THE EFFECT OF DATE OF PLANTING ON YIELD AND OTHER AGRONOMIC CHARACTERISTICS IN WHEAT AND BARLEY

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WHEAT AND BARLEY TRIALS

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AN ABSTRACT OF THE THESIS OF

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Title: The effect of date of planting on yield and other agronomic characteristics in wheat and barley.

A two-year study was carried out at the Agricultural Research and Education Center of the American University of Beirut in the Beqa'a Plain, Lebanon, to determine the effect of four dates of planting on yield and other agronomic characteristics in wheat and barley varieties. The grain yields of wheat and barley were the highest from the November 15 and November 30 plantings. The early varieties planted on November 1 and November 15 were injured by low temperatures that occurred in March of each year. The yield of straw and the size of the plants were reduced from the first to the last date of planting. The wheat and barley grain from seedings made on December 15 contained the highest protein percentage and that planted on November 1 contained the lowest protein content. Small difference in 100-kernel weights were observed in wheat when planted at different dates. The largest seeds in barley were produced from the later plantings made in 1964-65 and from the earlier plantings made in 1965-66. As the dates of plantings were delayed, the number of days from planting to heading and maturity were reduced in both crops.

In wheat, Senator Capelli produced higher amounts of grain and straw in 1965 than in 1966. It contained higher protein percentages in the grain, produced larger seeds and required more days from planting to heading and maturity than F.A.O.-6726 and Florence Aurore. In barley, Athinais produced the shortest plants and was the earliest in heading and maturity. Baladi contained more protein in the grain and headed later than F.A.O.-7028 and Athinais. F.A.O.-7028 produced the tallest plants and required a longer period for maturity than Baladi and Athinais.

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I. INTRODUCTION

Wheat and barley are grown extensively in all countries of the Near East. They are adapted to a wide range of soils and climatic conditions and produce satisfactory grain yields during favorable years. The Near Eastern Countries depend mainly on these two cereals as their basic food crops. At present half of the calories required by the population are supplied by wheat and barley (2, pp. 27). The people of the Near East consume an average of 160 kg per caput per year, as compared to 146 kg for those in the far East and 70 kg in North America (1, pp. 27). In the Near East, in 1962-63 (27, pp. 36), 18.0 million metric tons of wheat were produced on 17.7 million hectars. During this same year 7.0 million tons of barley were grown on 7.2 million hectars in this region. Because of the importance of these cereals, FAO (26), since 1950, has introduced in this region more than 2000 varieties of wheat and barley for local appraisal for yield and adaptability. However, very limited research has been done in the region on the important cultural practices that may greatly effect the yield of cereals. The date of planting is considered to be very important in the production of winter wheat and barley.

The purpose of this study, therefore, was to determine the effect of four dates of planting on the yield and other agronomic characteristics in wheat and barley. The study was undertaken under rainfed conditions for the two seasons, 1964-65 and 1965-66, at the Agricultural Research and Education Center of the American University of Beirut in the Beqa'a Plain, Lebanon. Three varieties of wheat, F.A.O. - 6726, Florence Aurore and Senator Capelli, and three varieties of barley, Athinais, Baladi and F.A.O. 7028, were included in the trials. Plantings were made on four dates, November 1, November 15, November 30 and December 15. Data for grain and straw yield, protein content, plant height, weight of 100-kernels and the number of days from planting to heading and maturity were recorded. The determination of more suitable dates of planting cereals should help the farmers in the Beqa'a Plain to obtain higher yields and avoid some risks due to climatical factors.

II. REVIEW OF LITERATURE

Planting dates of winter wheat and barley vary from one country to another and are largely determined by environmental and local conditions. Labor availability, the type of farm implements used, the amount of rainfall and soil moisture condition are factors which play an important role in investigations on dates of planting. Studies involving some of these factors have been made by several investigators. Several workers reported that both too early or too late seeding, may reduce the yield in cereals, and in some cases cause a complete failure of the crop. The literature related to the effect of date of planting on the yield and other agronomic characteristics of wheat and barley will be reviewed in this section.

Date of Planting and Yield

In some areas in the United States the presence of the Hessian fly determines the date of planting of winter wheat. Because of the damage caused by the Hessian fly to wheat in Ohio, Thatcher (30) recommended that "the best date appears to be September 22 in Wayen county, September 29 in Meigs and Miami counties, and October 6 in Clerment county". He stated that the 6-year average acre yield, in a

combined rate and date experiment, was more from 10 pecks than from six or eight pecks when seeded on September 15. Plantings made 10, 20, 30 and 40 days after September 15 reduced the average acre yield and decreased the grain quality.

Kiesselbach and Lyness (10) mentioned that cultural practices used should meet the requirements of the local conditions. On the basis of a 24-year experiment (1921-1944) in Nebraska involving six dates of planting from September 16 to October 22, they concluded that the highest yield was obtained from October 1 followed by September 23 plantings. From three years experimentation in Nebraska involving five planting dates and several locations, Ehlers (6) reported that the highest yield of 35.6 bushels per acre was obtained from the September 10 planting. In Kansas, Swanson found (29) that favorable moisture and temperature are important in rate and time of planting winter wheat. His research conducted during 1912-1923 showed that the highest yields were obtained with plantings made from September 20 to October 1 using four pecks of seed per acre. In a 4-year study, Roa et al. (21) planted winter wheat varieties during October and November in Bichpuri, Agra, India, and did not find any significant difference in yield among the dates studied.

