FIELD PERFORMANCE OF SEVERAL SEEDLOTS OF THREE SPRING WHEAT CULTIVARS UNDER TWO CROP MANAGEMENT LEVELS

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by

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ABSTRACT

Empey, Mervin Thomas, M. Sc. The University of Manitoba, May, 1992. Field performance of several seedlots of three spring wheat cultivars under two crop management levels.

Major Professor: Dr. E. H. Stobbe, Department of Plant Science.

Field experiments were conducted in 1986 and 1987 to determine the effect of seedlots of three spring wheat cultivars on seedling vigour and yield when grown under two levels of crop management. The conventional management level had a seed rate of 200 seeds m^{-2}, 50 kg ha^{-1} of nitrogen, no seed treatment and no foliar fungicide application. The high level of management was planted at 400 seeds m^{-2}, received 100 kg ha^{-1}, had a seed treatment and was treated with a foliar fungicide. Seedlots studied were certified seedlots of Katepwa and HY320 and commercial seedlots of Oslo. Seed vigour or seed quality differences were shown by significantly different plant stand establishments and yields in some of the experiments. Yield differences as high as 13% were observed between two seedlots of the same genotype. The relative rankings of seedlots were not consistent between the management level studies. Seed weight and seed protein were not related to crop emergence, dry matter production or yield formation. Seedlots of the commercial, seed, Oslo were more likely to be different than certified seedlots of Katepwa and HY320.

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LIST OF ABBREVIATIONS

K1	-	Katepwa seedlot number 1
H1	-	HY320 seedlot number 1
O1	-	Oslo seedlot number 1
K1C	-	Katepwa seedlot number 1 grown under conventional management
K1H	-	Katepwa seedlot number 1 grown under high management
H1C	-	HY320 seedlot number 1 grown under conventional management
H1H	-	HY320 seedlot number 1 grown under high management
O1C	-	Oslo seedlot number 1 grown under conventional management
O1H	-	Oslo seedlot number 1 grown under high management
Portage	-	Portage la Prairie

1.0 INTRODUCTION

Most countries in the world, including Canada, have regulatory agencies responsible for licensing or registering new cultivars and the selling of certified seed. In Canada, the criteria established for the sale of certified seed include varietal purity, minimum germination levels, limits to the amount of weed seeds and restrictions on the amount of diseased, shrunken and shrivelled seed. These parameters don't allow for variations in seed quality or vigour resulting from different environmental, harvesting, handling or storage conditions. The effect of crop management on the growth of certified seed has not been evaluated. For these reasons studies were conducted at the University of Manitoba, Plant Science Research Station at Portage la Prairie to:

(1) evaluate wheat seedlots using two management levels for differences in seedling vigour, grain yield and yield components.

(2) determine if seed mass or protein are responsible for any differences which might be found.

(3) determine the effect of crop management on a seedlots performance compared to other seedlots of the same genotype.

(4) to compare the field performance of certified wheat seedlots with the field performance of seedlots which were of commercial status.

2.0 LITERATURE REVIEW

2.1 Seed quality

Seed quality has commonly been based on germination, purity and seed health. Seed quality descriptions have been used to avoid planting undesirable seedlots. The concept of seed vigour has been introduced and studied in the past 30 - 40 years to help differentiate seed of similar germinative quality but of differing field performance. Perry (1980) states the International Seed Testing Association definition of vigour.

> 'Seed vigour is the sum total of those properties of the seed which determine the potential level of activity and performance of the seed or seed lot during germination and seedling emergence'

A good vigour test should be used in conjunction with the standard germination test to determine the planting value of a seedlot.

2.2 Seed Source Effects

The source of seed may affect grain yield of barley (McFadden, 1963), winter wheat (Quinby, 1962) and spring wheat (DasGupta and Austenson, 1973; Morrison et. al., 1991). Conversely, McNeal et al. (1960) found no significant differences in spring wheat cv. Thatcher seedlots which varied in test weight and protein content.

McFadden (1963) observed yield differences ranging from 9-16%

in 1960 and 3-13% in 1961 between seed sources within a cultivar. The grain yield rankings of the four cultivars in their experiment were dependent on the source of seed utilized. They concluded that seed source would be an important factor to be controlled in yield comparison trials between cultivars. Quinby et. al. (1962) found significantly different wheat yields between seed sources in two years of a three year study. No differences were observed in days to heading from the different seedlots.

Certified seed outyields commercial seed (Rossnagel and Baker, 1985; Anon., 1988). In a three year study in Manitoba certified seed outyielded commercial seed by 1.1 bushels/acre (Anon, 1988). The same report noted a Saskatchewan study which found certified seed to outyield commercial seed by 1.8 and 3.0 bushels/acre for wheat and barley, respectively.

Morrison et. al. (1991) observed differences amongst three certified seedlots of Katepwa spring wheat. The seedlots differed significantly in dry matter production at 2 weeks past seeding and also in grain yield.

Sonntag (1988) found significant yield differences between certified seedlots of Harrington barley and Katepwa wheat.

2.2.1 Seed mass effects on seedling vigour, grain yield and yield components

Seed size or weight has been shown to affect germination, emergence, seedling growth, yield and yield components in many economically important agricultural crops. Seed size is one seed quality factor which the producer can control with little cost in order to improve the quality of seed planted.

Seed size has not been found to affect percent germination (Demirlicakmak, Kaufmann, and Johnson, 1963; Kaufmann and McFadden, 1963), however it may cause differences in the rate of germination. Boyd et al. (1971) found a strong negative relationship between seed size and germination resistance for two-row and six-row barley cultivars. The initial growth advantage for the large seeds was maintained for at least two weeks based on plant dry weights. Lafond and Baker (1986), working with nine spring wheat genotypes, found small seeds germinated more rapidly than large seeds over temperatures ranging between 5-30 degrees C.. Bremner et al. (1963), in greenhouse studies, varied the embryo and endosperm size of wheat kernels by using the two seeds sizes and removing endosperm, determined that the relative growth rate of small embryos was greater than that of large embryos for the first six days of growth regardless of endosperm size. Thereafter growth was dependent on the amount of endosperm, thus favouring large seeds.

Seed size and emergence are generally positively correlated. Larger seeds emerge more rapidly and often in higher percentages than smaller seeds. This is particularly true for seeds emerging from deep planting or in other circumstances which make emergence conditions less than optimal (Gan et al. 1992).

Kaufmann and McFadden (1963) noticed that visual differences between seedlings grown from large and small barley seeds with the largest seedlings resulting from the large sized seed. Plants grown from the large seed were more advanced in maturity at heading and ripening. Spilde (1989) found harvested grain moisture content of wheat samples grown from large seed to be lower than samples from small or medium sized seed indicating advanced maturity from the use of large seed. Earlier harvesting may result in better quality resulting from increased harvest efficiency . Kaufmann and Guitard (1967) measured the width and length of the first two leaves of barley seedlings to determine that large seeds gave rise to larger seedlings. Lafond and Baker (1986), using the Haun scale of growth measurement, found that seedlings grown from large wheat seeds grew at a more rapid rate. This observation was confirmed by greater shoot dry matter production for the seedlings grown from large seeds after 28 days of growth.

Greater seedling vigour, as measured by shoot dry matter production, from large wheat seeds has been observed by other researchers (Evans and Bhatt, 1977; Ries and Everson, 1973).

Seed of large size or weight will often yield more than small or bulk seed. Yield advantages from using large seed of barley (Kiesselbach, 1924; Kaufmann and McFadden, 1960; Spilde, 1989) and wheat (Kiesselbach, 1924; Waldron, 1941; Austenson and Walton; Brown, 1973; Puri and Qualset, 1978) have been reported.

Whether large seed outyields bulk or small seed depends to some extent, on the method of calculating the seeding rate. Seeding rates based on a constant number of seeds favours large seeds and gives more consistent and larger yield differences than by using seed rates based on a constant mass of seed sown (Kiesselbach, 1924; Waldron, 1941; Carver, 1977). Brown (1973) determined that large seed of spring wheat (cvs. Glenlea and Neepawa) outyielded bulk seed by at least 4% over a range of seed rates when sown at a constant number of seeds between size fractions. Yield differences were not found when the seed was planted on a constant mass basis. Brown also found no significant differences in yield components between seed size fractions. By using a constant mass of seed, which farmers generally use, more small seeds are sown compared to a constant mass of large seeds and thus may compensate for poorer emergence or slower growth thereby reducing possible yield differences.

