM. IN THE EMBRYOS OF VERNALIZED GRAIN, GLUTAMIC ACID WAS THE CENTRAL LINK IN NITROGEN METABOLISM WHILST IN THE EMBRYOS OF UNVERNALIZED GRAIN IT WAS ASPARTIC ACID AND TO A LESS DEGREE GLUTAMIC ACID. VERNALIZED EMBRYOS CONTAINED A CONSIDERABLE AMOUNT OF LYSINE AND A SMALL QUANTITY OR ARGININE WHICH DIMINISHED IN THE COURSE OF VERNALIZATION. CONVERSELY, IN UNVERNALIZED EMBRYOS THE QUANTITY OF ARGININE WAS CONSIDERABLE, AND ITS CONCENTRATION INCREASED IN THE COURSE OF GERMINATION, WHILE THE LYSINE CONTENT REMAINED LOW. THE CHANGE

IN THE AMINO ACID METABOLISM OF THE EMBRYOS OCCURRING DURING THE COURSE OF VERNALIZATION UNDOUBTEDLY REFLECTS THE CHANGES IN THE MORE FUNDAMENTAL METABOLIC PROCESSES WHICH INFLUENCE THE FURTHER PROCESSES OF PLANT ONTOGENESIS.

THE LONG LASTING AND ALL-PERVASIVE AFTER EFFECTS OF VERNALIZATION SEEM TO BE ANALOGOUS IN MANY WAYS TO THE PERMANENT CHANGES OBSERVED IN BACTERIA-FREE TISSUE OF CROWN GALL TUMORS. IN THIS CONTEXT HIGHKIN (22) HAS POINTED OUT THAT SUCH CHANGES ARE LONG LASTING AND THE CHANGES IN METABOLISM ARE PASSED ON THROUGH SUBSEQUENT CELL GENERATIONS.

PRESENTLY, THE FUNDAMENTAL CHANGES IN THE MOLECULAR ENVIRONMENT OF VERNALIZED CELLS IS BUT LITTLE UNDERSTOOD. THIS FIRST PHASE OF MY OWN WORK HAS BEEN UNDERTAKEN ON MAINLY PHYSIOLOGICAL MEASURES OF CHANGE IN CEREAL ROOT TIPS. THE ORIGINAL QUESTION HAS BEEN ANSWERED IN THE AFFIRMATIVE RELATING EFFECTIVE COLD TREATMENT WITH INCREASED ROOT GROWTH VIGOR. IT IS HOPED TO PURSUE SOME PARAMETERS OF BIOCHEMICAL CHANGE IN THE CONTINUING PHASE OF RESEARCH.

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List of Tables in Appendix

* Data pertaining to growth periods 20, 24-34, 38-46, obtained, but ommited from text, solely for convenience of assembly of data in present typeset.

TABLE A_1

Marquis wheat (M_5)

Number of cells X 10^{-2} obtained in each root segment after 2 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	11.611	10.944	10.889	9.778	4.556
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	14.778	10.667	9.500	9.167	6.500
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	15.556	14.441	10.278	9.167	7.167
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	8.611	7.389	7.167	6.722	6.167
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	8.833	6.333	6.311	5.389	5.000
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.000	3.444	2.556	1.722	1.389
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.556	4.056	2.944	1.800	1.556

TABLE 4_2

Marquis wheat (M_5)

Number of cells X 10^{-2} in each root segment after 4 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	5.167	5.067	4.389	4.333	2.389
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	11.722	10.722	8.778	7.444	3.444
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	12.556	10.833	8.711	6.389	5.222
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	10.889	9.111	8.778	6.778	4.222
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	8.778	6.722	6.222	5.833	5.444
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	6.944	4.444	3.833	2.422	1.278
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.588	4.078	3.111	2.111	1.667

TABLE A3

Marquis wheat (M_5)

Number of cells X 10^{-2} obtained in each root segment after 6 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	5.177	5.111	4.722	4.278	3.27
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	14.722	10.977	10.278	8.167	7.44
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	22.566	14.389	11.667	11.667	9.22
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	10.889	9.500	8.333	7.611	5.06
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	8.778	7.056	6.667	6.278	4.44
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	6.944	5.556	4.550	4.389	2.28
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.611	4.333	3.944	2.500	1.667

TABLE A_4

Marquis wheat (M_5)

Number of cells X 10^{-2} obtained in each root segment after 8 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	7.111	6.211	5.500	5.278	4.222
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	17.222	13.333	12.111	10.500	8.889
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	23.778	16.500	13.333	13.111	10.444
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	11.222	9.889	9.500	8.500	5.778
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	9.000	7.778	7.000	6.889	4.889
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	7.111	5.778	4.789	4.789	2.333
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.889	4.444	4.000	2.778	1.789

TABLE A_5

Marquis wheat (M_5)

Number of cells X 10^{-2} in each root segment after 10 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	9.000	7.789	6.611	6.278	5.000
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	20.111	16.111	14.000	12.000	9.778
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	25.889	18.778	15.500	15.222	12.500
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	11.778	10.000	9.889	8.500	6.111
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	9.789	8.111	7.678	7.111	5.000
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	7.500	6.333	5.222	5.111	2.500
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	5.111	4.789	4.222	3.000	1.900

TABLE A_6

Marquis wheat (M_5)

Number of cells X 10^{-2} obtained in each root segment after 12 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	10.278	9.222	7.778	7.222	6.111
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	22.500	18.889	15.889	13.500	10.000
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	24.111	19.556	17.111	16.000	13.778
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	12.000	10.500	10.222	9.111	7.000
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	10.111	8.889	8.000	7.800	5.678
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	7.778	6.667	5.500	5.444	2.789
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	5.333	5.000	4.500	3.667	2.100

TABLE A$_7$

Marquis wheat (M_5)

Number of cells X 10^{-2} obtained in each root segment after 14 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	11.778	10.500	8.533	8.444	6.889
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	24.667	20.500	17.500	14.889	10.889
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	21.444	19.111	19.000	18.778	13.500
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	13.111	11.889	11.500	10.500	8.222
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	9.778	8.500	8.222	7.789	5.111
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	7.200	6.111	5.700	5.111	2.678
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.889	4.678	4.444	3.722	1.889

TABLE A_8

Marquis wheat (M_5)

Number of cells X 10^{-2} obtained in each root segment after 16 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	13.500	12.111	9.889	9.889	7.222
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	25.778	22.444	18.778	15.778	12.000
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	19.111	19.000	18.111	16.222	13.333
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	12.444	11.500	10.889	10.000	8.000
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	9.000	8.222	8.111	7.789	4.789
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	6.789	6.000	5.700	5.000	2.500
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.500	4.444	4.222	3.500	1.711

TABLE A_9

Marquis wheat (M_5)

Number of cells X 10^{-2} in each root segment after 18 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	15.333	13.778	12.278	11.278	8.222
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	26.056	24.333	19.889	16.444	13.222
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	17.50	16.889	16.278	14.167	12.111
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	11.611	11.056	10.389	9.187	7.889
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	8.278	8.167	8.056	7.722	4.556
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	6.278	5.944	5.667	4.889	2.389
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.111	4.111	4.111	3.722	1.58

TABLE A10

Marquis wheat (M_5)

Number of cells X 10^{-2} obtained in each root segment after 22 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	20.056	18.722	18.556	16.444	10.944
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	28.722	27.722	22.889	19.111	15.167
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	15.167	14.722	14.667	14.111	11.111
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	9.611	9.500	8.833	7.556	6.611
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	7.222	6.889	6.722	6.500	3.722
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.722	3.833	3.611	2.944	1.722
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	3.889	3.278	2.889	2.389	1.333

TABLE A_{11}

Marquis wheat (M_5)

Number of cells X 10^{-2} obtained in each root segment after 36 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	35.500	34.333	33.500	31.222	22.111
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	48.500	46.444	46.000	44.789	28.889
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	9.889	9.111	8.789	8.500	7.778
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	9.444	9.111	8.889	8.887	6.500
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	7.111	6.789	6.500	6.222	3.800
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.222	3.500	3.111	2.500	1.711
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.111	3.400	2.789	2.444	1.111

TABLE A_{12}

Marquis wheat (M_5)

Number of cells X 10^{-2} obtained in each root segment after 48 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)				
1.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	48.444	44.789	43.667	40.500	31.111
2.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	29.111	28.444	27.789	26.789	14.500
3.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	9.789	9.000	8.789	8.444	7.778
4.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	9.500	9.222	8.789	8.667	6.444
5.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	7.000	6.667	6.444	6.111	3.444
6.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.111	3.444	3.222	2.444	1.789
7.	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5K
	4.111	3.335	2.667	2.444	1.222

TABLE B_1

Rideau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 2 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	9.167	8.733	7.333	3.167	2.777	2.711	2.222
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	14.778	14.389	12.833	6.222	5.889	5.772	5.222
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	15.111	14.556	13.167	6.889	6.500	6.056	5.556
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.744	8.778	6.833	3.389	3.311	3.111	2.989
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	6.722	6.333	6.000	4.176	4.222	4.000	3.056
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	5.056	4.667	4.556	1.778	1.278	1.111	1.111
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	4.778	4.222	3.556	1.611	1.444	1.222	1.111