Robertson et al. (22) reported in Colorado that the rate of seeding experiments conducted from 1920-1937

resulted in significant differences in yield on summer fallow. They also stated that for best grain yields winter wheat should be planted between September 1 and 15 at a seeding rate of two pecks per acre. It was reported by Schafer et al. (25), in Washington, that wheat varieties sown at various dates between August 1 and December 1 gave the highest yield from the September 1 plantings followed by the August 15 plantings. They observed that there was very little smut present in the wheat harvested from the very late plantings. From six years of trials on seeding dates in Ontario, Zavitz (33) obtained an increase of two to three bushels per acre from wheat planted from August 25 to September 9 as compared to that planted after September 15. McMurdo (15) reported that in Colorado winter wheat produced the highest yield when planted from September 15 to October 15. In Ohio, during 1902-1910, Williams and Welton (31) found that higher average yields of grain were obtained from the September 22 plantings as compared with other dates made between September and October 27. Merrill (16) stated that in Utah the November plantings of winter wheat were better than those made earlier. Nuttonson (19, pp. 334) reviewed the results of an experiment conducted at the West Siberian Agricultural Station in connection with various dates of seeding winter wheat. He stated that the highest yield of 32.8 bushels per acre was produced from August 21 plantings. In Hyder Abad, Pakistan, Choudary and

Khalid (4) obtained 18.7 percent more grain from the October seedings than from those made in November and 58.6 percent more than from sowing made in December.

From a 5-year study in Lethbrige, Alberta, Pittman and Andrews (20) found that average winter survivals and average yields were the highest when winter wheat varieties were planted after August 30 and before September 16. In Montana, Donaldson (5) found that the highest yields were obtained by planting winter wheat between August 10 and September 10 at a seeding rate of three pecks per acre.

Date of Planting and Other Agronomic Characteristics

Nuttonson (19, pp. 333) stated that too early seeding of wheat may bring about excessive vegetative growth which may contribute to lowering its winter hardiness. In areas of low precipitation it may result in soil moisture depletion due to the jointing of the plant in the fall, and in areas where the Hessian fly is a problem, wheat planted too early is subject to damage by this insect. He further mentioned that too late seeding causes the plant not to form tillers. Also, late plantings may effect the root development which may cause the plants to suffer from both winter cold and spring drought. Knoch (13) indicated that winter barley varieties sown at three dates in September resulted in higher grain and straw yields than those planted later. Also, the earlier plantings produced the larger

number of tillers. Increasing the rate of seeding from 180 to 200 kg per hectar for the later planting did not compensate for the lower yield.

Slykhuis (27, pp. 114-118) studied the relationship between streak mosaics root rot and wheat yields from various dates of seeding. He found that seeding earlier than September 1 did not result in higher yields in the absence of streak mosaics, and that seeding after September 15 was associated with lower yields and later maturity. The data reviewed by Nuttonson (18, pp. 254) from Kirghiz Agricultural Experiment Station showed that the ripening of winter barley was delayed 15 days when planted three weeks later than the optimum date of seeding. From studies involving six dates of planting in Tolbuhin, Bulgaria, Mihajlov and Karaivanov (17) reported that the best time proved to be early in October using 400 seed per square meter. Wheat planted after October 25 resulted in a reduction in yield and in grain size. They found a difference of only 6 to 8 days in maturity from earliest and latest dates of seeding. Kiesellbach (11) conducted an experiment on dates of wheat seeding during 1921-1923 in Nebraska. The earlier plantings yielded five bushels more per acre than did the later plantings. The wheat obtained from the early planted plots contained 2.5 per cent less protein than that from the plots planted later. Fernandez and Laired (7) concluded that in Central Mexico the highest yields were obtained from

plots receiving the highest rate of nitrogen and grown under optimum soil moisture conditions. The protein content of the grain decreased with the wettest and increased with the driest treatment. Roberts (23) reviewed the investigations conducted by the United States Department of Agriculture and concluded that water supply is an important factor in determining the protein content of the wheat grain. The protein content of wheat grain was 11.63 per cent when grown under 22 to 24 inches of rainfall and 12.63 per cent with 25 inches of irrigation (Utah). Kiesselbach (12), using Nebraska No. 60 winter wheat, concluded that the yield was the highest from the earliest planting of September 22, and that the protein content decreased as the yield increased. At Davis California, Florrell (8) planted wheat, barley and oats at four seeding dates between December 6 and March 10. He found that all the varieties of wheat, barley and oats gave the lowest yield with the latest seeding date. Some lodging in most varieties was observed with the earliest plantings while no lodging was noticed in the latest planting. He further observed that nitrogen per cent in the grain increased as the plantings were delayed. Beuter and Foote (3) in Eastern Oregon reported, from four seeding dates made during 1958-1960, that the plants from earliest seeding were taller throughout the growing season. He also noticed that the straw yields were increased with the early plantings and were

reduced as the planting dates were delayed.