Waldron (1941) concluded that large kernels showed less of an advantage when grown under more favourable growing conditions than when grown under stressful conditions. Under stressful conditions large seeds outyielded small seeds. Large seeds were better able to withstand emergence stresses such as deep seeding, a cold seedbed, soil crusting and pathogen attack than smaller seeds, which will exhaust their energy source more rapidly. Under optimal or near-optimal growing conditions, seedlings originating from larger, more vigourous seed commenced inter-plant or inter-row competition for water, light or nutrients more quickly than seedlings originating from small seed. Under optimal conditions seedlings from small seed did not develop as quickly, resulting in delayed maturity, but no deduction in grain yield.

Austenson and Walton (1970) compared yield and yield components under spaced seeding (15cmx15cm). They found seed size to be responsible for yield differences as great as 4.5% in spring wheat. Heads/plant was the most important component of yield followed by seed/head and least of all by kernel mass. Seed spacing of 15 centimeters allowed for more extensive tillering than would be expected under field conditions. Demirlicakmak et al. (1963) found large barley seeds had a greater tillering capacity. Seed size and harvested kernel mass tend to be negatively correlated (Fjell et al.,1985).

2.2.2 Seed protein effects on seedling vigour, grain yield and

The protein level within a seed may be described as either grain protein concentration, which is the quantity in grams of protein per 100 grams of grain dry matter (McNeal et al., 1978) or as protein content which is the product of the grain protein concentration and the seed weight.

The amount of protein within a seed affects seedling growth. Metivier and Dale (1977) found the seed N content of some barley cultivars was important for leaf emergence, leaf size, especially the first leaf, photosynthetic rate and total soluble protein. These effects were eliminated when an early exogenous nitrogen application was made.

Lowe and Ries (1972) observed a high positive correlation (r=0.920**) between wheat seed protein content and dry matter

accumulation after three weeks of growth. Up to 88% of the variation in the initial trial could be explained by the relation between seed protein and dry matter accumulation.
Morphological development was visually more advanced at three weeks for plants originating from high protein seed than for those grown from lower protein seed. They found the maximum relative difference in vegetative growth occurred at 20 days after seeding and was maintained for the duration of their experiment (40 days). They suggested that more vigourous growth from higher protein seed may be as a result of the different levels of respiratory substrate and amino acids for protein synthesis. They found the protein - seed vigour effect to be maintained over a variety of environments and nutrient levels.

Evans and Bhatt (1977) found seedling vigour, as measured by shoot dry matter accumulation 20 days after sowing, to be positively related to protein content when seed size was held constant.

Bulisani and Warner (1980), working with winter wheat (cvs. Nugaines and Wanser), found seed protein content and seedling vigour to be positively correlated. Seed size and protein concentration were found to be positively correlated with seedling vigour but not as strongly as the total protein content. An exogenous N application within three days of germination eliminated the protein effect on seedling vigour. Ries et al. (1976) found protein content to be more strongly positively correlated with seedling vigour for winter wheat than either seed size or protein concentration. Protein content has also been found to be correlated with seedling vigour when seed size has had no effect on seedling vigour (Schweizer et al. 1969; Ries et al. 1970).

Schweizer et al. (1969) found seedling growth to be more closely associated with protein content of seed when environmental N supply was low (r=0.7335 for plants without supplemental N and r=0.63646 for plants with supplemental N).

Torres and Paulsen (1982), working with winter wheat, found increased protein content of the seed commonly increased the dry mass of seedlings and less often led to a faster emergence rate. The benefits of high protein seed was more pronounced under the more stressful conditions of deeper seeding up to the point were seed was unable to emerge (16cm). Exogenous N application had no affect on the protein effect which is in contrast with other research.

Ayers et al. (1976) found that protein and other storage material was utilized faster for high protein seed than low protein seed. There was however only small differences in net assimilation rate, leaf area ratio and relative growth rate when growth analysis studies were conducted.

The effect of seed protein on grain yield is not clear. Ries et al. (1970) found wheat grain yields to be correlated with seed protein content but not with seed size. In one of their experiments the effect of protein content on grain yield was eliminated by the addition of 120 kg ha^{-1} of N fertilizer. Conversely, Welch (1977) concluded that under practical conditions the protein content of the seed should not effect the grain yield of wheat.

Protein effects on yield components offer mixed results. Most effects of protein would be confounded by environmental factors such as N fertility level, soil moisture, and temperature throughout the critical periods of yield component formation. Different genotypes increase or build yield by different yield components making a general statement on grain protein content and yield components difficult.

Phillips and Schlesinger (1974) looked at seed size and protein concentration relationships in wheat samples. Hard red spring wheat was found to have higher protein concentration as seed size increased. The opposite effect was observed for hard red winter wheat seedlots. Evans and Bhatt (1977) found protein concentration of large size seed classes of a cultivar to be higher than protein levels observed in the smaller size classes of seed.

3.0 MATERIALS AND METHODS

3.1 Materials

Seedlots of three spring wheat cultivars were obtained from seed producers throughout Manitoba in the spring of 1986 and 1987. Seedlots of Katepwa and HY320 were certified seed while Oslo was commercial seed. Oslo was registered on the 18 March, 1987 becoming the second cultivar registered for the Canada Prairie Spring class (Graf et al. 1990). The seed used in the trials was collected from various regions, thus providing seed from different environments, harvesting, handling, and storage conditions.

The seed quality of the individual seed lots was quantitatively evaluated (Tables 3.1 - 3.3). Four 1000 kernel replicates of seed were counted on an electronic seed counter and weighed. The average was reported as the seed mass per kernel. Percent nitrogen was determined by the Kjeldahl method and a conversion factor of 5.7 was used to convert grain nitrogen concentration to grain protein concentration. The amount (mg) of protein $seed^{-1}$ was calculated by multiplying the seed weight by the protein concentration.

Table 3.1 Certified Katepwa seedlots' quality description

Year	Seed source	Germination (%)	Seed Mass (mg)	Seed Protein (%)	Protein content (mg/seed)
1986	K1	100	33.0	13.9	4.59
	K2	94.5	30.8	13.3	4.10
	K3	99.0	33.0	11.4	3.76
	K4	96.0	32.1	15.4	4.94
	K5	99.5	31.3	12.3	3.85
	K6	96.5	34.2	12.6	4.31
	K7	96.5	33.6	11.5	3.86
1987	K8	91.5	33.3	13.2	4.40
	K9	98.0	30.6	13.3	4.07
	K10	95.5	31.6	14.4	4.55
	K11	97.0	33.8	13.2	4.46
	K12	96.5	32.5	13.2	4.29
	K13	97.5	31.5	12.8	4.03

Table 3.2 Certified HY320 seedlots' quality description

Year	Seed source	Germination (%)	Seed Mass (mg)	Seed Protein (%)	Protein content (mg/seed)
1986	H1	87.5	37.9	11.0	4.17
	H2	92.0	48.4	11.0	5.32
	H3	87.5	33.2	11.7	3.88
	H4	95.5	37.1	12.0	4.45
	H5	94.5	44.1	10.2	4.50
	H6	95.5	40.8	9.3	3.79
	H7	94.0	41.4	10.0	4.14
1987	H8	96.0	36.0	12.2	4.39
	H9	93.0	37.7	11.2	4.22
	H10	95.0	38.7	11.7	4.53
	H11	91.0	38.3	12.0	4.60
	H12	97.0	29.4	10.8	3.18
	H13	95.0	31.7	12.2	3.87

Table 3.3 Oslo seedlots' quality description

Year	Seed source	Germination (%)	Seed Mass (mg)	Seed Protein (%)	Protein content (mg/seed)
1986	O1	96.0	40.2	12.3	4.94
	O2	98.5	35.5	11.6	4.12
	O3	93.0	34.8	11.9	4.14
	O4	95.0	34.9	11.1	3.87
	O5	99.5	36.4	11.4	4.15
	O6	95.5	34.6	11.9	4.12
1987	O7	92.0	36.8	12.7	4.67
	O8	92.5	36.6	11.7	4.28
	O9	93.0	38.6	13.5	5.21
	O10	93.0	35.1	12.6	4.42
	O11	93.0	35.8	12.9	4.62

The germination percentage of each seed lot was determined by placing 50 seeds into 100 * 15 mm petri plates containing two sheets of Number One Qualitative filter paper and 5 ml of distilled water. Four replicates of each seedlot were placed into a germination cabinet[1] set at 20

[1]. Product of Controlled Environments, Winnipeg, MB.

degrees C for seven days. Additional water was supplied as required. Seeds were considered to have germinated when the radicle and the coleoptile had elongated at least 2 mm. Germination percentage was recorded on the seventh day. The germination percentage was used in conjunction with the seed mass to calculate seed rates for each seedlot based on a certain number of viable seeds per unit area.