TABLE B_2

Ridaau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 4 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	11.611	10.778	8.056	4.778	4.000	3.833	3.778
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	15.833	14.278	11.833	6.722	5.333	4.000	4.000
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	16.500	14.611	13.889	8.833	6.889	6.833	6.611
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.771	7.222	6.214	4.844	4.333	4.211	3.722
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.889	8.778	7.711	4.833	4.278	4.211	3.333
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	7.338	6.667	6.556	2.667	2.556	2.389	2.111
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	5.111	5.000	4.278	2.222	1.789	1.111	1.100

TABLE B_3

Rideau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 6 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	12.611	12.556	11.664	7.111	5.111	5.000	4.778
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	16.722	16.111	16.000	14.389	14.222	13.889	13.167
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	21.222	20.333	20.000	14.778	14.056	13.833	13.611
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.944	8.444	8.267	8.222	8.200	8.111	8.111
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.444	8.167	7.444	5.833	5.222	5.000	4.778
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	7.399	7.667	6.778	3.667	3.333	3.056	2.389
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	5.500	5.444	5.167	2.833	2.222	1.611	1.278

TABLE B_4

Rideau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 8 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.000	7.789	7.500	7.111	7.000	6.889	6.500
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	17.222	17.111	16.789	14.500	14.444	14.111	14.000
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	22.789	21.500	21.111	15.500	15.111	14.789	14.111
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	9.111	8.789	8.500	8.500	8.444	8.222	8.000
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	$R5C_2$	R_5C_1
	9.000	8.789	8.111	6.111	6.000	5.789	5.111
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	7.778	7.667	7.222	3.789	3.667	3.222	3.000
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	5.700	5.444	5.111	3.000	2.789	2.222	1.789

TABLE B_5

Rideau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 10 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.111	8.000	7.778	7.333	7.111	6.789	6.444
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	17.789	17.111	16.789	14.789	14.444	14.000	13.500
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	23.567	22.789	22.500	17.000	16.500	16.111	16.000
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.789	9.500	9.444	8.889	8.500	8.111	7.500
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	9.500	9.111	8.789	6.789	6.500	6.000	5.444
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	7.789	7.789	7.333	4.111	4.000	3.789	3.500
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	6.000	5.789	5.222	3.222	3.000	2.500	2.222

TABLE B_6

Rideau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 12 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	9.789	9.444	9.111	7.444	7.222	7.000	6.889
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	18.500	18.000	17.789	15.000	14.789	14.500	14.111
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	25.111	24.789	23.500	16.111	16.000	15.789	15.500
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	10.500	10.111	10.000	8.111	7.789	7.222	7.000
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	10.000	9.789	9.500	7.500	7.111	6.789	6.222
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	7.111	7.000	6.667	4.333	4.111	3.789	3.222
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	6.111	6.000	5.889	3.500	3.111	3.000	2.500

TABLE B_7

Rideau Wheat (R_5)

Number of cells X 10^{-2} in each root segment after 14 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	11.222	11.000	10.789	7.444	7.111	6.111	7.000
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	19.111	18.500	18.000	15.500	14.500	14.222	13.789
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	22.789	21.789	21.000	15.444	15.000	14.678	14.333
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	9.789	9.500	9.111	7.500	7.111	7.000	6.789
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.789	8.500	8.111	6.111	6.000	5.500	5.222
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	6.789	6.667	6.444	4.000	3.789	3.500	3.222
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	5.500	5.000	4.889	3.111	2.789	2.500	2.222

TABLE B_8

Rideau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 16 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	12.778	12.500	12.111	7.500	7.444	7.333	7.222
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	18.789	14.000	18.222	14.789	14.111	14.000	13.500
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	18.444	17.789	17.500	14.500	14.111	14.000	13.789
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	9.000	8.789	8.500	7.500	7.111	7.000	6.789
5.	R_5C_4	R5C5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.111	8.000	7.500	5.667	5.222	4.778	4.222
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	6.222	6.111	5.789	3.500	3.222	3.000	2.789
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	5.222	5.000	4.789	2.789	2.500	2.222	1.789

TABLE B_9

Rideau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 18 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	16.111	14.996	14.778	7.333	6.889	6.778	4.844
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	20.859	19.667	19.333	14.333	13.789	13.500	13.441
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	15.444	15.222	15.117	13.778	13.111	12.889	12.722
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.556	8.444	8.296	7.333	7.111	6.778	6.444
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	7.444	7.333	6.556	4.333	4.200	3.889	3.771
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	5.944	5.278	5.222	5.056	3.000	2.889	3.771
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	4.111	4.000	3.667	2.222	2.000	1.889	1.778

TABLE B_{10}

Rideau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 22 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	18.833	17.000	15.667	11.000	9.889	8.778	8.111
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	24.444	23.944	23.333	14.809	14.833	12.607	12.000
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	15.111	14.944	14.611	10.111	10.000	9.944	9.611
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.333	8.267	8.111	7.222	6.833	6.056	5.667
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	7.111	7.000	6.944	4.356	4.311	3.889	3.722
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	4.222	4.111	3.889	3.000	2.889	2.711	2.667
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	3.778	3.611	3.444	2.111	2.000	1.889	1.778

TABLE B_{11}

Rideau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 36 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	32.111	31.500	31.000	20.111	19.789	19.222	18.500
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	44.444	42.222	41.789	24.111	23.789	22.500	21.000
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.222	8.000	7.778	6.500	6.222	6.000	5.789
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.111	8.111	8.000	5.789	5.222	5.000	4.789
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	6.789	6.500	6.222	3.111	2.789	2.500	2.444
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	3.789	3.500	3.111	2.111	2.000	1.789	1.500
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	3.500	3.111	3.000	1.789	1.500	1.444	1.111

TABLE B_{12}

Rideau wheat (R_5)

Number of cells X 10^{-2} in each root segment after 48 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	44.500	43.500	42.789	28.789	28.111	27.789	26.500
2.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	26.111	25.500	24.789	11.333	10.789	10.222	10.000
3.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	8.111	7.789	7.500	6.500	6.111	5.789	5.500
4.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	7.789	7.500	7.111	5.500	5.222	4.789	4.500
5.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	6.500	6.111	6.000	3.111	3.000	2.789	2.500
6.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	3.500	3.222	3.000	2.000	1.789	1.789	1.500
7.	R_5C_4	R_5C_5	R_5C_6	R_5K	R_5C_3	R_5C_2	R_5C_1
	3.111	3.000	2.789	1.500	1.444	1.222	1.111

TABLE C_1

Rideau Wheat (R14)

Number of cells $X10^{-2}$ in each root segment after 2 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	4.444	4.333	2.889	2.833	2.778	2.222	2.111
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	11.667	10.556	10.111	7.667	7.556	7.222	6.667
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	15.333	13.333	8.278	8.222	8.000	7.333	7.111
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	10.111	9.778	3.500	3.387	3.111	3.000	2.889
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	6.889	6.833	5.111	5.000	4.889	4.444	4.111
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	5.222	5.000	2.333	2.111	1.789	1.667	1.444
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.333	3.211	1.944	1.611	1.556	1.500	1.444

TABLE C_3

Rideau Wheat (R_{14})

Number of cells $\times 10^{-2}$ in each root segment after 4 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	7.833	6.056	4.722	4.111	3.831	3.722	2.056
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	11.778	11.722	7.722	6.722	6.611	5.778	5.722
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	15.889	14.611	9.556	8.889	8.111	7.789	7.222
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	10.556	10.056	4.667	4.222	3.789	3.222	3.000
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	7.611	7.111	5.789	5.222	4.889	4.111	4.056
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	5.289	5.222	2.222	2.000	1.889	1.444	1.222
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.889	3.444	2.222	2.000	1.611	1.389	1.111

TABLE C_5

Riddau wheat (R_{14})

Number of cells X 10^{-2} in each root segment after 6 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	7.833	6.778	4.833	4.778	4.056	3.556	3.333
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	13.000	12.889	12.611	12.611	11.333	10.333	9.833
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	23.333	21.944	12.500	11.944	11.850	10.889	10.167
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	11.389	10.889	6.944	6.389	5.778	5.056	5.000
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	8.722	8.222	4.611	4.444	4.222	4.111	3.889
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	5.444	5.111	2.389	2.889	2.222	2.000	1.889
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.556	3.056	1.389	1.222	1.111	1.000	1.000

TABLE C4

Rideau Wheat (R_{14})

Number of cells X 10^{-2} in each root segment after 8 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	8.222	8.000	5.222	5.000	4.789	4.500	4.222
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	15.111	14.789	13.222	13.000	12.789	12.500	12.222
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	24.111	23.222	13.000	12.789	12.500	12.444	12.111
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	12.000	11.789	7.111	7.000	6.889	6.500	6.111
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	9.000	8.889	4.889	4.500	4.222	4.000	3.789
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	5.789	5.500	2.500	2.222	2.000	1.789	1.660
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.789	3.504	2.444	2.222	2.111	1.789	1.500