III. MATERIALS AND METHODS

The investigation pertaining to dates of planting winter wheat and barley were undertaken under rainfed condition for the two seasons 1964-65 and 1965-66, at the Agricultural Research and Education Center of the American University of Beirut in the Beqa'a Plain, 80 kilometers east of Beirut, Lebanon. The type of soil, according to Salib (24, pp. 65-66), was fine in texture, calcareous and alkaline in reaction with a pH of 8.0, variable in available phosphorous, low in total nitrogen and in organic matter. The land of experimental area was under fallow for one year. Eight kilograms per dunum of nitrogen in the form of ammonium sulfonitrate (26.5 per cent nitrogen) and eight kg of P_2O_5 in the form of super phosphate (18 per cent P_2O_5) were applied to the soil each year. The super phosphate was broad-casted and discked into the soil prior to the planting. The nitrogen was top-dressed on the soil surface in February.

Three varieties of wheat, F.A.O.-6726, Florence Aurore and Senator Capelli, and three varieties of barley, Athinais, Baladi and F.A.O.-7028 were included in the study. The selection of winter wheat and barley varieties was based on their different maturity ratings and performance

at AREC (32). Among the wheat varieties used, F.A.O.-6726 is known to be early in maturity. Florence Aurore is regarded as being an intermediate while Senator Capelli is late in maturity. In the barley varieties studied, Athinais is considered as an early variety while Baladi and F.A.O.-7028 are both intermediate in their maturity. Weeds were controlled by hand and by hoeing throughout the growing season.

Plantings were made on four different dates, November 1, November 15, November 30 and December 15 (delayed 4 days in 1964 due to wet soil). The plantings were made with the Planet Junior Planter. The experimental area was irrigated by means of sprinkled irrigation only once immediately after the first planting to permit immediate germination of the seed. The data on the total monthly rainfall, average temperature for the years 1964-65 and 1965-66, are shown in table 8 in the Appendix.

The lay-out of the experiment was based on a split-plot-design in a Latin square with four replications, having the dates of planting as the main plots, and the wheat and barley varieties as the sub-plots. Each of the sub-plots was made up of three rows each 4.5 m long and 25 cm apart. The size of each main plot was 4.5 x 5.6 m, each block 4.5 x 23.7 m and the area of the total experiment was 23 x 23.7 m.

Data for grain and straw yield, protein content,

plant height, weight of 100-kernels and number of days from planting to heading and maturity were recorded.

For determining grain and straw yield, four meters from each central row of each sub-plot were harvested, leaving a quarter of a meter on both ends to avoid border effect. The cutting of the plants was done by hand sickle. Each sample was kept separately in cloth sacks and sun dried for 2 to 3 weeks. Threshing and cleaning was done with appropriate nursery equipment. The clean seeds were weighed for grain yield, and the difference between the total grain-straw weights and grain weights gave the straw weights. The modified kjeldahl method (9, pp. 12-13) was followed to determine the protein content of the wheat and barley grain. A representative sample from each sub-plot was ground, stored in a screw top bottle, and weighed for analysis. The nitrogen values for each sample were multiplied by the factors 5.7 and 5.83 to get the protein percentage of wheat and barley, respectively. Plant height was measured from the ground level to the upper most spikelet at the time of full maturity. One-hundred kernel weights were determined by counting and weighing 100 sound seeds. The number of days between planting heading and maturity of each variety was calculated.

In wheat the variety Florence Aurore and in barley the variety Athinais were considered as the check. The November 1 date was considered as a check for the dates of

planting.

To analyze the data, statistical methods appropriate to split-plot-design in a Latin square according to Leclerg, et al. (14) were used. To determine the difference between the different treatment combination, analysis of variance, F test and (t) test were calculated.

V. RESULTS AND DISCUSSION

The experiment was undertaken for the two seasons, 1964-65 and 1965-66, at the Agricultural Research and Education Center of the American University of Beirut in the Beqa'a Plain, Lebanon. Data were collected on the effect of four dates of planting on the grain and straw yield, protein percentage, plant height, weight of 100-kernels, and the number of days from planting to heading and maturity in wheat and barley. The data for each character mentioned are reported in Tables 1 to 7, and the analysis of variance are shown in Tables 9 to 15 in the appendix. The L.S.D. figures for treatments significant at the five per cent and one per cent levels are given at the bottom of the analysis of variance table for each character concerned.

Grain Yield of Wheat and Barley

The grain yields of wheat were effected by the various planting dates studied as shown in Table 1. The results were highly significant in 1966, but not significant in 1965. The higher amount and more uniform distribution of the rainfall in 1964-65 (Table 8) resulted in higher yields in 1965 as compared to those obtained for the

1965-66 season. Plantings made on November 30 produced the highest average yields in 1965, while the highest yields in 1966 were obtained from the November 15 and November 30 plantings.