All seedlots had been cleaned to accepted standards.

3.2 General Procedures

Field experiments were conducted for two years at Portage la Prairie, Manitoba. The 1986 experiments were grown on a Neuhorst clay loam soil. The 1987 field experiments were sown on a Fortier clay soil.

Seedlots of the three wheat cultivars were tested under two management levels . The differences between the conventional and the high level of management are indicated in Table 3.4.

Table 3.4 Level of management utilized for wheat seed evaluation

Management level	Nitrogen applied actual (kg ha^{-1})	Viable seed rate (seeds m^{-2})	Seed treated	Foliar fungicide
conventional	50	200	no	no
high	100	400	yes	yes

Experiments were designed as randomized complete blocks with six and eight replicates in 1986 and 1987, respectively. The individual plot size was 2.2 * 7.0 m.

Two passes each with a cultivator and tine harrows was the method employed to produce a good seedbed. Seeding was done with a Noble 2000 hoe drill with a cone divider attachment. Row spacing was 20 centimeters and seed was placed to a depth of 3 centimeters.

Seed utilized in the high management trials was treated with a recommended rate of Vitavax[2] fungicide.

Nitrogen, phosphate and potassium were placed with the seed in 1986 at rates of 45, 45 and 27 kg ha^{-1}, respectively. In 1987 the same nutrients were added with the seed at rates of 33, 50, and 20 kg ha^{-1}. Ammonium nitrate was broadcast, prior to emergence, to give the required nitrogen fertilizer rate each year. Soil tests indicated high natural fertility both years (Appendix 3).

Plant emergence counts were taken twice as a measure of seedling vigour. The first count was taken between 7 to 11 days after seeding depending on growing conditions. Four 0.25 m^2 quadrants were sampled in each seedlot. Plants were in the one leaf growth stage. The second count was taken at approximately three weeks after seeding. Plants from two 0.25 m^2 quadrants were excavated, and counted. The plants

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[2]. Product of Uniroyal, Elmira, ON.

were excised at the crown and the shoots were placed in a drying oven for 48 hours at 80 degrees C. Shoot dry matter was recorded on a per area and a per plant basis. Plant growth stage at three weeks past seeding ranged from one leaf to five leaves with two tillers.

The appropriate herbicides were used each year to control weeds. Volunteer barley was hand weeded from the plots in 1986.

The fungicides propiconizole[3] (125g a.i./ha) and triadimefon[4] (274 g a.i./ha) were applied on June 14 and July 15, 1986 to the high management experiments. In 1987 propiconizole was sprayed on June 27.

Head counts were made on five 1 meter lengths of row a meter in from the front of the plot. The same five rows were sampled in each plot to eliminate any discrepancies between drill runs. Prior to harvesting, 40 heads were clipped from the same rows in each plot for yield component studies. Heads from main culms and tillers were not differentiated. The heads were air-dried and then threshed on a belt thresher. The seeds were counted on an electronic seed counter and weighed. Seeds head^{-1} and kernel weight were calculated.

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[3]. Tilt - product of Ciba-Geigy, Mississauga, ON.

[4]. Bayleton - product of Chem Agro, Mississauga, ON.

A Hege small plot combine was used to harvest the six centre rows of the plot area. The grain sample was dried, cleaned and weighed. Grain weight was adjusted on a 14.5 % moisture basis.

3.2.1 Experiment 1. The effect of seedlots of different quality on seedling vigour, grain yield and yield components when grown under conventional management in 1986; a) Katepwa b) HY320 c) Oslo

Seven certified seed lots of Katepwa and HY320, along with six commercial seedlots of Oslo were utilized. HY320 and Oslo were sown on May 22, with Katepwa planted May 26. All cultivars were harvested on September 9.

3.2.2 Experiment 2. The effect of seedlots of different quality on seedling vigour, grain yield and yield components when grown under high management in 1986; a) Katepwa b) HY320 c) Oslo

The same seedlots were employed for each wheat cultivar in the high management trial as under the conventional management level with the exception that H4 was not used due to limited seed supply. The only difference in seeding dates was with HY320 where a problem with the seeding equipment necessitated reseeding on June 3. Katepwa and Oslo was harvested September 9, with the harvesting of HY320 delayed until October 9.

3.2.3 Experiment 3. The effect of seedlots of different quality on seedling vigour, grain yield and yield components when grown under conventional management in 1987; a) Katepwa b) HY320 c) Oslo

The number of seed lot entries for Katepwa, HY320 and Oslo trials were six, six, and five, respectively. Katepwa was sown on May 7, while HY320 and Oslo were seeded May 14. Katepwa was harvested August 13, Oslo on August 20 and HY320 on August 21.

3.2.4 Experiment 4. The effect of seedlots of different quality on seedling vigour, grain yield and yield components when grown under high management in 1987; a) Katepwa b) HY320 c) Oslo

The number of seed lots, date of seeding, and harvest date were identical for the high management level as those indicated for the trials under conventional management.

3.3 Statistical analysis

Data collected from all experiments was analyzed in a similar manner. Analysis of variance was performed using SAS (SAS Institute, 1985) on all seedling vigour, grain yield and yield component data. When significant treatment differences occurred (0.10 level of probability), an LSD test was performed to compare means. Only differences significant at the 10% level were considered meaningful.

4.0 RESULTS

Experiment 1 The effect of seedlots of different quality on seedling vigour, grain yield and yield components when grown under conventional management in 1986; a) Katepwa b) HY320 c) Oslo

Seedlots utilized in this experiment were K1-K7, H1-H7 and O1-O6 (Tables 3.1 - 3.3).

Seedlots of Katepwa exhibited no statistically meaningful differences in emergence or seedling vigour as measured by shoot dry matter three weeks after seeding (Table 4.1). Final emergence, taken on the 22 day after seeding, ranged between 71-87 % for the different seedlots.

Significant differences in crop emergence at 8 days for seedlots of HY320 were not maintained at the second or final emergence count (Table 4.2). Final emergence ranged between 60 to 73 % for HY320 seedlots. Shoot dry matter produced at three weeks was similar amongst HY320 seed sources.

Oslo seedlots emerged fairly uniformly, however their shoot dry matter production (seedling vigour) was significantly different (Table 4.3). Seedlot O5C was more vigourous than the other seedlots.

Table 4.1 Effect of Katepwa seedlot on crop emergence and seedling vigour grown under conventional management in 1986 at Portage

Seedlot	Plants emerged m^{-2} at 7 days	Plants emerged m^{-2} at 22 days	Shoot dry matter m^{-2} at 22 days (g)	Shoot dry matter $plant^{-1}$ at 22 days (mg)
K1C	169	142	22.18	152.75
K2C	167	166	22.86	136.58
K3C	167	173	24.84	143.33
K4C	167	174	24.76	143.75
K5C	150	174	22.49	127.28
K6C	142	161	19.46	117.05
K7C	140	150	18.77	120.98

Table 4.2 Effect of HY320 seedlot on crop emergence and seedling vigour grown under conventional management in 1986 at Portage

Seedlot	Plants emerged m^{-2} at 8 days	Plants emerged m^{-2} at 21 days	Shoot dry matter m^{-2} at 22 days (g)	Shoot dry matter $plant^{-1}$ at 22 days (mg)
HIC	102 a	145	11.89	88.27
H2C	67 c	132	13.93	99.22
H3C	87 ab	138	12.34	88.90
H4C	81 bc	126	15.42	122.53
H5C	85 abc	119	10.93	91.30
H6C	73 bc	130	12.31	94.42
H7C	86 ab	133	13.16	99.10

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Table 4.3 Effect of Oslo seedlot on crop emergence and seedling vigour grown under conventional management in 1986 at Portage

Seedlot	Plants emerged m^{-2} at 8 days	Plants emerged m^{-2} at 21 days	Shoot dry matter m^{-2} at 21 days (g)	Shoot dry matter $plant^{-1}$ at 21 days (mg)
O1C	122	121	10.41 c	85.21 b
O2C	108	125	9.95 c	79.72 b
O3C	123	139	11.56 bc	83.92 b
O4C	106	151	12.74 ab	84.62 b
O5C	115	136	13.99 a	100.57 a
O6C	93	147	11.71 abc	79.95 b

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

The seedlots of Katepwa did not differ significantly in yield components or grain yield (Table 4.4). The highest yielding seedlot, K1C, outyielded the lowest yielding seedlot, K7C by 10.9%.