TABLE C

Rideau Wheat (R_{14})

Number of cells X 10^{-2} in each root segment after 10 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	8.889	8.500	5.889	5.500	5.222	4.789	4.667
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	17.500	17.222	13.789	13.500	13.000	12.889	12.111
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	24.500	23.789	13.500	13.111	12.789	12.789	12.500
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	12.789	12.000	7.789	7.500	7.222	6.889	6.111
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	9.222	9.111	5.111	5.000	4.789	4.500	4.222
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	6.111	5.789	2.789	2.600	2.222	2.111	1.789
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.900	3.500	2.111	2.000	2.000	2.000	1.789

TABLE C_6

Rideau Wheat (R_{14}) -

Number of cells $\times 10^{-2}$ in each root segment after 12 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	9.500	9.111	6.000	5.789	5.500	5.222	5.111
2.	$R_{14}C_5$	$R_{14}C_6$	R14K	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	19.556	19.111	14.500	14.000	13.789	13.111	12.789
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	25.500	25.111	14.111	14.000	13.500	13.111	12.789
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	13.500	13.111	8.111	7.789	7.500	7.200	7.000
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	9.778	9.500	4.667	4.500	4.444	4.111	3.789
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	6.222	5.789	3.000	2.789	2.500	2.222	2.000
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	4.111	4.000	2.000	1.789	1.667	1.500	1.500

TABLE C_7

Rideau Wheat (R_{14}) -

Number of cells X 10^{-2} in each root segment after 14 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	10.778	10.111	6.500	6.222	5.789	5.500	5.222
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	21.222	20.789	14.789	14.000	14.000	13.500	13.111
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	21.678	21.111	13.667	13.500	13.111	12.789	12.111
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	11.111	11.000	8.444	8.111	7.789	7.500	7.222
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	9.500	9.222	4.500	4.111	3.789	3.500	3.111
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	5.600	5.222	2.667	2.444	2.111	1.789	1.500
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.789	3.600	1.789	1.789	1.500	1.500	1.111

TABLE C_8

Rideau Wheat (R_{14})

Number of cells X 10^{-2} in each root segment after 16 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	12.000	11.667	6.789	6.500	6.222	5.789	5.500
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	23.111	21.789	14.222	14.111	14.000	13.789	13.500
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	18.111	17.789	13.111	12.500	12.222	12.000	11.789
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	10.222	9.389	8.000	7.839	7.222	7.000	6.789
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	8.667	8.500	4.500	4.222	4.000	3.789	3.222
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	5.444	5.111	2.500	2.222	2.111	1.500	1.111
7	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.667	3.556	1.789	1.600	1.500	1.500	1.222

TABLE C_9

Rideau wheat (R_{14})

Number of cells X 10^{-2} in each root segment after 18 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	13.333	12.111	7.222	7.000	6.889	6.167	6.111
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	26.000	22.444	13.389	13.222	12.789	11.889	11.222
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	16.609	15.500	12.500	12.409	11.500	10.500	10.222
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	9.000	8.889	7.500	7.222	6.500	6.000	5.889
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	7.722	7.222	4.444	4.222	3.389	3.722	3.500
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	5.228	5.000	2.500	2.448	2.222	2.000	1.889
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.444	3.000	2.000	1.889	1.722	1.722	1.500

TABLE C_{20}

Rideau wheat (R_{14})

Number of cells X 10^{-2} in each root segment after 22 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	16.833	15.500	10.889	9.500	9.222	8.889	8.550
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	22.444	21.278	14.222	14.000	13.889	13.222	13.000
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	15.000	14.689	10.111	9.889	9.444	9.111	8.789
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	8.111	8.000	6.500	6.222	5.500	5.222	5.111
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	7.000	6.889	3.889	3.500	3.111	3.000	2.889
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	4.278	3.667	2.222	2.000	1.889	1.711	1.500
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.222	3.000	2.000	1.889	1.722	1.722	1.500

TABLE C_{11}

Rideau wheat (R_{14})

Number of cells $\times 10^{-2}$ in each root segment after 36 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	31.111	30.889	19.111	19.000	18.789	18.500	18.000
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	42.444	41.000	22.111	21.789	21.500	21.000	20.500
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	7.789	7.500	6.222	6.000	5.789	5.500	5.111
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	7.789	7.500	5.000	4.789	4.222	4.000	3.789
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	6.667	6.222	3.000	2.789	2.500	2.444	2.444
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.667	3.444	2.000	2.000	1.789	1.667	1.500
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.444	3.000	1.789	1.500	1.444	1.222	1.222

TABLE C_{12}

Rideau wheat (R_{14})

Number of cells X 10^{-2} in each root segment after 48 hours growth with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Segment	Vernalization (weeks)						
1.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	42.222	42.000	26.500	26.000	25.789	25.000	24.444
2.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	25.111	25.000	11.000	10.500	10.000	9.889	9.667
3.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	7.111	7.000	6.000	5.789	5.500	5.444	5.111
4.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	7.111	7.000	5.111	5.000	4.789	4.667	4.444
5.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	6.400	6.111	3.000	2.789	2.667	2.500	2.222
6.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.111	3.000	2.000	1.789	1.789	1.667	1.500
7.	$R_{14}C_5$	$R_{14}C_6$	$R_{14}K$	$R_{14}C_4$	$R_{14}C_3$	$R_{14}C_2$	$R_{14}C_1$
	3.000	2.789	1.778	1.667	1.500	1.222	1.222

TABLE D_1

Marquis wheat (M_5)

Increment in length in mms X10^{-3} of segment 1 with time, imbibition and vernalization.

Duncan's test (5% level)

Experimental period (hours)	Vernalization (weeks)							
2	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	1.15	0.81	0.68	0.67	0.55	0.51	0.49	0.36
4	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	0.87	0.70	0.60	0.53	0.50	0.48	0.43	0.36
6	M_5C_1	M_5C_3	M_5C_4	M_5C_2	M_5C_5	M_5C_6	M_5C_7	M_5K
	0.57	0.50	0.50	0.48	0.43	0.41	0.37	0.35
8	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	6.1	6.0	5.7	5.4	5.0	4.6	4.3	4.0
10	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	6.1	6.0	5.9	5.3	5.1	5.0	4.7	4.1
12	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	6.5	6.4	6.1	5.7	5.5	5.3	5.1	4.1
14	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	7.0	7.0	6.7	6.5	6.3	6.1	6.1	5.7
16	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	8.1	8.0	7.5	7.3	7.1	7.0	6.3	5.4
18	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	9.3	9.0	8.7	8.5	8.2	8.0	7.7	5.8
20	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5C_8
	10.0	10.0	9.9	9.5	9.1	8.7	8.1	6.1
22	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	11.1	11.0	10.9	10.5	10.0	9.7	9.7	7.2
24	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	12.3	12.1	11.9	11.9	10.5	10.0	9.5	6.0
36	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	24.40	24.10	23.8	23.5	21.1	20.9	20.5	15.0
48	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	89.7	87.1	86.6	86.0	86.0	85.4	85.1	55.0

TABLE 12

Marquis Wheat (M_5)

Increment in length in mms X 10^{-3} of segment 2 with time, imbibition and vernalization.

Duncan's test (5% level)

Experimental period (hours)	Time (hours)							
2	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	1.15	0.97	8.66	7.66	6.33	6.22	6.22	6.11
4	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	13.1	1.20	1.11	9.77	8.00	7.73	6.88	5.33
6	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	8.9	8.8	8.7	8.0	7.5	7.2	6.8	6.1
8	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	45.3	45.1	44.8	44.5	44.0	42.0	41.1	31.1
10	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	52.0	51.8	51.1	50.9	50.0	49.9	49.5	37.7
12	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	66.0	65.1	64.8	64.2	63.9	63.4	63.0	51.1
14	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	80.0	78.8	78.1	77.2	76.1	75.0	74.1	62.2
16	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	155.5	154.0	152.1	151.1	150.0	149.5	148.9	120.0
18	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	178.1	177.8	176.7	175.6	173.3	172.1	170.0	150.0
20	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	190.0	188.9	188.1	187.0	186.7	184.1	183.3	158.9
22	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	210.0	207.8	205.6	204.4	200.2	199.9	197.6	177.8
24	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	230.0	228.9	225.6	220.0	213.9	215.5	210.0	183.3
36	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	231.1	229.6	228.7	225.0	224.5	224.4	223.3	170.0
48	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	180.0	179.8	179.0	178.4	177.9	177.2	177.0	130.0

TABLE B_3

Marquis Wheat (M_5)

Increment in length in mms X 10^{-3} of segment 3 with time, imbibition and vernalization.