The three wheat varieties used in the study varied widely in yield in both years, 1965 and 1966. Compared to Florence Aurore, Senator Capelli produced the highest average grain yield and F.A.O.-6726 the lowest yield in 1965. In 1966, Florence Aurore outyielded both Senator Capelli and F.A.O.-6726. The large amount and the uniform distribution of rainfall in 1964-65 favored the late maturing Senator Capelli. However, the low amount of rainfall during April and May 1966 greatly reduced the yield of Senator Capelli. The yields of F.A.O.-6726, an early maturing variety, were reduced each year by the injury it received following a frost in late March.

There was a significant interaction between average grain yield of the varieties and the planting dates. In 1965, the highest grain yield was obtained from Senator Capelli with the November 30 planting, and lowest grain yield was obtained from F.A.O.-6726 with the November 1 planting. In the year 1966, the lowest grain yield was obtained from F.A.O.-6726 with the November 1 planting and Senator Capelli with the December 15 planting.

Dates of planting did not significantly influence the average grain yield of barley in 1965, but highly

Table 1. Effect of dates of planting on the average grain yield in kg per dunum+ of winter wheat and barely during 1965 and 1966.

Varieties	Date of planting									
	November 1		November 15		November 30		December 15		Mean	
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966
Wheat										
F.A.O.-6726	90	21	109	148	141	155	126	115	117**	109*
Florence Aurore	158	105	160	161	156	155	150	110	156	132
Senator Capelli	220	96	219	91	254	86	158	70	213**	86*
Mean	156	74	163	133**	184	132**	145	98*		
Barley										
Athinais	100	48	179	181	279	199	225	151	196	145
Baladi	273	124	201	147	296	153	189	148	240*	143
F.A.O.-7028	196	35	294	125	446	141	191	165	282**	116
Mean	190	69	225	151**	340	164**	202	155**		

* Denotes difference significant at the 5% level.
** Denotes difference significant at the 1% level.
+ 1 dunum = 1000 square meters

significant differences in yields were obtained in 1966 as shown in Table 1. Average grain yields of barley were higher in 1965 than in 1966 due to the high amount of rainfall prevalent in the first year. In both years the highest average yields of barley were obtained from the November 30 plantings followed by those made on November 15.

The yields of the barley varieties differed widely and were not consistent. The damage resulting from the late March 1966 frost greatly reduced the yields of Athinais and F.A.O.-7028, the two early maturing varieties, when planted on November 1. On the average, Baladi and F.A.O.-7028 produced higher yields than Athinais in 1965. The yield data for the barley varieties for the 1966 crop differed with each of the plantings and were not consistent or significant.

The interaction between grain yields of the varieties and planting dates was statistically significant. When the plantings were made on November 1, Baladi outyielded Athinais and F.A.O.-7028. Athinais and F.A.O.-7028, however, produced more grain per dunum than Baladi when planted on December 15.

Straw Yield of Wheat and Barley

Average straw yields of wheat were significantly influenced by the various dates of planting as indicated in Table 2. The earlier plantings of the wheat consist-

ently produced more straw than those planted after November 1 in both years. On the average 674 kg per dunum of straw were produced when wheat was planted on November 1, while only 469 kg were obtained from the December 15 plantings. For the November 15 and November 30 plantings made during the two seasons, an average of 648 and 540 kg per dunum, respectively, of straw were harvested. These results are confirmed by Beutor and Foote (3) in Eastern Oregon who, from four seeding dates, found that the straw yields were increased with the early plantings and were reduced as the planting dates were delayed.

The yields of straw of the wheat varieties were greatly influenced by season as shown in Table 2. During the favorable growing season of 1964-65, the late maturing variety, Senator Capelli, produced the greatest amount of straw at each of the four planting dates in comparison to the two other varieties. On the other hand, F.A.O.-6726, an early maturing variety, produced the highest yields of straw at each of the four dates of planting, as compared to Florence Aurore and Senator Capelli, during the more unfavorable growing season of 1965-66. The lack of rainfall during April and May in 1966 reduced the straw yields of the two later maturing wheat varieties.

The average straw yields of barley varieties planted at various dates are shown in Table 2. In general, less straw was produced by barley in all later plantings

Table 2. Effect of dates of planting on the average straw yield in kg per dunum of winter wheat and barley during 1965 and 1966.

Varieties	Date of planting									
	November 1		November 15		November 30		December 15		Mean	
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966
Wheat										
F.A.O.-6726	434	778	418	769	434	525	480	465	442**	634
Florence Aurore	652	754	665	684	614	498	456	354	597	572
Senator Capelli	828	602	848	504	731	442	682	374	773**	481**
Mean	638	711	644	652*	593	488**	540*	398**		
Barley										
Athinais	744	966	920	789	811	578	737	546	803	720
Baladi	776	529	896	608	724	498	739	426	784	515**
F.A.O.-7028	625	901	682	641	829	538	660	453	699**	633
Mean	715	799	833	679	788	538**	712	475**		

* Denotes difference significant at the 5% level.
** Denotes difference significant at the 1% level.

after the November 1 planting. On the basis of the 2-year average, 752 kg of straw per dunum for November 1 and 593 kg per dunum for December 15 plantings were obtained. Statistically significant differences for straw yields were obtained only in 1966 between the early and the late plantings.