HY320 seedlot grain yields were statistically different from each other, however, yield component differences were not observed (Table 4.5). The difference in grain yield between seedlots of HY320 were as large as 10.7%.

Oslo seedlots were similar to HY320 seedlots by differing in grain yield but not in components of yield (Table 4.6). The maximum difference between yield among Oslo seed sources was 12.3%.

Table 4.4 Effect of Katepwa seedlots on grain yield and yield components grown under conventional management in 1986 at Portage.

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds $head^{-1}$	Thousand kernel weight (g)
K1C	4005	554	27.4	38.3
K2C	3938	596	27.3	37.6
K3C	3913	567	27.5	38.0
K4C	3822	534	27.0	37.9
K5C	3813	590	27.5	37.7
K6C	3664	593	27.5	37.7
K7C	3610	540	27.1	37.6

Table 4.5 Effect of HY320 seedlots on grain yield and yield components grown under conventional management in 1986 at Portage

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds $head^{-1}$	Thousand kernel weight (g)
H1C	4689 a	398	45.0	36.9
H2C	4662 a	360	44.6	37.5
H3C	4517 ab	362	45.5	37.3
H4C	4460 abc	370	45.8	37.1
H5C	4363 bc	373	44.6	36.7
H6C	4353 bc	378	43.9	37.6
H7C	4233 c	356	44.6	37.5

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Table 4.6 Effect of Oslo seedlots on grain yield and yield components grown under conventional management in 1986 at Portage

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds head^{-1}	Thousand kernel weight (g)
O1C	3855 a	422	31.3	40.8
O2C	3842 a	430	30.0	41.1
O3C	3748 a	437	31.1	40.4
O4C	3665 ab	434	30.2	40.3
O5C	3468 b	421	30.9	40.9
O6C	3434 b	383	29.8	40.8

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Experiment 2 The effect of seedlots of different quality on seedling vigour, grain yield and yield components when grown under high management in 1986; a) Katepwa b) HY320 c) Oslo

Seedlots used for this experiment were the same ones used as for the first experiment with the exception that H4H was excluded due to insufficient seed.

Early plant counts (7 days) indicated that Katepwa seedlots differed significantly in emergence (Table 4.7). The differences in seedling vigour were not maintained until the vigour determination at three weeks.

HY320 seedlots differed only in final emergence (Table 4.8).

Oslo seedlots were similar in emergence but shoot dry matter observations indicted differences among seedlots on a per plant and on a per meter^{-2} basis (Table 4.9). Seedlot O4H produced the least shoot dry matter by each measurement.

Table 4.7 Effect of Katepwa seedlot on crop emergence and seedling vigour grown under high management in 1986 at Portage

Seedlot	Plants emerged m^{-2} at 7 days	Plants emerged m^{-2} at 22 days	Shoot dry matter m^{-2} at 22 days (g)	Shoot dry matter $plant^{-1}$ at 22 days (mg)
K1H	324 b	280	35.74	129.73
K2H	335 b	325	39.61	121.50
K3H	376 a	339	41.11	120.28
K4H	326 b	353	44.82	134.35
K5H	368 a	335	39.83	121.22
K6H	322 b	303	37.30	124.83
K7H	324 b	273	33.62	122.47

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Table 4.8 Effect of HY320 seedlot on crop emergence and seedling vigour grown under high management in 1986 at Portage

Seedlot	Plants emerged m^{-2} at 7 days	Plants emerged m^{-2} at 21 days	Shoot dry matter m^{-2} at 21 days (g)	Shoot dry matter $plant^{-1}$ at 21 days (mg)
H1H	188	459 a	38.85	84.78
H2H	139	373 b	37.26	99.52
H3H	154	408 ab	35.06	85.52
H5H	174	388 b	37.53	96.25
H6H	186	401 b	40.09	101.53
H7H	159	391 b	37.99	99.38

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Table 4.9 Effect of Oslo seedlot on crop emergence and seedling vigour grown under high management in 1986 at Portage

Seedlot	Plants emerged m^{-2} at 8 days	Plants emerged m^{-2} at 21 days	Shoot dry matter m^{-2} at 21 days (g)	Shoot dry matter $plant^{-1}$ at 21 days (mg)
O1H	214	285	29.45 a	105.95 a
O2H	187	268	25.00 bc	92.85 ab
O3H	195	262	23.22 c	87.87 bc
O4H	174	292	22.05 c	76.37 c
O5H	176	267	27.86 ab	105.67 a
O6H	189	250	23.22 c	94.70 ab

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

There were no significant differences between Katepwa seedlots grown under high management with regards to yield components or grain yield. Greatest differences in yield (13.5%) were found between seedlots K5H and K6H (Table 4.10).

The thousand kernel weight was the only yield component resulting from different HY320 seedlots to be statistically different (Table 4.11). Grain yields were not significantly different with the greatest difference in yields between seedlots being 5.9%.

Oslo seedlots displayed significant differences in yield. Seedlots O4H and O6H yielded less than all other Oslo seedlots (Table 4.12). The largest yield difference amongst seedlots tested was 7.3%. The two seedlots which yielded the least were also the lowest ones with regards to the number of seeds head^{-1}. Seeds head^{-1} was the only yield component to exhibit significant differences between seedlots.

Table 4.10 Effect of Katepwa seedlot on grain yield and yield components grown under high management in 1986 at Portage.

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds head^{-1}	Thousand kernel weight (g)
K1H	3178	669	20.9	36.1
K2H	3383	735	21.5	36.9
K3H	3326	637	22.3	36.1
K4H	3135	645	21.9	36.1
K5H	3506	686	21.6	36.4
K6H	3088	666	21.2	36.4
K7H	3307	640	20.6	36.3

Table 4.11 Effect of HY320 seedlot on grain yield and yield components grown under high management in 1986 at Portage

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds head^{-1}	Thousand kernel weight (g)
H1H	4977	377	43.6	36.9 b
H2H	4834	348	44.2	36.8 b
H3H	4932	375	44.8	36.8 b
H5H	5121	371	44.0	38.3 a
H6H	5115	361	41.8	37.0 b
H7H	5058	353	43.1	38.2 a

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Table 4.12 Effect of Oslo seedlot on grain yield and yield components grown under high management in 1986 at Portage

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds $head^{-1}$	Thousand kernel weight (g)
O1H	4625 a	558	26.9 ab	42.1
O2H	4599 a	497	27.3 a	42.1
O3H	4699 a	573	26.7 ab	42.4
O4H	4380 b	541	25.0 c	41.5
O5H	4667 a	549	26.0 bc	41.9
O6H	4402 b	548	24.9 c	41.8

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Experiment 3 The effect of seedlots of different quality on seedling vigour, grain yield and yield components when grown under conventional management in 1987; a) Katepwa b) HY320 c) Oslo

Seedlots utilized in this experiment were K8-K13, H8-H13, and O7-O11 (Tables 3.1 - 3.3).

Katepwa seedlots did not differ in emergence or shoot dry matter production (Table 4.13). HY320 emergence was similar between seedlots. Shoot dry matter $plant^{-1}$ was lower for H12C and H13C than for any of the other seedlots (Table 4.14). Oslo seedlots displayed significant differences in emergence and shoot dry matter production (Table 4.15). Seedlot O10C produced the best plant stand. Seedlot O11C emerged the poorest of all seedlots thus contributing to the lowest production of shoot dry matter m^{-2}. On a per plant basis this seedlot was lower in shoot dry matter production than three of the four other seedlots.