Duncan's test (5% level)

Experimental period (hours)	Vernalization (weeks)							
2	M_5C_1 15.0	M_5C_2 14.5	M_5C_3 10.9	M_5C_4 9.22	M_5C_5 9.22	M_5C_6 8.00	M_5C_7 8.00	M_5K 6.89
4	M_5C_1 1.92	M_5C_2 1.60	M_5C_3 14.0	M_5C_4 9.66	M_5C_5 8.66	M_5C_6 8.00	M_5C_7 7.77	M_5K 7.44
6	M_5C_1 49.8	M_5C_2 37.0	M_5C_3 27.0	M_5C_4 24.3	M_5C_5 22.6	M_5C_6 19.2	M_5C_7 17.2	M_5K 11.3
8	M_5C_1 83.9	M_5C_2 83.1	M_5C_3 82.7	M_5C_4 82.0	M_5C_5 81.1	M_5C_6 80.0	M_5C_7 79.1	M_5K 59.8
10	M_5C_1 80.0	M_5C_2 79.5	M_5C_3 79.1	M_5C_4 78.8	M_5C_5 78.2	M_5C_6 77.8	M_5C_7 77.1	M_5K 52.4
12	M_5C_1 71.1	M_5C_2 71.1	M_5C_3 70.5	M_5C_4 70.1	M_5C_5 69.2	M_5C_6 68.8	M_5C_7 68.2	M_5K 48.8
14	M_5C_1 64.1	M_5C_2 63.1	M_5C_3 63.0	M_5C_4 62.5	M_5C_5 62.2	M_5C_6 61.1	M_5C_7 60.3	M_5K 48.8
16	M_5C_1 69.5	M_5C_2 67.0	M_5C_3 68.7	M_5C_4 68.2	M_5C_5 67.7	M_5C_6 67.0	M_5C_7 66.6	M_5K 51.1
18	M_5C_1 52.0	M_5C_2 51.1	M_5C_3 50.2	M_5C_4 49.9	M_5C_5 49.1	M_5C_6 47.8	M_5C_7 47.1	M_5K 38.1
20	M_5C_1 41.0	M_5C_2 40.0	M_5C_3 39.6	M_5C_4 39.0	M_5C_5 38.9	M_5C_6 37.8	M_5C_7 37.1	M_5K 30.0
22	M_5C_1 24.0	M_5C_2 23.3	M_5C_3 22.7	M_5C_4 22.1	M_5C_5 21.1	M_5C_6 21.1	M_5C_7 20.2	M_5K 18.1
24	M_5C_1 15.1	M_5C_2 14.0	M_5C_3 13.1	M_5C_4 12.4	M_5C_5 11.1	M_5C_6 11.1	M_5C_7 10.7	M_5K 11.80

* 26-48 Data obtained for all period to 48 hours when level indicated no change was observed from last noted period. **Specific data not included.**

TABLE D_4

MARQUIS WHEAT (M_5)

Increase in length of segment 4, in mms. X 10^3 with time, imbibition and vernalization. Duncan's test (5% level).

Time Hours	Vernalization (weeks)							
2	M_5C_1 28.4	M_5C_2 22.3	M_5C_3 16.4	M_5C_5 15.7	M_5C_4 15.0	M_5C_6 12.6	M_5C_7 12.1	M_5K 9.1
4	M_5C_1 41.2	M_5C_2 40.8	M_5C_3 37.1	M_5C_5 31.8	M_5C_4 30.7	M_5C_6 29.3	M_5C_7 28.6	M_5K 27.3
6	M_5C_1 106.6	M_5C_2 99.8	M_5C_3 89.8	M_5C_5 83.9	M_5C_4 80.6	M_5C_6 79.3	M_5C_7 70.6	M_5K 45.3
8	M_5C_1 107.0	M_5C_2 100.0	M_5C_3 99.1	M_5C_5 99.0	M_5C_4 98.2	M_5C_6 97.7	M_5C_7 96.0	M_5K 71.1
10	M_5C_1 85.5	M_5C_2 85.1	M_5C_3 84.5	M_5C_5 84.1	M_5C_4 83.5	M_5C_6 83.0	M_5C_7 82.2	M_5K 71.5
12	M_5C_1 72.2	M_5C_2 71.5	M_5C_3 70.9	M_5C_5 70.4	M_5C_4 69.9	M_5C_6 69.2	M_5C_7 68.4	M_5K 42.2
14	M_5C_1 41.1	M_5C_2 40.0	M_5C_3 38.9	M_5C_5 38.0	M_5C_4 37.7	M_5C_6 36.9	M_5C_7 36.5	M_5K 30.0
16	M_5C_1 22.1	M_5C_2 21.1	M_5C_3 20.2	M_5C_5 19.9	M_5C_4 19.2	M_5C_6 19.0	M_5C_7 18.9	M_5K 10.0
18	M_5C_1 14.4	M_5C_2 13.5	M_5C_3 13.1	M_5C_5 12.2	M_5C_4 11.7	M_5C_6 10.8	M_5C_7 10.4	M_5K 7.8

* 20-40 Data obtained for all period to 48 hours when level indicated no change was observed from last noted period.

TABLE D_5

Marquis wheat: Increment in length in mms X10^{-3} of segment 5 with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Time Hours	Vernalization (weeks)							
2	M_5C_1	M_5C_2	M_5C_4	M_5C_3	M_5C_5	M_5C_6	M_5C_7	M_5K
	3.69	3.60	3.60	3.13	2.82	2.77	2.74	2.62
4	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	9.32	9.23	8.02	7.18	6.40	6.01	5.42	5.22
6	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	7.10	7.00	6.82	6.36	6.05	5.86	5.77	4.36
8	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	9.50	9.40	8.50	8.70	8.10	7.70	7.10	5.20
10	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	5.3	5.2	5.0	4.8	4.3	4.0	3.9	3.5
12	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	4.7	4.3	4.0	3.7	3.1	2.8	2.8	2.4
14	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	4.2	4.1	3.9	3.3	3.2	3.2	3.1	2.7
16	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	4.1	4.0	3.9	3.5	3.4	2.8	2.7	2.5

* 18-40 Data obtained for all period to 48 hours when level indicated no change was observed from last noted period. Specific data not included.

TABLE D_6

Marquis wheat: Increment in length in mms $X10^3$ of segment 6 with time, imbibition, vernalization and seed variety.

Duncan's test (5% level)

Time Hours	Vernalization (weeks)							
2	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_6	M_5C_5	M_5C_7	M_5K
	4.53	3.59	3.54	3.37	3.36	3.20	3.04	1.93
4	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_7	M_5C_6	M_5K
	4.71	4.69	4.59	4.16	3.59	3.04	2.95	2.84
6	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	2.21	1.96	1.95	1.68	1.61	1.20	1.07	0.95
8	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	7.3	7.1	6.8	6.5	6.1	5.5	5.0	4.8
10	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	4.1	4.0	3.9	3.8	3.8	3.6	3.2	3.0
12	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	2.3	2.3	2.1	1.5	1.5	1.5	1.5	0.9

* 14-48 Data obtained for all period to 48 hours when level indicated no change was observed from last noted period. **Specific data not included.**

TABLE D_7

Marquis wheat: Increment in mms $X10^{-3}$ in length of segment 7 with time, imbibition, vernalization and seed variety.

Time Hours	Vernalization (weeks)							
2	M_5C_1	M_5C_2	M_5C_4	M_5C_3	M_5C_6	M_5C_5	M_5C_7	M_5K
	2.89	2.87	2.79	2.64	2.40	2.31	2.17	1.38
4	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5K	M_5C_6	M_5C_7
	1.74	1.69	1.54	1.50	1.20	1.19	1.06	0.97
6	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	2.50	1.80	1.80	1.60	1.60	1.40	1.10	1.00
8	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	5.30	5.10	4.70	4.30	4.20	4.10	4.10	3.80
10	M_5C_1	M_5C_2	M_5C_3	M_5C_4	M_5C_5	M_5C_6	M_5C_7	M_5K
	2.2	2.2	2.1	1.9	1.7	1.4	1.4	1.4

* 12-48 Data obtained for all period to 48 hours when level indicated no change was observed from last noted period. Specific data not included.