The varieties of barley varied widely in straw production during the 2-year study. Athinais, the early maturing variety, produced the greatest amount of straw in comparison to Baladi and F.A.O.-7028. In 1965, the average increase in straw yield of Athinais over F.A.O.-7028 was 104 kg per dunum. In 1966, Athinais excelled Baladi by 205 kg per dunum in straw yield.

Protein Percentage of Wheat and Barley

The average protein percentages of wheat planted at various seeding dates are shown in Table 3. The average protein content of the wheat grains produced in 1965 was 15.3 per cent and that from the 1966 crop was 16.1 per cent. The higher rainfall obtained during 1964-65 reduced the protein content of the wheat produced in the first year. Fernandez (7) found that the protein content of the grain decreased with the wettest and increased during the driest seasons. The protein content of the grain was the highest for the wheat obtained from the later plantings and lowest for the wheat from the earliest plantings. Wheat planted on November 1, on the average, contained 15.1 per cent

protein while that planted on December possessed 16.2 per cent protein. At Davis, California, Florrell (8) planted wheat, barley and oats at four seeding dates between December 6 and March 10. He found that the nitrogen per cent in the grain increased as the plantings were delayed.

Varieties of wheat varied significantly in protein content in 1965, but not in 1966. Senator Capelli contained significantly higher protein percentage in the grain than that obtained in either Florence Aurore and F.A.O.-6726 in 1965. The grain produced in 1966 varied only slightly in protein percentage.

There was a significant interaction in the protein percentage of the varieties and planting dates only in 1965. The protein content of Senator Capelli was lower than that of F.A.O.-6726 only from the November 1, 1965 plantings. The grain of Senator Capelli contained more protein than the grain from F.A.O.-6726 from the harvests made on November 15, November 30 and December 15.

The average protein percentages of barley varieties planted at various dates are shown in Table 3. The average protein content for barley harvested in 1965 was 11.4 per cent and that for 1966 was 12.9 per cent. The higher rainfall during the 1964-65 season produced barley containing less protein than that grown during the drier season of 1965-66. There was a tendency towards higher protein percentages in the barley grains as the planting dates were

Table 3. Effect of dates of planting on the average protein percentage of winter wheat and barley during 1965 and 1966.

Varieties	Date of planting									
	November 1		November 15		November 30		December 15		Mean	
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966
Wheat										
F.A.O.-6726	15.7	15.9	15.2	16.3	14.7	16.2	15.0	17.2	15.2	16.4
Florence Aurore	14.1	15.3	15.6	15.6	14.2	16.2	15.8	16.2	14.9	15.8
Senator Capelli	15.0	14.9	15.6	16.5	16.2	16.7	16.5	16.5	15.8*	16.2
Mean	14.9	15.4	15.5	16.1	15.0	16.4	15.8	16.6		
Barley										
Athinais	12.0	13.9	10.8	12.5	12.0	12.1	12.1	13.0	11.7	12.9
Baladi	10.4	12.8	11.9	12.6	12.3	14.1	12.2	13.8	11.7	13.3
F.A.O.-7028	10.6	12.7	10.5	12.2	10.7	12.5	11.2	13.1	10.8**	12.6
Mean	11.0	13.1	11.1	12.4*	11.7	12.9	11.8	13.3		

* Denotes difference significant at the 5% level.
** Denotes difference significant at the 1% level.

delayed. Based on the 2 year averages, the protein percentages were 12.0, 11.7, 12.3 and 12.6 for the November 1, November 15, November 30 and December 15 plantings, respectively.

Baladi, the two row variety, contained a higher protein percentage in the grain obtained from the last three seedings than that present in Athinais and F.A.O.-7028. On the first date of planting, the grain of Athinais contained a higher protein content than that of the other two varieties.

A highly significant interaction between the protein content of barley varieties and dates of planting was found. Small differences in protein percentages in the grain were evident between Baladi and F.A.O.-7028 when harvested on November 1, 1965 and 1966 (0.2 to 0.1 per cent) respectively. These differences, however, were 1.6 per cent and 1.6 per cent protein in the grains of the two varieties when harvested on November 30, 1965 and 1966, respectively.

Plant Height of Wheat and Barley

The effect of dates of planting on the plant height of wheat are shown in Table 4. The wetter season of 1964-65 produced taller wheat plants than the drier season of 1965-66. Plant heights were reduced 16 and 20 cm as the dates of planting were delayed from November 1 to December 15, 1965 and 1966, respectively. Wheat sown on November 1

grew to an average height of 100 cm while that planted on December 15 was 82 cm in height. Beuter and Foote (3) in Easter Oregon, from four seeding dates made during 1958-1960, reported that the plants from the earliest seeding were taller throughout the growing season.