Table 4.13 Effect of Katepwa seedlot on crop emergence and seedling vigour, grown under conventional management in 1987 at Portage

Seedlot	Plants emerged m^{-2} at 13 days	Plants emerged m^{-2} at 25 days	Shoot dry matter m^{-2} at 25 days (g)	Shoot dry matter $plant^{-1}$ at 25 days (mg)
K8C	139	200	9.80	48.41
K9C	106	196	8.89	45.05
K10C	124	201	10.50	52.33
K11C	108	191	10.63	55.39
K12C	115	202	11.30	54.90
K13C	124	211	11.09	52.33

Table 4.14 Effect of HY320 seedlot on crop emergence and seedling vigour, grown under conventional management in 1987 at Portage.

Seedlot	Plants emerged m^{-2} at 13 days	Plants emerged m^{-2} at 25 days	Shoot dry matter m^{-2} at 25 days (g)	Shoot dry matter $plant^{-1}$ at 25 days (mg)
H8C	156	162	9.91	60.51 a
H9C	155	169	9.77	57.59 a
H10C	139	161	10.20	62.56 a
H11C	161	171	10.61	62.90 a
H12C	162	166	8.02	48.31 b
H13C	147	159	7.81	49.06 b

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Table 4.15 Effect of Oslo seedlot on crop emergence and seedling vigour, grown under conventional management in 1987 at Portage

Seedlot	Plants emerged m^{-2} at 13 days	Plants emerged m^{-2} at 26 days	Shoot dry matter m^{-2} at 26 days (g)	Shoot dry matter $plant^{-1}$ at 26 days (mg)
O7C	149 bc	179 bc	10.17 a	56.68 a
O8C	159 b	191 ab	9.99 a	52.25 ab
O9C	144 c	164 c	9.47 a	56.46 a
O10C	181 a	212 a	10.66 a	49.45 bc
O11C	109 d	129 d	5.96 b	46.23 c

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Seedlots of Katepwa wheat grown under conventional management in 1987 showed no statistically significant differences in either yield or yield components (Table 4.16). The largest difference in yield between seedlots was 1.7% for seedlots K8C and K12C or K13C. Similarily, HY320 seedlots did not differ in yield components or yield under the conventional management (Table 4.17). The largest yield difference was 3.8% between H8C and H13C. Seedlots of Oslo were different in the yield components seeds $head^{-1}$ and thousand kernel weight. The yield component differences may have been responsible for yield differences. The seedlot (O11C) that had the poorest vigour also had the lowest grain yield. It was able to compensate for a reduced plant stand by tillering to a greater extent than the stands produced by the other seedlots.

Table 4.16 Effect of Katepwa seedlot on grain yield and yield components grown under conventional management in 1987 at Portage

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds $head^{-1}$	Thousand kernel weight (g)
K8C	4267	565	26.9	35.9
K9C	4241	564	26.9	35.9
K10C	4229	579	26.7	35.7
K11C	4213	574	26.6	35.9
K12C	4195	568	26.3	36.2
K13C	4195	565	26.9	36.1

Table 4.17 Effect of HY320 seedlot on grain yield and yield components grown under conventional management in 1987 at Portage

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds $head^{-1}$	Thousand kernel weight (g)
H8C	4401	392	40.9	33.9
H9C	4390	388	40.8	33.7
H10C	4365	403	40.4	34.4
H11C	4282	392	41.0	33.8
H12C	4261	383	40.9	34.1
H13C	4241	376	40.7	34.5

Table 4.18 Effect of Oslo seedlot on grain yield and yield components grown under conventional management in 1987 at Portage

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds $head^{-1}$	Thousand kernel weight (g)
O7C	4084 a	461	31.0 bc	36.5 a
O8C	4042 a	421	31.8 ab	36.5 a
O9C	3961 ab	446	31.2 bc	36.4 a
O10C	3858 b	444	30.4 c	37.0 a
O11C	3838 b	419	32.7 a	35.3 b

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Experiment 4 The effect of seedlots of different quality on seedling vigour, grain yield and yield components when grown under high management in 1987; a) Katepwa b) HY320 c) Oslo

Seedlots used in this experiment were identical to the ones used for the conventional management experiment.

Katepwa seedlots produced significantly different plant stands as measured on the 26 day after seeding (Table 4.19). The plant stand differences were not translated into shoot dry matter differences. HY320 seedlots produced plant populations that did not statistically differ (Table 4.20). The average plant shoot dry matter was different among stands produced from the six HY320 seedlots. Seedlot H12H produced the smallest seedlings at 26 days. Oslo seedlots grown under high management displayed significant differences in emergence and shoot dry matter production (Table 4.21). Seedlot O11H was the least vigourous of the Oslo seedlots.

Seedlot O11H also had the lowest seedling vigour under conventional management.

Table 4.19 Effect of Katepwa seedlot on crop emergence and seedling vigour grown under high management in 1987 at Portage

Seedlot	Plants emerged m^{-2} at 13 days	Plants emerged m^{-2} at 25 days	Shoot dry matter m^{-2} at 25 days (g)	Shoot dry mater $plant^{-1}$ at 25 days (mg)
K8H	240	404 ab	20.44	50.71
K9H	222	374 abc	19.36	51.60
K10H	223	422 a	21.28	51.61
K11H	246	323 c	18.82	59.71
K12H	233	355 bc	17.91	49.79
K13H	225	386 ab	19.02	49.33

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Table 4.20 Effect of HY320 seedlot on crop emergence and seedling vigour grown under high management in 1987 at Portage

Seedlot	Plants emerged m^{-2} at 13 days	Plants emerged m^{-2} at 26 days	Shoot dry matter m^{-2} at 26 days (g)	Shoot dry matter $plant^{-1}$ at 26 days (mg)
H8H	327	332	16.20	48.83 b
H9H	325	345	17.46	50.00 b
H10H	297	318	17.31	54.22 ab
H11H	328	364	20.94	57.65 a
H12H	316	358	15.08	42.40 c
H13H	313	350	17.16	48.72 b

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Table 4.21 Effect of Oslo seedlots on crop emergence and seedling vigour grown under high management in 1987 at Portage.

Seedlot	Plants emerged m^{-2} at 13 days	Plants emerged m^{-2} at 26 days	Shoot dry matter m^{-2} at 26 days (g)	Shoot dry matter $plant^{-1}$ at 26 days (mg)
O7H	338 ab	367 a	15.46 b	42.39 c
O8H	356 a	380 a	18.31 a	49.11 b
O9H	320 b	325 b	18.10 a	55.60 a
O10H	357 a	397 a	18.10 a	45.39 bc
O11H	240 c	255 c	10.71 c	41.78 c

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

Katepwa seedlots were not significantly different in the yield or the yield components they produced when grown under high management (Table 4.22). The highest yielding seedlot yielded 7.1% higher than the lowest yielding seedlot. There were not significant differences in yield or yield components from the seedlots of HY320 grown under high management (Table 4.23). The greatest range in yields produced from the HY320 seedlots was 6.8%. Statistically meaningful differences were found for yield, seeds $head^{-1}$, and thousand kernel weight amongst seedlots of Oslo (Table 4.24). The range in grain yields was 4.7%.

Table 4.22 Effect of Katepwa seedlots on grain yield and yield components grown under high management in 1987 at Portage

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds $head^{-1}$	Thousand kernel weight (g)
K8H	4258	691	25.3	36.4
K9H	4258	704	24.0	36.4
K10H	4295	701	24.5	36.3
K11H	4402	685	24.3	36.5
K12H	4112	699	25.3	37.0
K13H	4168	695	24.8	36.7

Table 4.23 Effect of HY320 seedlots on grain yield and yield components grown under high management in 1987 at Portage

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds $head^{-1}$	Thousand kernel weight (g)
H8H	4859	430	40.1	35.7
H9H	4956	435	41.1	34.9
H10H	5165	396	40.4	36.6
H11H	5203	453	40.6	35.5
H12H	4849	440	39.3	36.3
H13H	5128	426	40.6	37.1

Table 4.24 Effect of Oslo seedlot on grain yield and yield components grown under high management in 1987 at Portage

Seedlot	Grain yield kg ha^{-1}	Heads m^{-2}	Seeds $head^{-1}$	Thousand kernel weight (g)
O7H	4536 a	510	29.1 b	39.9 a
O8H	4360 b	499	27.9 c	40.6 a
O9H	4334 b	493	29.1 b	40.6 a
O10H	4499 a	505	27.8 c	40.0 a
O11H	4412 ab	533	30.1 a	37.7 b

Means followed by different letters within a column are significantly different at $P < 0.10$ (LSD) test.