TABLE E_1

Rideau wheat (R_5): Increment in length in mms. X10^3 with time, imbibition, and vernalization

Duncan's test (5% level)

Time Hours	Vernalization (weeks)							
2	R_5C_4 0.91	R_5C_5 0.89	R_5C_7 0.81	R_5C_6 0.52	R_5K 0.45	R_5C_3 0.37	R_5C 0.38	R_5C_1 0.27
4	R_5C_4 0.79	R_5C_5 0.69	R_5C_6 0.63	R_5C_7 0.58	R_5C_3 0.50	R_5K 0.43	R_5C_2 0.36	R_5C_1 0.31
6	R_5C_4 0.67	R_5C_5 0.65	R_5C_6 0.64	R_5K 0.44	R_5C_7 0.42	R_5C_3 0.35	R_5C_2 0.36	R_5C_1 0.30
8	R_5C_4 6.1	R_5C_5 6.2	R_5C_6 6.2	R_5C_7 6.0	R_5K 4.8	R_5C_3 4.5	R_5C_2 0.32	R_5C_1 4.0
10	R_5C_4 6.1	R_5C_5 5.8	R_5C_6 5.4	R_5C_7 5.2	R_5K 4.6	R_5C_3 4.4	R_5C_2 4.1	R_5C_1 4.1
12	R_5C_4 5.7	R_5C_5 5.5	R_5C_6 5.4	R_5C_7 5.2	R_5K 4.7	R_5C_3 4.4	R_5C_2 4.4	R_5C_1 4.2
14	R_5C_4 6.0	R_5C_5 5.8	R_5C_6 5.6	R_5C_7 5.5	R_5K 4.9	R_5C_3 4.7	R_5C_2 4.5	R_5C_1 4.2
16	R_5C_4 5.9	R_5C_5 5.7	R_5C_6 5.2	R_5C_7 5.0	R_5K 4.4	R_5C_3 4.1	R_5C_2 3.7	R_5C_1 3.5
18	R_5C_4 6.9	R_5C_5 6.5	R_5C_6 6.3	R_5C_7 6.2	R_5K 5.5	R_5C_3 5.3	R_5C_2 5.1	R_5C_1 4.7
20	R_5C_4 7.6	R_5C_5 7.4	R_5C_6 7.0	R_5C_7 6.8	R_5K 5.9	R_5C_3 5.7	R_5C_2 5.5	R_5C_1 5.2
22	R_5C_4 8.4	R_5C_5 8.1	R_5C_6 7.8	R_5C_7 7.4	R_5K 6.5	R_5C_3 6.2	R_5C_2 6.1	R_5C_1 5.8
24	R_5C_4 9.5	R_5C_5 9.1	R_5C_6 9.0	R_5C_7 8.9	R_5K 7.1	R_5C_3 7.0	R_5C_2 6.7	R_5C_1 6.0
36	R_5C_4 18.7	R_5C_5 18.2	R_5C_6 18.0	R_5C_7 17.8	R_5K 14.3	R_5C_3 14.1	R_5C_2 14.0	R_5C_1 13.5
48	R_5C_4 61.1	R_5C_5 60.0	R_5C_6 58.9	R_5C_7 58.6	R_5K 40.0	R_5C_3 38.5	R_5C_2 38.5	R_5C_1 37.8

TABLE E_2

Rideau Wheat R_5. Increment in length in mms x 10^3 of segment 2, with imbibition and vernalization. Duncan's test (5% level)

Time hours	Treatment							
2	R_5C_4 12.6	R_5C_5 9.3	R_5C_6 8.22	R_5C_7 8.22	R_5K 7.22	R_5C_3 5.56	R_5C_1 5.22	R_5C_2 5.00
4	R_5C_5 17.8	R_5C_4 7.4	R_5C_6 6.44	R_5C_7 6.10	R_5K 5.22	R_5C_3 5.00	R_5C_2 4.80	R_5C_1 4.45
6	R_5C_4 9.6	R_5C_5 9.4	R_5C_6 8.38	R_5C_7 8.44	R_5K 7.11	R_5C_3 6.66	R_5C_2 6.00	R_5C_1 6.00
8	R_5C_4 21.0	R_5C_5 21.0	R_5C_6 20.7	R_5C_7 20.5	R_5K 18.5	R_5C_3 17.5	R_5C_2 16.6	R_5C_1 16.2
10	R_5C_4 40.0	R_5C_5 39.6	R_5C_6 39.2	R_5C_7 38.9	R_5K 25.6	R_5C_3 25.1	R_5C_2 24.6	R_5C_1 24.0
12	R_5C_4 67.1	R_5C_5 66.7	R_5C_6 65.6	R_5C_7 65.0	R_5K 52.2	R_5C_3 51.5	R_5C_2 51.0	R_5C_1 50.5
14	R_5C_4 90.0	R_5C_5 88.9	R_5C_6 88.6	R_5C_7 88.0	R_5K 72.0	R_5C_3 71.1	R_5C_2 70.6	R_5C_1 70.0
16	R_5C_4 94.4	R_5C_5 93.8	R_5C_6 92.7	R_5C_7 92.2	R_5K 85.0	R_5C_3 85.0	R_5C_2 84.4	R_5C_1 83.4
18	R_5C_4 118.8	R_5C_5 118.5	R_5C_6 117.0	R_5C_7 116.5	R_5K 100.2	R_5C_3 98.9	R_5C_2 97.8	R_5C_1 97.1
20	R_5C_4 131.1	R_5C_5 130.0	R_5C_6 129.5	R_5C_7 128.9	R_5K 115.0	R_5C_3 113.5	R_5C_2 113.0	R_5C_1 112.7
22	R_5C_4 155.0	R_5C_5 154.0	R_5C_6 153.5	R_5C_7 153.0	R_5K 133.6	R_5C_3 133.0	R_5C_2 132.8	R_5C_1 132.0
24	R_5C_4 171.1	R_5C_5 170.0	R_5C_6 168.9	R_5C_7 168.0	R_5K 143.9	R_5C_3 143.5	R_5C_2 142.5	R_5C_1 142.2
36	R_5C_4 201.0	R_5C_5 200.2	R_5C_6 199.5	R_5C_7 199.0	R_5K 162.2	R_5C_3 161.0	R_5C_2 161.0	R_5C_1 160.0
48	R_5C_4 165.0	R_5C_5 164.4	R_5C_6 163.5	R_5C_7 163.1	R_5K 110.0	R_5C_3 104.6	R_5C_2 103.5	R_5C_1 102.2

TABLE E_3

[illegible] (T$_3$). [illegible] in [illegible] x 10^3 of [illegible], [illegible] and [illegible]. [illegible] (5% level).

Time Hours	Treatment							
2	R_5C_4 15.9	R_5C_5 14.5	R_5C_7 12.8	R_5C_6 12.2	R_5C_3 8.87	R_5K 8.82	R_5C_2 6.33	R_5C_1 5.70
4	R_5C_4 27.4	R_5C_5 17.5	R_5C_7 16.9	R_5C_6 14.7	R_5K 12.5	R_5C_1 12.2	R_5C_3 11.7	R_5C_2 11.6
6	R_5C_4 44.1	R_5C_5 40.0	R_5C_6 32.6	R_5C_7 31.3	R_5K 27.0	R_5C_3 26.0	R_5C_2 25.5	R_5C_1 25.1
8	R_5C_4 62.2	R_5C_5 62.0	R_5C_6 61.5	R_5C_7 61.0	R_5K 40.0	R_5C_3 38.9	R_5C_2 37.8	R_5C_1 36.7
10	R_5C_4 85.0	R_5C_5 83.6	R_5C_6 83.3	R_5C_7 82.2	R_5K 65.0	R_5C_3 64.4	R_5C_2 63.5	R_5C_1 63.0
12	R_5C_4 90.2	R_5C_5 90.0	R_5C_6 88.5	R_5C_7 87.8	R_5K 69.5	R_5C_3 68.9	R_5C_2 67.8	R_5C_1 66.7
14	R_5C_4 45.0	R_5C_5 44.4	R_5C_6 44.0	R_5C_7 43.8	R_5K 28.9	R_5C_3 28.5	R_5C_2 28.0	R_5C_1 27.6
16	R_5C_4 48.7	R_5C_5 48.2	R_5C_6 48.0	R_5C_7 47.5	R_5K 32.2	R_5C_3 31.1	R_5C_2 30.5	R_5C_1 30.1
18	R_5C_4 62.1	R_5C_5 61.1	R_5C_6 60.5	R_5C_7 60.0	R_5K 52.2	R_5C_3 51.1	R_5C_2 50.6	R_5C_1 50.1
20	R_5C_4 40.0	R_5C_5 38.5	R_5C_6 38.0	R_5C_7 37.8	R_5K 28.9	R_5C_3 28.5	R_5C_2 27.5	R_5C_1 27.1
22	R_4C_4 21.0	R_5C_5 20.0	R_5C_6 20.0	R_5C_7 19.5	R_5K 11.1	R_5C_3 10.0	R_5C_2 9.5	R_5C_1 9.1
24	R_4C_4 1.5	R_5C_5 1.5	R_5C_6 0.9	R_5C_7 0.9	R_5K 0.5	R_5C_3 0.5	R_5C_2 0.4	R_5C_1 0.2
* 26-48	*Data obtained for all period to 48 hours when level indicated no change was observed from last noted period							

TABLE 54

Rideau Wheat (R_5)

Increment in length in mms x 10^3 of segment 4 with time imbibition and vernalization.