The wheat varieties studied varied significantly in their plant height. In 1965, F.A.O.-6726 produced significantly shorter plants than did either Florence Aurore and Senator Capelli. However, in 1966, the shortest straw was produced by Senator Capelli. This was due to the lack of rainfall during April and May in 1966, which reduced plant growth more in the late maturing variety than in the earlier varieties, F.A.O.-6726 and Florence Aurore.

The interaction between plant heights in wheat and planting dates was significant in both years. Differences in plant height response were greater between the early variety, F.A.O.-6726, and the later maturing varieties, Florence Aurore and Senator Capelli when planted on November 1 as compared to the difference in plant heights obtained from the November 30 and December 15 plantings.

The data presented in Table 4 shows the plant heights of barley varieties planted on different dates. Although the two growing seasons varied greatly in moisture availability, the average heights of the barley plants were 87 and 88 cm for 1965 and 1966, respectively. This is in contrast to the response of the wheat varieties grown under

Table 4. Effect of dates of planting on the average plant height in cm of winter wheat and barley during 1965 and 1966.

Varieties	Date of planting									
	November 1		November 15		November 30		December 15		Mean	
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966
Wheat										
F.A.O.-6726	90	90	96	100	96	85	85	75	92**	88
Florence Aurore	115	104	109	90	106	84	95	73	106	88
Senator Capelli	116	88	110	85	100	78	94	73	105	81**
Mean	107	94	105	92	101**	82**	91**	74**		
Barley										
Athinais	77	98	83	91	80	82	75	78	79	87
Baladi	95	90	85	82	83	79	80	73	86**	81**
F.A.O.-7028	103	95	100	97	94	100	86	94	96**	95**
Mean	92	94	89*	90	86**	87*	80**	82**		

*Denotes difference significant at the 5% level.
** Denotes difference significant at the 1% level.

similar conditions. The heights of barley plants were the tallest on the November 1 plantings and consistently shorter as the plantings were delayed until December 15. Barley plants harvested on November 1, on the average, were 93 cm tall while those harvested on December 15 were 81 cm in height.

Varieties of barley varied widely in plant height. F.A.O.-7028 was the tallest variety in both years while the shortest straw was produced by Athinais in 1965 and Baladi in 1966.

Significant interactions were found between plant height and planting dates in barley. In 1965, Athinais produced the tallest plants when planted on November 15, while the other varieties produced the tallest plants on the seedings made on November 1. In 1966, the variations in plant heights between the different dates of plantings for F.A.O.-7028 were small, while those for Baladi and Athinais were much greater.

Weight of 100-Kernels of Wheat and Barley

Small differences were found in the average 100-kernel weight of wheat when planted on different dates as shown in Table 5. The average 100-kernel weight of wheat was higher from the wheat crop produced in 1965 than in 1966. The higher amount of rainfall and a longer growing season of the first year produced larger wheat seeds than

the seed grown during 1965-66 when less rain was received during the shorter growing season.

The wheat varieties differed greatly in 100-kernel weight. Senator Capelli produced large size seeds in both years while the grain of F.A.O.-6726 was smaller than that of the other two varieties. Florence Aurore produced seeds intermediate in size in 1965 and the largest seed in 1966 in comparison to F.A.O.-6726 and Senator Capelli.

There was significant interaction between seed size in 1965. Florence Aurore produced larger wheat grains than F.A.O.-6726 from plantings made on the three dates in November, while the seed size was the same from the December 15 plantings. Also, the seed size was the same for Florence Aurore and Senator Capelli when planted on November 1 and November 15. However, Senator Capelli produced larger seeds than Florence Aurore when planted on November 30 and December 15.

Significant differences were found in 1965 in the average 100-kernel weight of barley due to the various plantings as shown in Table 5. Average 100-kernel weight of barley plants were higher in 1965 than in 1966. A higher amount of rainfall and a longer growing season contributed to the bigger seed size and heavier seed weight of barley plants in the first year as compared to the second year. Average 100-kernel weights were higher with November 30 and December 15 plantings than the November 1 and November 15

Table 5. Effect of dates of planting on the average weight in grams of 100-kernels of winter wheat and barley during 1965 and 1966.

Varieties	Date of planting									
	November 1		November 15		November 30		December 15		Mean	
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966
Wheat										
F.A.O.-6726	2.9	2.7	3.0	2.5	3.1	2.4	3.0	2.1	3.0**	2.4**
Florence Aurore	3.7	3.0	3.9	2.9	3.7	2.9	3.1	2.8	3.6	2.9
Senator Capelli	3.9	2.8	4.0	2.9	4.4	2.9	4.2	2.8	4.1**	2.8
Mean	3.5	2.8	3.6	2.8	3.7	2.7	3.4	2.6		
Barley										
Athinais	3.8	3.3	3.9	3.9	4.6	2.9	4.3	2.9	4.2	3.0
Baladi	4.3	3.4	3.5	3.0	4.9	2.6	4.9	2.8	4.4	3.0
F.A.O.-7028	4.3	3.8	4.1	3.3	4.6	2.6	4.5	3.1	4.4	3.2
Mean	4.1	3.5	3.8	3.4	4.7**	2.7	4.6**	2.9		

** Denotes difference significant at the 1% level.

plantings in 1965.