5.0 DISCUSSION

5.1 Seedling vigour

Germination tests (Tables 3.1 - 3.3) indicated that seedlots of the three varieties had adequate viability and none of the seedlots displayed seed dormancy. The lowest germination percentage (87.5%) was found for two HY320 seedlots in 1986. This level of viability is still high enough to meet the minimum germination requirement (85%) for Canada Certified No. 1 seed (Anon 1988). The uniformity of germination would indicate that another seed factor must be responsible for the differences in seedling vigour, yield and yield components observed in the experiments.

In 1986 early season precipitation and cold temperatures delayed field work until the third week of May (Appendix 1). The wet seedbed coupled with deep initial cultivation of the clay loam soil resulted in a lumpy seedbed. The poor seedbed created a stress for seedling emergence, thereby limiting final emergence to levels varying between 60-70% for the two semi-dwarf cultivars and 70-85% for the Katepwa wheat. These levels of emergence are probably higher than expected for most field emergence experiments or in a producers field. In 1987 the emergence levels of all seedlots of all three wheat cultivars, with the exception of O11 (Tables 4.15 and 4.21), was > 80%. The seedbed preparation in 1987 was more suitable to rapid, uniform emergence.

Significant differences in early emergence between seedlots was noted in 1986 for HY320 under conventional management (Table 4.2) and Katepwa wheat under high management (Table 4.7). Final emergence counts indicated that differences were only present for a short period of time. In 1987 Oslo seedlots maintained differences in emergence through both sampling periods for both management levels (Table 4.15 and 4.21). It appears that seedlot O11 was of significantly lower vigour than all other Oslo seedlots tested that year. O11 had a germination percentage of 93% yet is of significantly lower vigour than seedlots which had similar germination rates. The farmer who produced O11 indicated that he had used a commercial dryer (heat) to dry the seed sample. This is in agreement with Abdul-Baki (1969) who determined that germination is not always a good indicator of a seedlots level of vigour.

Differences in seedling vigour have been reported to be more noticeable under stress conditions (Waldron, 1941; Torres, 1982). One would expect that differences among seedlots to be accentuated in 1986 compared to 1987 as a result of the poorer seedbed preparation. This can not be confirmed from these studies, since different seedlots were used in 1987 than in 1986. Good crop growth conditions following seeding in 1986 may have eliminated differences which were present shortly after emergence.

Shoot dry matter m^{-2} is a measure of the biomass produced and does not account for differences in plant stand. Shoot dry matter $plant^{-1}$ is a better indicator of the differences in size of the individual seedlings. Shoot dry matter differences were found in Oslo under both types of management in 1986, even though differences in emergence were not detected. In 1987 seedling vigour differences were determined among seedlots of Oslo under both types of management. HY320 seedlots produced seedlings which differed significantly in individual plant size under each management system. It appears that Oslo, the cultivar which was commercial seed, was more variable than the two cultivars that were certified seed.

5.2 Yield and Yield Components

Significant yield differences attributed to seed source were found under conventional management for HY320 and Oslo in 1986. The highest yielding seedlot outyielded the lowest seedlot by more than 10% for each variety grown under conventional management in 1986. This yield reduction represents about 400 kg ha^{-1} or approximately 6 bu $acre^{-1}$. There were no noticeable differences in yield components which could explain the yield variations.

Under high crop management in 1986, seedlots of Oslo varied significantly in yield produced. The seeds $head^{-1}$ may have been partially responsible for the yield variation. Seedlot O5 produced the largest plants at the time of shoot dry matter sampling (Table 4.3), however this advantage was not maintained until harvest (Table 4.6) under the conventional management, indicating that there may have been too much competition early in the season for some nutrient or for soil moisture which may have resulted in poor yield production later .

The only variation in 1987 in yield and yield components was found with Oslo. Seeds head^{-1} and thousand kernel mass were the yield components which may have produced the yield differences. Seedlot O11, under either conventional or high management, produced the poorest plant stand. This seedlot compensated for poor establishment by increased tiller production and survival thereby eliminating any differences in heads meter^{-1} between seedlots. The seeds on the tillers had less time for grain filling as indicated by the significantly lower thousand kernel mass (Table 4.24). Under good growing conditions a crop may compensate for reduced plant stands by altering the components of yield (Anderson et al., 1975).

5.3 Seed quality parameters

Seed weight and seed protein (% or mg seed^{-1}) did not predict emergence, shoot dry matter production, grain yield or yield components. These findings are in contrast with the work of other researchers (Ayers et al., 1976; Evans and Bhatt, 1977; Ries and Everson, 1973). The limited range for the quality parameters may have made differences attributable to these quality factors hard to detect. Mian and Nafziger (1992) found that seed of three winter wheat cultivars, over a fairly large range in seed weight, showed little effect on emergence, grain yield and heads per unit area. An alternate explanation may be that nitrogen fertility levels were too high to get a response to seed protein (Bulisani and Warner,1980) or that conditions were not stressful enough to observe a response to seed quality (Waldron, 1941; Torres, 1982).

5.4 Crop management

Interactions between management levels and seedlots can not be statistically analyzed for significance as the experiment did not use a split-plot design. Comparisons between cultivars subjected to different growing conditions as a result of different seed dates can not be accurately compared. Generally, crop management affected seedlot rankings when differences for a parameter were significant under both management levels. There were instances when management did not affect the rankings of seedlots (O11 seedling vigour).

5.5 Cultivars

Wheat is a self-pollinated crop with only about 1 % of flowers being cross pollinated. By following strict isolation practices, seed growers minimize the amount of outcrossing in wheat, thereby maintaining varietal purity. Thus, differences observed in the experiments were due to the environment rather than genotype.

Katepwa seedlots tended to be the least variable of the three cultivars as only on two occasions, over both years and management levels, was there statistically meaningful differences detected amongst parameters. HY320 seedlots were intermediate in variability as six parameters were found to differ significantly over the two years and the two management levels. Oslo seedlots displayed the greatest amount of variability as a total of twenty parameters measured over the two years and two crop management systems were found to have statistically significant differences. These results would indicate that the variability in the commercial seed (Oslo) was much greater than that for the two certified varieties (HY320 and Katepwa). A possible explanation may be that seed producers may follow better, more consistent, crop management practices thereby minimizing the variability between seedlots. Large seed has been found to be more susceptible to internal damage during threshing, resulting in reduced seed vigour (Bourgeois, 1992, pers. comm.). This could explain the greater variability for the two large seed size cultivars, HY320 and Oslo, than for the smaller seed size cultivar, Katepwa.

6.0 CONCLUSIONS

1. Differences between seedlots were found for each of the three spring wheat cultivars. Katepwa seedlots seemed to be the most uniform with the least number of statistically different parameters determined. Oslo seedlots, obtained as commercial seed from producers, had more variation amongst seedlots than the two varieties which were certified seed only.

2. Crop management level sometimes changed the seedlot ranking when a statistically different parameter was observed for both management levels . The high management level didn't eliminate seedlot differences as was expected.

3. The effect of seed quality parameters was inconclusive. The range in parameters may not have been great enough to show differences or perhaps the stress on the seed and crop may have been too light for significant differences to appear.

4. Often early seedling vigour advantages were lost later in the growing season probably by yield component compensation thus eliminating any yield differences that may have been expected.

LITERATURE CITED

Abdul-Baki, A.A. 1969. Relationship of glucose metabolism to germinability and vigor in barley and wheat seeds. Crop Sci. 9:732-737.

Anderson, C.H. 1975. Comparison of preseeding tillage with total and minimal tillage of various seeding machines on spring wheat production in southern Saskatchewan. Can. J. Plant Sci. 55:59-67.

Anonymous. 1988. Regulations and procedures for pedigreed crop production. Canadian Seed Growers' Association. Circular 6.

Austenson, H.M. and P.D. Walton. 1970. Relationship between initial seed weight and mature plant characters in spring wheat. Can. J. Plant Sci. 50:53-58.

Ayers, G.S., V.F. Wert and S.K. Ries. 1976. The relationship of proteins to seedling vigour in wheat. Ann. of Bot. 40:563-570.

Boyd, W.R., A.G. Gordon and L.J. Lacroix. 1971. Seed size, germination resistance and seedling vigor in barley. Can. J. Plant Sci. 51:93-99.