Duncan's test (5% level)

Time Hours	Vernalization (weeks)							
2	R_5C_5 28.3	R_5C_4 26.6	R_5C_6 25.4	R_5C_7 25.0	R_5K 20.1	R_5C_3 19.1	R_5C_2 17.3	R_5C_1 16.3
4	R_5C_5 78.1	R_5C_4 77.2	R_5C_6 70.5	R_5C_7 69.0	R_5K 35.6	R_5C_3 34.1	R_5C_2 32.6	R_5C_1 31.4
6	R_5C_4 147.3	R_5C_5 144.1	R_5C_6 99.5	R_5C_7 97.1	R_5K 43.0	R_5C_3 41.1	R_5C_2 41.0	R_5C_1 40.0
8	R_5C_4 125.0	R_5C_5 124.4	R_5C_6 121.1	R_5C_7 120.0	R_5K 105.6	R_5C_3 104.4	R_5C_2 102.2	R_5C_1 101.1
10	R_5C_4 91.0	R_5C_5 90.0	R_5C_6 88.9	R_5C_7 88.2	R_5K 78.9	R_5C_3 77.8	R_5C_2 76.9	R_5C_1 75.6
12	R_5C_4 31.1	R_5C_5 30.8	R_5C_6 30.2	R_5C_7 30.0	R_5K 25.0	R_5C_3 24.4	R_5C_2 24.1	R_5C_1 23.8
14	R_5C_4 26.0	R_5C_5 25.5	R_5C_6 25.0	R_5C_7 24.6	R_5K 20.0	R_5C_3 18.9	R_5C_2 18.0	R_5C_1 18.0
16	R_5C_4 25.0	R_5C_5 24.4	R_5C_6 24.2	R_5C_7 23.6	R_5K 18.5	R_5C_3 18.0	R_5C_2 17.5	R_5C_1 17.0
18	R_5C_4 12.3	R_5C_5 12.2	R_5C_6 11.5	R_5C_7 11.1	R_5K 9.7	R_5C_3 9.5	R_5C_2 9.3	R_5C_1 9.2
20-48*	* Data obtained for all period to 48 hours when level indicated no change was observed from last noted period.							

TABLE E_5

Rideau wheat (R_5): Increment in length in mms X10^3 of segment 5, with time, imbibition and vernalization.

Duncan's test (5% level)

Time hours	Vernalization (weeks)							
2	R_5C_4 3.69	R_5C_5 3.34	R_5C_6 2.63	R_5C_7 2.63	R_5K 1.94	R_5C_3 1.84	R_5C_2 1.65	R_5C_1 1.64
4	R_5C_4 10.0	R_5C_5 7.93	R_5C_6 7.83	R_5C_7 6.91	R_5K 4.32	R_5C_3 3.91	R_5C_2 3.82	R_5C_1 3.68
6	R_5C_4 5.22	R_5C_5 5.16	R_5C_6 4.86	R_5C_7 4.71	R_5K 3.86	R_5C_3 3.11	R_5C_2 3.01	R_5C_1 2.96
8	R_5C_4 5.0	R_5C_5 4.8	R_5C_6 4.6	R_5C_7 4.4	R_5K 3.5	R_5C_3 3.3	R_5C_2 3.2	R_5C_1 3.0
10	R_5C_4 3.6	R_5C_5 3.4	R_5C_6 3.1	R_5C_7 3.0	R_5K 2.2	R_5C_3 2.1	R_5C_2 1.9	R_5C_1 1.5
12	R_5C_4 3.5	R_5C_5 3.2	R_5C_6 3.2	R_5C_7 3.0	R_5K 2.7	R_5C_3 2.4	R_5C_2 2.4	R_5C_1 2.2
14	R_5C_4 3.7	R_5C_5 3.5	R_5C_6 3.4	R_5C_7 3.2	R_5K 2.5	R_5C_3 2.2	R_5C_2 2.2	R_5C_1 2.1
16	R_5C_4 3.9	R_5C_5 3.6	R_5C_6 3.5	R_5C_7 3.1	R_5K 2.4	R_5C_3 2.0	R_5C_2 2.0	R_5C_1 1.5
1-48*	*Data obtained for all period to 48 hours when level indicated no change was observed from last noted period. Specific data not included.							

TABLE E_6

Rideau Wheat (R_5). Increment in length in mms X 10^3 of segment 6, with time imbibition and vernalization. Duncan's test (5% level).

Time hours	Treatment							
2	R_5C_4	R_5C_5	R_5C_7	R_5C_6	R_5K	R_5C_1	R_5C_3	R_5C_2
	2.93	2.19	1.51	1.38	1.27	1.26	1.05	0.97
4	R_5C_4	R_5C_5	R_5C_7	R_5C_6	R_5K	R_5C_1	R_5C_3	R_5C_2
	2.7	1.82	1.74	1.64	1.32	1.31	1.20	1.15
6	R_5C_4	R_5C_5	R_5C_7	R_5C_6	R_5K	R_5C_1	R_5C_3	R_5C_2
	1.96	1.88	1.71	1.70	0.96	0.80	0.71	0.70
8	R_5C_4	R_5C_5	R_5C_7	R_5C_6	R_5K	R_5C_1	R_5C_3	R_5C_2
	2.70	2.50	2.20	2.10	1.50	1.30	1.11	1.00
10-48	Data obtained for all period to 48 hours when level indicated no change was observed from last noted period. Specific data not included.							

TABLE E_7

Rideau Wheat (R_5) Increment in length of segment 7 in mms with time, imbibition and vernalization. Duncan's test (5% level).

hours	Treatment							
2	R_5C_4 2.47	R_5C_5 2.12	R_5C_6 1.46	R_5C_7 1.43	R_5K 1.25	R_5C_1 1.16	R_5C_2 1.01	R_5C_3 0.97
4	R_5C_4 2.01	R_5C_5 1.82	R_5C_6 1.71	R_5C_7 1.62	R_5K 0.97	R_5C_1 0.91	R_5C_2 0.80	R_5C_3 0.76
6-48	Data obtained for all period to 48 hours when level indicated no change was observed from last noted period.							

TABLE E_1

Rideau Wheat (R_{14}). Increment in length in mms X 10^3 of segment 1, with time, imbibition and vernalization. Duncan's test (5% level).

Time (hours)	Vernalization (weeks)							
2	$R_{14}C_5$ 0.95	$R_{14}C_6$ 0.70	$R_{14}C_7$ 0.69	$R_{14}K$ 0.55	$R_{14}C_4$ 0.53	$R_{14}C_3$ 0.48	$R_{14}C_2$ 0.44	$R_{14}C_1$ 0.41
4	$R_{14}C_5$ 0.56	$R_{14}C_6$ 0.54	$R_{14}C_7$ 0.50	$R_{14}K$ 0.36	$R_{14}C_4$ 0.31	$R_{14}C_3$ 0.31	$R_{14}C_2$ 0.30	$R_{14}C_1$ 0.28
6	$R_{14}C_5$ 0.62	$R_{14}C_6$ 0.61	$R_{14}C_7$ 0.58	$R_{14}K$ 0.36	$R_{14}C_4$ 0.31	$R_{14}C_3$ 0.31	$R_{14}C_2$ 0.29	$R_{14}C_1$ 0.27
8	$R_{14}C_5$ 5.7	$R_{14}C_6$ 5.5	$R_{14}C_7$ 5.4	$R_{14}K$ 3.8	$R_{14}C_4$ 3.4	$R_{14}C_3$ 3.2	$R_{14}C_2$ 3.1	$R_{14}C_1$ 2.9
10	$R_{14}C_5$ 6.1	$R_{14}C_6$ 6.0	$R_{14}C_7$ 5.7	$R_{14}K$ 4.1	$R_{14}C_4$ 4.1	$R_{14}C_3$ 3.8	$R_{14}C_2$ 3.5	$R_{14}C_1$ 3.3
12	$R_{14}C_5$ 6.2	$R_{14}C_6$ 6.2	$R_{14}C_7$ 6.0	$R_{14}K$ 5.1	$R_{14}C_4$ 4.7	$R_{14}C_3$ 4.2	$R_{14}C_2$ 3.8	$R_{14}C_1$ 3.5
14	$R_{14}C_5$ 6.0	$R_{14}C_6$ 6.0	$R_{14}C_7$ 5.9	$R_{14}K$ 5.2	$R_{14}C_4$ 5.1	$R_{14}C_3$ 4.7	$R_{14}C_2$ 4.6	$R_{14}C_1$ 4.0
16	$R_{14}C_5$ 5.5	$R_{14}C_6$ 5.4	$R_{14}C_7$ 5.1	$R_{14}K$ 5.0	$R_{14}C_4$ 4.8	$R_{14}C_3$ 4.7	$R_{14}C_2$ 4.4	$R_{14}C_1$ 4.1
18	$R_{14}C_5$ 5.1	$R_{14}C_6$ 5.0	$R_{14}C_7$ 4.9	$R_{14}K$ 4.8	$R_{14}C_4$ 4.4	$R_{14}C_3$ 4.2	$R_{14}C_2$ 3.8	$R_{14}C_1$ 3.8
20	$R_{14}C_5$ 6.2	$R_{14}C_6$ 6.1	$R_{14}C_7$ 5.7	$R_{14}K$ 4.9	$R_{14}C_4$ 4.5	$R_{14}C_3$ 4.4	$R_{14}C_2$ 4.1	$R_{14}C_1$ 4.0
22	$R_{14}C_5$ 7.8	$R_{14}C_6$ 7.5	$R_{14}C_7$ 7.2	$R_{14}K$ 6.2	$R_{14}C_4$ 6.2	$R_{14}C_3$ 6.1	$R_{14}C_2$ 5.8	$R_{14}C_1$ 5.5
24	$R_{14}C_5$ 8.2	$R_{14}C_6$ 8.0	$R_{14}C_7$ 7.9	$R_{14}K$ 6.8	$R_{14}C_4$ 6.7	$R_{14}C_3$ 6.6	$R_{14}C_2$ 6.4	$R_{14}C_1$ 6.1
36	$R_{14}C_5$ 12.8	$R_{14}C_6$ 12.6	$R_{14}C_7$ 12.0	$R_{14}K$ 9.8	$R_{14}C_4$ 9.6	$R_{14}C_3$ 9.0	$R_{14}C_2$ 8.6	$R_{14}C_1$ 8.2
48	$R_{14}C_5$ 60.0	$R_{14}C_6$ 58.9	$R_{14}C_7$ 57.8	$R_{14}K$ 39.0	$R_{14}C_4$ 38.5	$R_{14}C_3$ 38.0	$R_{14}C_2$ 37.8	$R_{14}C_1$ 37.1

TABLE F_2

Rideau Wheat (R_{14}). Increment in length in mms X 10^3 of segment 2, with time imbibition and vernalization. Duncan's test (5% level).