Small differences were found in seed size in the three varieties of barley studied.

The interaction between 100-kernel weight and planting dates was significant only in 1965. Athinais produced larger seeds than Baladi only from the November 15 planting. The seeds of Baladi and F.A.O.-7028 were larger than Athinais on all other dates of planting made during 1964-65.

Days from Planting to Heading of Wheat and Barley

The data presented in Table 6 indicate that the average number of days from planting to heading of wheat was influenced greatly by the various dates of planting. Because of the moisture shortages during March and April 1966, fewer days were required for the plants to head in 1965-66 than during the more favorable season of 1964-65. On the basis of the 2-year average, the number of days from planting to heading was reduced 32 days as the seeding was delayed from November 1 to December 15. On the average the wheat headed in 172, 162, 154 and 140 days when planted on November 1, November 15, November 30 and December 15, respectively.

The number of days from planting to heading was different for the three varieties used. Senator Capelli required the most time while F.A.O.-6726 required the least. On the basis of the 2-year average data, Senator Capelli,

Table 6. Effect of dates of seeding on the average number of days from planting to heading of winter wheat and barley during 1965 and 1966.

Varieties	Date of planting									
	November 1		November 15		November 30		December 15		Mean	
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966
Wheat										
F.A.O.-6726	175	151	162	146	153	143	142	128	158**	142**
Florence Aurore	181	161	168	158	161	149	148	137	164	151
Senator Capelli	190	173	178	162	167	152	152	137	172**	156**
Mean	182	162	169**	155**	160**	148**	147**	134**		
Barley										
Athinais	169	144	157	136	145	129	133	119	151	132
Baladi	175	158	162	149	154	143	142	129	158**	145**
F.A.O.-7028	171	150	159	144	151	136	138	126	155**	139**
Mean	172	151	159**	143**	150**	136	138**	125**		

** Denotes difference significant at the 1% level.

Florence Aurore and F.A.O.-6726 headed in 150, 157 and 164 days after planting, respectively.

The interaction between the heading of wheat varieties and planting dates was highly significant. Plantings at 15-day intervals, at all seeding dates, consistently and uniformly reduced the number of days from planting to heading only in two varieties, F.A.O.-6727 and Florence Aurore. For Senator Capelli, the average reduction in days to heading, in comparison to F.A.O.-6726, was 18 days when planted on November 1 and only 9 days when planted on December 15.

The dates of seeding significantly influenced the average number of days from planting to heading of barley as reported in Table 6. More days were required for the plants to head in the favorable season of 1964-65 than in the unfavorable season of 1965-66. Also, as the dates of planting were delayed the number of days to heading were reduced. On the average barley planted on November 1 required 161 days to head while that sown on December 15 required 131 days.

Varieties of barley varied in the number of days to heading when planted on various dates. Baladi and F.A.O.-7028 required a longer period between seeding and heading than Athinais at each of the four planting dates in both years. Baladi consistently required more days between planting and heading than did F.A.O.-7028.

A significant interaction between varieties and days from planting to heading was obtained only in 1966 (Table 14). Since the barley varieties headed rather uniformly when planted on the four different dates the interaction is not evident from an inspection of the data in Table 6.

Days from Planting to Maturity of Wheat and Barley

The average number of days from planting to maturity in wheat was found to be significantly influenced by the four dates of planting studied as reported in Table 7. Due to the defeciency of rainfall during April and May 1966 fewer days were required between planting and maturity in 1965-66 than during the more favorable growing season of 1964-65. The number of days from planting to maturity consistently decreased as the planting dates were delayed from November 1 to December 15. On the basis of the 2-year average, the number of days between planting and maturity was 220, 207, 192, 175 days for the seedings made on November 1, November 15, November 30, and December 15, respectively. In wheat, the November 1 plantings hastened maturity only 2 and 3 days as compared to the planting made on December 15 in 1965-66, respectively. In Tolbuhin, Bulgaria, Mihajlov and Karaivanov (17) found that there was a difference of only 6 to 8 days in maturity from earliest and latest dates of seeding.

Wheat varieties differed widely in number of days

between planting and maturity when planted on various dates. Senator Capelli required the longest number of days while F.A.O.-6726 required the shortest period from planting to maturity at all planting dates. Florence Aurore was intermediate in this respect in comparison to Senator Capelli and F.A.O.-6726.

The interaction between the planting dates and the days required for maturity was significant. The relative difference in the number of days from planting to maturity between F.A.O.-6726 and Senator Capelli was uniform and consistent for the four dates of planting. However, the difference in the number of days from planting to maturity between Florence Aurore and Senator Capelli were small for the November 1 plantings and large for the November 15 and the December 15 plantings.

The data for the days from planting to maturity for barley varieties sown on different dates are shown in Table 7. Due to the drought period during the later part of the 1965-66 season, fewer days were required between seeding and maturity than for comparable periods during the 1964-65 season. The number of days from planting to maturity decreased consistently as the plantings were delayed from November 1 to December 15. On the basis of the 2-year averages, the number of days for the barley plants to mature was 210, 192, 180, 165 days when planted on November 1, November 15, November 30 and December 15, respectively. The

Table 7. Effect of dates of planting on the average number of days from planting to maturity of winter wheat and barley during 1965 and 1966.