Bremner, P.M., R.N. Eckersall and R.K. Scott. 1963. The relative importance of embryo size and endosperm size in causing the effects associated with seed size in wheat. J. Agric. Sci., Camb. 61:139-145.

Brown, P.D. 1973. MSc Thesis, University of Manitoba 71pp. Seed size of wheat - its inheritance and influence on yield.

Bulisani, E.A. and R.L. Warner. 1980. Seed protein and nitrogen effects upon seedling vigor in wheat. Agron. J. 72:657-662.

Carver, M.F.F. 1977. The influence of seed size on the performance of cereals in variety trials. J. Agric. Sci., Camb. 89:247-249.

Dasgupta P.R. and H.M. Austenson. 1973. Relations between estimates of seed vigor and field performance in wheat. Can. J. Plant Sci. 53:43-46.

Demirlicakmak, A., M.L.Kaufmann and L.P.V. Johnson. 1963. The influence of seed size and seeding rate on yield and yield components of barley. Can. J. Plant Sci. 43:330-337.

Evans, L.E. and G.M. Bhatt. 1977. Influence of seed size, protein content and cultivar on early seedling vigor in wheat. Can. J. Plant Sci. 57:929-935.

Fjell, D.L., G.M. Paulsen and T.L. Walter. 1985. Relationship among planted and harvested kernel weights and grain yield and protein percentage in winter wheats. Euphytica. 34:751-757.

Gan, Y., E.H. Stobbe and J. Moes. 1992. Plant to plant variablity and its impact on grain yield in wheat. p. 101-111. In: Proc. Manitoba Agri-Forum, Winnipeg, Manitoba.

Graf, R.J., P. Hucl, J. Smith and L.S.P. Song. 1990. Oslo red spring wheat. Can J. Plant Sci. 70:299-302.

Kaufmann, M.L. and A.D. McFadden. 1960. The competitive interaction between barley plants grown from large and small seeds. Can. J. Plant Sci. 40:623-629.

Kaufmann, M.L. 1963. The influence of seed size on results of barley yield trials. Can. J. Plant Sci. 43:51-58.

Kaufmann, M.L. and A.A. Guitard. 1967. The effect of seed size on early plant development in barley. Can. J. Plant Sci. 47:73-78.

Kiesselbach, T.A. 1924. Relation of seed size to the yield of small grain crops. J. Amer. Soc. Agron. 16:670-682.

Lafond, G.P. and R.J. Baker. 1986. Effects of genotype and seed size on speed of emergence and seedling vigor in nine spring wheat cultivars. Crop Sci. 26:341-346.

Lowe, L.B., G.S. Ayers and S.K. Ries. 1972. Relationship of seed protein and amino acid composition to seedling vigor and yield of wheat. Agron. J. 64:608-611.

Lowe, L.B. and S.K. Ries. 1973. Endosperm protein of wheat seed as a determinant of seedling growth. Plant Physiol. 51:57-60.

McFadden, A.D. 1963. Effect of seed source on comparative test results in barley. Can. J. Plant Sci. 43:295-300.

McNeal, F.H., M.A. Berg, A.L. Dubbs, J.L. Kroll, D.E. Baldridge and G.P. Hartmann. 1960. The evaluation of spring wheat seed from different sources. Agron. J. 52:303-304.

McNeal, F.H., C.F. McGuire and M.A. Berg. 1978. Recurrent selection for grain protein content in spring wheat. Crop Sci. 18:779-782.

Metivier, J.R. and J.E. Dale. 1977. The effects of grain nitrogen and applied nitrate on growth, photosynthesis and protein content of the first leaf of barley cultivars. Ann. of Bot. 41:1287-1296.

Mian, A.R. and E.D. Nafziger. 1992. Seed size effects on emergence, head number, and grain yield of winter wheat. J. Prod. Agric. 5:265-268.

Morrison, I.N., K.M. Nawolsky, M.H. Entz and A.E. Smith. 1991. Differences among certified wheat seedlots in response to trifluralin. Agron. J. 83:119-123.

Perry, D.A. 1980. The concept of seed vigour and its relevance to seed production techniques. p 585-591. In Hebblethwaite, P.D. (ed.) Seed production. Butterworths, London.

Phillips, D.P. and J.S. Schlesinger. 1974. Protein separation by kernel sizing. Bakers Digest. 48:40-41.

Puri, Y.P. and C.O. Qualset. 1978. Effect of seed size and seeding rate on yield and other characteristics of durum wheat. Phyton. 36:41-51.

Quinby, J.R., L.P.Reitz and H.H. Laude. 1962. Effect of source of seed on productivity of hard red winter wheat. Crop Sci. 2:201-203.

Ries, S.K., O. Moreno, W.F. Meggitt, C.J. Schweizer and S.A. Ashkar. 1970. Wheat seed protein: Chemical influence on and relationship to subsequent growth and yield in Michigan and Mexico. Agron. J. 62:746-748.

Ries, S.K. and E.H. Everson. 1973. Protein content and seed size relationships with seedling vigor of wheat cultivars. Agron. J. 65:884-886.

Ries, S.K., G. Ayers, V. Wert and E.H. Everson. 1976. Variation in protein, size and seedling vigor with position in heads of winter wheat cultivars. Can. J. Plant Sci. 56:823-827.

Rossnagel, B.G. and R.J. Baker. 1985. Effects of seed cleaning on yield of pedigreed and commercial seed lots of barley and wheat. Can. J. Plant Sci. 65:1114.

SAS Institute, Inc. 1985. SAS user's guide: Statistics 5th ed. SAS Inst., Inc., Cary, NC.

Schweizer, C.J. and S.K. Ries. 1969. Protein content of seed: Increase improves growth and yield. Science. 165:73-75.

Sonntag, W.W., B.G. Rossnagel, and R.J. Baker. 1988. Factors affecting performance of different pedigree seedlots of Harrington and Katepwa wheat. p. 212-216. In Proc. Soils and Crop Workshop, Saskatoon, Sask., 18-19 Feb. 1988. Div. of Ext. and Community Relations, Univ. Sask., Saskatoon.

Spilde, L.A. 1989. Influence of seed size and test weight on several agronomic traits of barley and hard red spring wheat. J. Prod. Agric. 2:169-172.

Torres, J.L. and G.M. Paulsen. 1982. Increasing seed protein content enhances seedling emergence and vigor in wheat. J. Plant Nut. 5:1133-1140.

Waldron, L.R. 1941. Analysis of yield of hard red spring wheat grown from seed of different weights and origin. J. Ag. Res. 62:445-460.

Welch, R.W. 1977. Seedling vigour and grain yield of cereals grown from seeds of varying protein contents. J. Agric. Sci., Camb. 88:119-125.

APPENDIX

Appendix 1 Weather data 1986

May 1986

Date	Temperature °C Max.	Min.	Mean	Rain (mm)	Snow (cm)
1	3.0	-2.5	0.3	TR	TR
2	9.7	-2.5	3.6		
3	20.4	1.1	10.8		
4	17.0	7.0	12.0	1.2	
5	11.8	5.9	8.9	34.2	
6	10.0	1.4	5.7	5.3	TR
7	11.2	-0.4	5.4		
8	10.0	4.9	7.5		
9	20.3	5.4	12.9	2.1	
10	19.1	7.9	13.5	0.2	
11	22.9	5.2	14.1	1.0	
12	19.2	10.2	14.7		
13	21.6	7.4	14.5		
14	20.6	5.2	12.9	1.2	
15	18.4	5.0	11.7	TR	
16	11.8	3.9	7.9		
17	11.0	3.4	7.2	0.2	
18	16.8	0.1	8.5		
19	22.6	7.7	15.2		
20	23.2	8.2	15.7		
21	24.2	4.0	14.1		
22	24.3	5.4	14.1		
23	22.2	10.0	16.1		
24	22.3	9.8	16.1	0.5	
25	27.4	9.6	18.5		
26	29.0	11.7	20.4		
27	31.5	11.0	21.3		
28	33.6	15.2	24.4		
29	34.2	16.8	25.5		
30	30.4	15.3	22.9		
31	26.9	11.0	19.0		
Mean	20.2	6.6	13.4		
Total				45.9	TR
Normal	17.0	4.6	10.8	60.0	3.7