Time (hours)	Vernalization (weeks)							
2	$R_{14}C_5$ 10.9	$R_{14}C_6$ 10.8	$R_{14}C_7$ 10.1	$R_{14}K$ 6.7	$R_{14}C_4$ 6.5	$R_{14}C_2$ 5.9	$R_{14}C_3$ 5.3	$R_{14}C_1$ 5.2
4	$R_{14}C_5$ 11.2	$R_{14}C_6$ 11.2	$R_{14}C_7$ 10.5	$R_{14}K$ 7.7	$R_{14}C_4$ 6.5	$R_{14}C_2$ 6.5	$R_{14}C_3$ 5.8	$R_{14}C_1$ 5.6
6	$R_{14}C_5$ 9.6	$R_{14}C_6$ 9.0	$R_{14}C_7$ 8.0	$R_{14}K$ 6.2	$R_{14}C_4$ 6.1	$R_{14}C_2$ 5.7	$R_{14}C_3$ 5.4	$R_{14}C_1$ 5.1
8	$R_{14}C_5$ 18.7	$R_{14}C_6$ 18.2	$R_{14}C_7$ 17.8	$R_{14}K$ 15.2	$R_{14}C_4$ 15.1	$R_{14}C_2$ 14.7	$R_{14}C_3$ 14.4	$R_{14}C_1$ 13.5
10	$R_{14}C_5$ 38.0	$R_{14}C_6$ 37.8	$R_{14}C_7$ 36.7	$R_{14}K$ 28.9	$R_{14}C_4$ 27.8	$R_{14}C_2$ 26.7	$R_{14}C_3$ 25.0	$R_{14}C_1$ 24.7
12	$R_{14}C_5$ 59.9	$R_{14}C_6$ 59.3	$R_{14}C_7$ 58.9	$R_{14}K$ 41.1	$R_{14}C_4$ 40.1	$R_{14}C_2$ 38.9	$R_{14}C_3$ 38.3	$R_{14}C_1$ 37.8
14	$R_{14}C_5$ 85.0	$R_{14}C_6$ 84.4	$R_{14}C_7$ 83.8	$R_{14}K$ 68.9	$R_{14}C_4$ 67.8	$R_{14}C_2$ 65.9	$R_{14}C_3$ 64.9	$R_{14}C_1$ 63.8
16	$R_{14}C_5$ 91.0	$R_{14}C_6$ 90.0	$R_{14}C_7$ 89.7	$R_{14}K$ 78.9	$R_{14}C_4$ 77.8	$R_{14}C_2$ 75.0	$R_{14}C_3$ 73.1	$R_{14}C_1$ 72.2
18	$R_{14}C_5$ 100.2	$R_{14}C_6$ 99.9	$R_{14}C_7$ 99.0	$R_{14}K$ 89.9	$R_{14}C_4$ 89.2	$R_{14}C_2$ 88.7	$R_{14}C_3$ 88.0	$R_{14}C_1$ 87.8
20	$R_{14}C_5$ 127.2	$R_{14}C_6$ 127.1	$R_{14}C_7$ 126.5	$R_{14}K$ 108.9	$R_{14}C_4$ 108.5	$R_{14}C_2$ 108.0	$R_{14}C_3$ 107.5	$R_{14}C_1$ 107.2
22	$R_{14}C_5$ 142.0	$R_{14}C_6$ 141.1	$R_{14}C_7$ 139.9	$R_{14}K$ 120.0	$R_{14}C_4$ 119.5	$R_{14}C_2$ 118.7	$R_{14}C_3$ 117.6	$R_{14}C_1$ 116.6
24	$R_{14}C_5$ 161.2	$R_{14}C_6$ 160.0	$R_{14}C_7$ 160.0	$R_{14}K$ 149.7	$R_{14}C_4$ 148.9	$R_{14}C_2$ 147.8	$R_{14}C_3$ 146.0	$R_{14}C_1$ 145.5
36	$R_{14}C_5$ 191.1	$R_{14}C_6$ 190.0	$R_{14}C_7$ 189.8	$R_{14}K$ 147.8	$R_{14}C_4$ 146.9	$R_{14}C_2$ 146.5	$R_{14}C_3$ 146.0	$R_{14}C_1$ 105.7
48	$R_{14}C_5$ 133.3	$R_{14}C_6$ 133.0	$R_{14}C_7$ 132.8	$R_{14}K$ 111.1	$R_{14}C_4$ 110.0	$R_{14}C_2$ 105.8	$R_{14}C_3$ 105.5	$R_{14}C_1$ 105.0

TABLE F$_3$

Rideau Wheat (R_{14}). Increment in length in mms X 10^3 of segment 3, with time imbibition and vernalization. Duncan's test (5% level).

Treatment hours								
2	$R_{14}C_5$ 14.6	$R_{14}C_6$ 14.5	$R_{14}C_7$ 13.8	$R_{14}C_4$ 11.6	$R_{14}K$ 9.3	$R_{14}C_3$ 9.0	$R_{14}C_1$ 8.9	$R_{14}C_2$ 7.7
4	$R_{14}C_5$ 25.1	$R_{14}C_6$ 23.1	$R_{14}C_7$ 21.9	$R_{14}C_4$ 19.4	$R_{14}K$ 19.1	$R_{14}C_3$ 18.3	$R_{14}C_1$ 17.3	$R_{14}C_2$ 15.3
6	$R_{14}C_5$ 50.6	$R_{14}C_6$ 48.6	$R_{14}C_7$ 47.5	$R_{14}C_4$ 21.3	$R_{14}K$ 21.1	$R_{14}C_3$ 20.0	$R_{14}C_1$ 19.0	$R_{14}C_2$ 18.2
8	$R_{14}C_5$ 61.1	$R_{14}C_6$ 60.1	$R_{14}C_7$ 58.9	$R_{14}C_4$ 31.1	$R_{14}K$ 31.0	$R_{14}C_3$ 30.0	$R_{14}C_1$ 29.4	$R_{14}C_2$ 28.9
10	$R_{14}C_5$ 81.1	$R_{14}C_6$ 80.1	$R_{14}C_7$ 79.5	$R_{14}C_4$ 55.0	$R_{14}K$ 53.5	$R_{14}C_3$ 53.1	$R_{14}C_1$ 52.8	$R_{14}C_2$ 52.2
12	$R_{14}C_5$ 90.0	$R_{14}C_6$ 88.9	$R_{14}C_7$ 87.8	$R_{14}C_4$ 66.7	$R_{14}K$ 65.6	$R_{14}C_3$ 65.0	$R_{14}C_1$ 64.8	$R_{14}C_2$ 60.0
14	$R_{14}C_5$ 42.0	$R_{14}C_6$ 41.1	$R_{14}C_7$ 40.7	$R_{14}C_4$ 38.1	$R_{14}K$ 38.0	$R_{14}C_3$ 37.6	$R_{14}C_1$ 36.7	$R_{14}C_2$ 35.8
16	$R_{14}C_5$ 39.1	$R_{14}C_6$ 38.9	$R_{14}C_7$ 37.8	$R_{14}C_4$ 35.4	$R_{14}K$ 35.0	$R_{14}C_3$ 34.7	$R_{14}C_1$ 34.4	$R_{14}C_2$ 32.2
18	$R_{14}C_5$ 55.1	$R_{14}C_6$ 55.0	$R_{14}C_7$ 54.5	$R_{14}C_4$ 48.9	$R_{14}K$ 47.8	$R_{14}C_3$ 46.9	$R_{14}C_1$ 45.8	$R_{14}C_2$ 45.5
20	$R_{14}C_5$ 25.8	$R_{14}C_6$ 25.4	$R_{14}C_7$ 24.9	$R_{14}C_4$ 18.9	$R_{14}K$ 18.5	$R_{14}C_3$ 17.6	$R_{14}C_1$ 17.4	$R_{14}C_2$ 17.1
22	$R_{14}C_5$ 12.5	$R_{14}C_6$ 12.0	$R_{14}C_7$ 11.8	$R_{14}C_4$ 9.3	$R_{14}K$ 9.0	$R_{14}C_3$ 8.5	$R_{14}C_1$ 8.1	$R_{14}C_2$ 7.6
24	$R_{14}C_5$ 4.2	$R_{14}C_6$ 4.1	$R_{14}C_7$ 4.0	$R_{14}C_4$ 3.3	$R_{14}K$ 3.3	$R_{14}C_3$ 3.0	$R_{14}C_1$ 2.5	$R_{14}C_2$ 2.4

*26-48 Data obtained for all period to 48 hours when level indicated no change was observed from last noted period. Specific data not included.

TABLE F4

Rideau Wheat (R_{14})

Increment in length in mms. 10^3 of segment 4 with time, imbibition and vernalization. Duncan's test (5% level).

Time Hours	Vernalization (weeks)							
2	$R_{14}C_5$ 27.6	$R_{14}C_6$ 23.5	$R_{14}C_7$ 19.8	$R_{14}K$ 19.4	$R_{14}C_4$ 18.3	$R_{14}C_3$ 17.7	$R_{14}C_2$ 17.3	$R_{14}C_1$ 15.9
4	$R_{14}C_5$ 56.4	$R_{14}C_6$ 52.6	$R_{14}C_7$ 48.6	$R_{14}K$ 44.6	$R_{14}C_4$ 41.1	$R_{14}C_3$ 36.4	$R_{14}C_2$ 35.9	$R_{14}C_1$ 34.9
6	$R_{14}C_5$ 110.2	$R_{14}C_6$ 99.3	$R_{14}C_7$ 94.3	$R_{14}K$ 44.3	$R_{14}C_4$ 43.2	$R_{14}C_3$ 38.0	$R_{14}C_2$ 37.5	$R_{14}C_1$ 37.0
8	$R_{14}C_5$ 120.0	$R_{14}C_6$ 117.8	$R_{14}C_7$ 115.6	$R_{14}K$ 85.6	$R_{14}C_4$ 83.3	$R_{14}C_3$ 81.7	$R_{14}C_2$ 79.9	$R_{14}C_1$ 78.9
10	$R_{14}C_5$ 88.0	$R_{14}C_6$ 87.5	$R_{14}C_7$ 86.5	$R_{14}K$ 63.3	$R_{14}C_4$ 62.8	$R_{14}C_3$ 61.1	$R_{14}C_2$ 60.5	$R_{14}C_1$ 60.0
12	$R_{14}C_5$ 37.7	$R_{14}C_6$ 35.6	$R_{14}C_7$ 35.0	$R_{14}K$ 21.1	$R_{14}C_4$ 20.8	$R_{14}C_3$ 20.0	$R_{14}C_2$ 19.8	$R_{14}C_1$ 19.1
14	$R_{14}C_5$ 22.0	$R_{14}C_6$ 21.8	$R_{14}C_7$ 21.1	$R_{14}K$ 15.6	$R_{14}C_4$ 15.4	$R_{14}C_3$ 15.0	$R_{14}C_2$ 14.9	$R_{14}C_1$ 14.4
16	$R_{14}C_5$ 19.1	$R_{14}C_6$ 18.9	$R_{14}C_7$ 18.5	$R_{14}K$ 14.1	$R_{14}C_4$ 14.0	$R_{14}C_3$ 12.9	$R_{14}C_2$ 12.2	$R_{14}C_1$ 12.0
18	$R_{14}C_5$ 12.1	$R_{14}C_6$ 12.1	$R_{14}C_7$ 12.0	$R_{14}K$ 11.0	$R_{14}C_4$ 10.8	$R_{14}C_3$ 10.5	$R_{14}C_2$ 10.1	$R_{14}C_1$ 10.0
20	$R_{14}C_5$ 5.3	$R_{14}C_6$ 5.2	$R_{14}C_7$ 5.1	$R_{14}K$ 4.5	$R_{14}C_4$ 4.4	$R_{14}C_3$ 4.1	$R_{14}C_2$ 3.7	$R_{14}C_1$ 3.4

22-48 * Data obtained for all period to 48 hours when level indicated no change was observed from last noted period. Specific data not included.

TABLE F_5

Rideau Wheat. Increment in length in mms X 10^3 imbibition and vernalization. Duncan's test (5% level).

Treatment hours	Vernalization (weeks)							
2	$R_{14}C_5$ 3.65	$R_{14}C_6$ 3.48	$R_{14}C_7$ 2.95	$R_{14}C_4$ 2.90	$R_{14}C_3$ 2.82	$R_{14}K$ 2.78	$R_{14}C_1$ 2.63	$R_{14}C_2$ 2.61
4	$R_{14}C_5$ 7.68	$R_{14}C_6$ 7.53	$R_{14}C_7$ 6.95	$R_{14}C_4$ 4.20	$R_{14}C_3$ 3.80	$R_{14}K$ 3.47	$R_{14}C_1$ 3.34	$R_{14}C_2$ 3.08
6	$R_{14}C_5$ 6.27	$R_{14}C_6$ 5.80	$R_{14}C_7$ 5.60	$R_{14}C_4$ 4.36	$R_{14}C_3$ 4.24	$R_{14}K$ 4.11	$R_{14}C_1$ 3.80	$R_{14}C_2$ 3.70
8	$R_{14}C_5$ 4.70	$R_{14}C_6$ 4.60	$R_{14}C_7$ 4.50	$R_{14}C_4$ 3.50	$R_{14}C_3$ 3.40	$R_{14}K$ 3.00	$R_{14}C_1$ 2.80	$R_{14}C_2$ 2.50
10	$R_{14}C_5$ 4.10	$R_{14}C_6$ 4.10	$R_{14}C_7$ 4.10	$R_{14}C_4$ 3.00	$R_{14}C_3$ 2.80	$R_{14}K$ 2.50	$R_{14}C_1$ 2.40	$R_{14}C_2$ 2.20
12	$R_{14}C_5$ 3.8	$R_{14}C_6$ 3.6	$R_{14}C_7$ 3.4	$R_{14}C_4$ 2.7	$R_{14}C_3$ 2.5	$R_{14}K$ 2.2	$R_{14}C_1$ 1.9	$R_{14}C_2$ 1.5
14	$R_{14}C_5$ 2.1	$R_{14}C_6$ 2.1	$R_{14}C_7$ 1.9	$R_{14}C_4$ 1.5	$R_{14}C_3$ 1.5	$R_{14}K$ 1.1	$R_{14}C_1$ 0.9	$R_{14}C_2$ 0.7

*16-48 *Data obtained for all period to 48 hours when level indicated no change was observed from last noted period.

TABLE F_6

Rideau Wheat (R_{14}). Increment in length in mms. X 10^3 of segment 6, with time, imbibition and vernalization. Duncan's test (5% level).

Treatment hours	Vernalization (weeks)							
2	$R_{14}C_5$ 3.23	$R_{14}C_6$ 2.92	$R_{14}C_7$ 2.71	$R_{14}C_4$ 2.61	$R_{14}K$ 2.59	$R_{14}C_3$ 2.51	$R_{14}C_2$ 2.50	$R_{14}C_1$ 2.32
4	$R_{14}C_5$ 3.99	$R_{14}C_6$ 3.42	$R_{14}C_7$ 3.11	$R_{14}C_4$ 2.58	$R_{14}K$ 2.11	$R_{14}C_3$ 1.96	$R_{14}C_2$ 1.94	$R_{14}C_1$ 1.86
6	$R_{14}C_5$ 1.41	$R_{14}C_6$ 1.27	$R_{14}C_7$ 1.18	$R_{14}C_4$ 0.56	$R_{14}K$ 0.47	$R_{14}C_3$ 0.38	$R_{14}C_2$ 0.36	$R_{14}C_1$ 0.30
8	$R_{14}C_5$ 2.0	$R_{14}C_6$ 2.0	$R_{14}C_7$ 1.9	$R_{14}C_4$ 1.5	$R_{14}K$ 1.3	$R_{14}C_3$ 1.1	$R_{14}C_2$ 1.1	$R_{14}C_1$ 0.9
*10-48	*Data obtained for all period to 48 hours when level indicated no change was observed from last noted period.							

TABLE F_7

Rideau Wheat (R_{14}). Increment in length in mms X 10^3 of segment 7 with time, imbibition and vernalization. Duncan's test (5% level).

Treatment hours	Vernalization (weeks)							
2	$R_{14}C_5$ 2.62	$R_{14}C_6$ 2.18	$R_{14}C_7$ 2.02	$R_{14}C_4$ 1.44	$R_{14}C_3$ 1.32	$R_{14}C_2$ 1.30	$R_{14}C_1$ 1.21	$R_{14}K$ 1.20
4	$R_{14}C_5$ 0.56	$R_{14}C_6$ 0.55	$R_{14}C_7$ 0.51	$R_{14}K$ 0.46	$R_{14}C_4$ 0.42	$R_{14}C_3$ 0.37	$R_{14}C_2$ 0.33	$R_{14}C_1$ 0.27
6	$R_{14}C_5$ 0.04	$R_{14}C_6$ 0.03	$R_{14}C_7$ 0.02	$R_{14}K$ 0				
*8-48	* Data obtained for all period to 48 hours when level indicated no change was observed from last noted period.							