June 1986

Date	Temperature °C Max.	Min.	Mean	Rain (mm)	Snow (cm)
1	17.3	8.1	12.7		
2	27.7	9.6	18.7	0.6	
3	24.0	12.2	18.1		
4	17.5	5.4	11.5		
5	21.9	7.5	14.7	TR	
6	25.9	12.9	19.4	13.9	
7	22.6	10.0	16.3		
8	22.7	3.0	12.9		
9	23.7	10.0	16.9	TR	
10	17.3	12.8	15.1		
11	23.6	11.5	17.6		
12	21.7	8.8	15.3	TR	
13	22.3	6.1	14.2	0.3	
14	17.8	4.7	11.3	1.8	
15	16.4	8.0	12.2	7.6	
16	17.9	5.6	11.8		
17	24.9	10.3	17.6		
18	32.1	11.0	21.6		
19	33.1	16.0	24.6	12.2	
20	25.2	16.1	20.7	1.8	
21	26.6	15.9	21.3	15.6	
22	24.4	12.5	18.5	1.4	
23	16.0	8.2	12.1	4.0	
24	25.4	7.0	16.2		
25	25.5	17.3	21.4	0.8	
26	23.1	13.5	18.3	32.6	
27	23.3	13.2	18.3	TR	
28	22.7	12.4	17.6		
29	20.6	8.7	14.7		
30	19.6	12.3	16.0	0.2	
31					
Mean	22.8	10.4	16.6		
Total				92.8	0
Normal	22.7	10.7	16.9	76.0	0

July 1986

Date	Temperature °C Max.	Min.	Mean	Rain (mm)	Snow (cm)
1	23.6	12.2	17.9		
2	23.7	11.2	17.5		
3	31.4	16.1	23.8	20.2	
4	25.9	15.0	20.5	0.2	
5	23.7	17.2	20.5	5.0	
6	21.3	13.2	17.3		
7	24.4	12.7	18.6		
8	26.0	11.9	18.9	5.0	
9	23.5	12.6	18.1	13.8	
10	18.0	13.1	15.6	39.0	
11	20.4	13.6	17.0	9.3	
12	15.9	13.1	14.5	1.6	
13	20.7	13.1	16.9	0.9	
14	26.4	14.4	20.4	1.4	
15	27.7	14.7	21.2		
16	24.8	18.4	21.6	TR	
17	25.5	17.0	21.3	13.5	
18	27.9	14.9	21.4		
19	23.6	13.5	18.6	14.6	
20	22.3	11.5	16.9		
21	26.9	13.1	20.0		
22	26.5	14.7	20.6		
23	30.8	18.2	24.5	7.6	
24	23.5	15.1	19.3		
25	27.8	13.0	20.4	1.8	
26	25.9	16.0	21.0	1.8	
27	26.4	13.7	20.1		
28	26.5	16.0	21.3	2.0	
29	29.1	15.6	22.4	8.4	
30	24.1	14.5	19.3	TR	
31	24.7	12.0	18.4	3.0	
Mean	24.8	14.2	19.5		
Total				149.1	
Normal	25.6	13.5	19.6	77.4	0

August 1986

Date	Temperature °C Max.	Min.	Mean	Rain (mm)	Snow (cm)
1	21.1	11.5	16.3	0.8	
2	23.0	10.6	16.8		
3	27.8	13.2	20.5	2.0	
4	27.6	13.6	20.6	TR	
5	27.1	13.9	20.5	TR	
6	27.9	14.4	21.2	6.0	
7	25.9	14.5	20.2		
8	27.2	13.0	20.1		
9	19.6	11.1	15.4	2.4	
10	19.9	7.0	13.5	TR	
11	23.5	8.0	15.8		
12	28.3	12.9	20.6		
13	30.0	15.4	22.7		
14	26.7	15.7	21.2		
15	30.9	12.7	21.8		
16	24.0	11.0	17.5		
17	21.4	6.5	14.0		
18	28.0	8.2	18.1		
19	34.5	16.5	25.5	1.8	
20	20.9	9.3	15.1		
21	24.3	7.1	15.7		
22	19.6	8.6	14.1	6.0	
23	25.5	7.1	16.3		
24	24.6	14.0	19.3	1.8	
25	17.1	9.8	13.5	TR	
26	14.9	5.4	10.2	TR	
27	16.8	4.6	10.7		
28	24.1	5.4	14.8		
29	28.7	11.2	20.0		
30	30.0	10.5	20.3		
31	21.4	11.6	16.5		
Mean	24.6	10.8	17.7		
Total				20.8	0
Normal	24.9	12.2	18.6	78.7	0

Appendix 2 Weather data 1987

May 1987

Date	Temperature (C) Max.	Min.	Mean	Precip. (mm)
1	20	4	12	0
2	19	2	11	0
3	22	1	11	0.6
4	24	7	16	TR
5	27	10	16	0
6	22	5	13	0
7	21	5	13	0
8	32	7	21	0
9	17	7	12	0
10	26	4	15	0
11	19	4	12	0
12	32	12	22	0
13	15	9	19	3
14	23	5	14	0
15	34	11	21	0
16	16	10	13	15
17	16	6	11	0
18	19	5	12	0
19	20	9	14	0
20	18	3	12	6
21	9	1	4	1
22	17	-3	12	0
23	25	9	14	0
24	25	7	17	0
25	21	9	14	1
26	17	10	14	4
27	23	13	16	3
28	15	14	19	5
29	17	13	16	0
30	19	11	20	0
31	11	12	23	0
Avr.	21.3	7.3	14.8	38.6

June 1987

Date	Temperature (C) Max.	Min.	Mean	Precip. (mm)
1	23	11	18	9
2	17	7	12	4
3	21	5	12	0
4	19	9	13	0
5	27	10	18	0
6	28	16	21	9
7	23	10	19	0
8	21	6	14	0
9	24	7	16	0
10	24	9	14	10
11	27	14	20	0
12	31	15	23	0
13	35	13	26	0
14	30	15	23	0
15	25	13	26	0
16	33	14	25	0
17	30	19	24	2
18	29	14	22	0
19	29	12	22	0
20	30	15	22	2
21	30	16	23	3
22	34	17	26	0
23	27	15	22	3
24	26	12	19	0
25	22	12	16	2
26	23	8	16	0
27	26	7	16	0
28	21	9	16	0
29	24	8	17	0
30	26	6	17	0
Avr.	26.0	11.9	19.0	44.0

July 1987

Date	Temperature (C) Max.	Min.	Mean	Precip. (mm)
1	26	13	18	10
2	25	11	19	0
3	27	9	19	0
4	29	14	22	0
5	31	18	23	0
6	23	15	18	3
7	27	15	21	0
8	25	11	18	0
9	29	13	22	2
10	26	16	20	4
11	19	13	16	0
12	21	11	16	0
13	25	10	17	0
14	22	11	16	1
15	26	11	18	0
16	28	11	21	0
17	24	15	19	0
18	18	14	16	18
19	23	14	17	17
20	28	15	21	0
21	20	11	15	1
22	23	14	18	4
23	26	15	20	0
24	29	11	20	1
25	29	16	22	0
26	28	13	21	0
27	31	13	21	0
28	33	17	26	0
29	32	14	24	0
30	26	18	22	21
31	24	19	21	0
Avr.	25.4	13.9	19.7	82.0

August 1987

Date	Temperature (C) Max.	Min.	Mean	Precip. (mm)
1	32	20	24	1
2	31	13	23	0
3	22	13	16	0
4	21	7	15	0
5	27	12	19	7
6	26	14	19	0
7	30	10	20	0
8	31	17	22	0
9	26	14	19	0
10	28	10	18	14
11	25	15	20	7
12	22	9	15	0
13	22	9	16	0
14	20	11	14	182
15	12	15	18	0
16	19	12	15	0
17	14	16	16	0
18	22	10	15	0
19	25	8	16	0
20	25	9	18	0
21	21	11	18	3
22	19	7	13	0
23	21	6	14	0
24	26	8	16	0
25	21	9	15	0
26	23	8	16	0
27	26	10	17	0
28	27	13	19	0
29	23	13	17	3
30	18	6	13	0
31	13	4	14	0
Avr.	23.3	10.7	17.2	117.0

Appendix 3 Soil test results or recommendations

1986	Nitrogen Recommendation	60	kg ha-1
	Potassium	10	
1987	Nitrogen available (NO3-)	59.9	kg ha-1
	Phosphorus	15.1	
	Potassium	540.0	
	Sulphur	162.0	
	% Organic matter	6.0	
	pH	7.7	