Varieties	Date of planting									
	November 1		November 15		November 30		December 15		Mean	
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966
Wheat										
F.A.O.-6726	220	212	207	199	191	184	172	169	198*	191**
Florence Aurore	228	214	215	199	199	184	180	169	206	192
Senator Capelli	228	220	215	210	202	195	184	179	207*	201**
Mean	225	215	212**	203**	197**	187**	179**	172**		
Barley										
Athinais	215	197	203	182	184	167	170	152	193	174
Baladi	215	203	201	182	183	176	172	164	193	181**
F.A.O.-7028	220	209	202	183	191	179	172	164	196*	184**
Mean	217	203	202**	182**	186**	174**	171**	160**		

* Denotes difference significant at the 5% level.
** Denotes difference significant at the 1% level.

early plantings made on November 1 hastened the maturity of barley only two and three days when compared to the barley planted on the middle of December.

Varieties of barley varied significantly in the number of days between planting and maturity. Athinais required fewer days while F.A.O.-7028 required a larger number of days between planting and maturity on all dates of planting, except when planted on November 15, 1964. The number of days between planting and maturity for Baladi in 1965 were similar to that for Athinais. In 1966, however, Baladi required longer periods from planting to maturity when planted on November 1 and December 15.

A significant interaction between the planting dates and days from planting to maturity of varieties was found only in 1966. The number of days between planting and maturity was the same for Athinais and F.A.O.-7028 when planted on November 15. However, for the other three dates of planting, F.A.O.-7028 required 11 or 12 days more between planting and maturity than did Athinais. Also, the number of days between planting and maturity were the same for Baladi and Athinais from seeding made on November 15. Baladi required a longer number of days from planting to maturity than did Athinais when planted on November 1, November 30 and December 15.

Lodging of the Plants

Lodging of both wheat and barley plants was present

in the field plots during both seasons. It was more severe in 1965-66 than in the growing season of 1964-65. In general, all varieties planted on November 1 were subjected to lodging. Plant lodging was observed also on the plantings made on November 15. The plants from the November 1 planting showed greater lodging than those from the November 15 seedings.

Among the wheat varieties studied, lodging was most severe in F.A.O.-6726, less severe in Senator Capelli and least severe in Florence Aurore. The barley varieties varied in their susceptibility to lodging. Baladi showed more lodging than either Athinais or F.A.O.-7028. Some loding was observed in the variety Baladi on the first three dates of planting.

Winter Injury

The freezing temperatures -4.2°C to -7.0°C that occurred between March 13 and March 15, 1965 and -4°C and -5°C on March 23 and March 24, 1966, respectively, produced leaf and plant injury to the wheat and barley in the field plots. The plants from the first two dates of planting sown in 1965-66 showed greater winter injury than the plants on comparable plantings made during the 1964-65 season.

The early wheat variety, F.A.O.-6726, was partially killed by frost when planted on November 1 and November 15 of both years. It was headed at the time of the frost and the injury was most severe on the plants from the November 1

plantings. The later maturing varieties, Florence Aurore and Senator Capelli, showed smaller top growth than F.A.O.-6726 at the time of the frost and were not injured by the low temperatures.

The barley varieties differed widely in their resistance to frost injury caused by the frost when planted on November 1 and November 15. Athinais was partially killed by the frost when planted on November 1 and November 15. It is an early variety and was heading at the time the low temperature occurred. The injury was more severe on the plants from the November 1 than the November 15 planting. F.A.O.-7028 was also partially killed by the frost, but the injury was not as severe as that in Athinais. Baladi was found to be the most resistant against the frost injury and suffered little damage from the low temperatures that occurred in late March.

IV. SUMMARY AND CONCLUSIONS

The experiment was carried out under dry land conditions for the two seasons 1964-65 and 1965-66 at the Agricultural Research and Education Center of the American University of Beirut in the Beqa'a Plain, Lebanon. Studies were made to determine the effect of four dates of planting on the grain and straw yield, protein percentage, plant height, weight of 100-kernels and the number of days from planting to heading and maturity in wheat and barley. Three varieties of wheat, F.A.O.-6726, Florence Aurore, and Senator Capelli, and three varieties of barley, Athinais, Baladi and F.A.O.-7028 and four dates of planting, November 1, November 15, November 30 and December 15 were involved in the present study.

The grain yields of wheat and barley were greatly influenced by the various dates of planting, with the November 15 and November 30 seedings producing the highest grain yield. The yields of wheat and barley were higher in 1965 than in 1966. Among the wheat varieties, Senator Capelli produced the highest average grain yield and F.A.O.-6726 the lowest yield as compared to Florence Aurore in 1965. In 1966, Florence Aurore outyielded both Senator Capelli and F.A.O.-6726. Among the barley varieties, Baladi and F.A.O.-7028 produced higher yields than Athinais

in 1965. The relative yields of both wheat and barley varieties were affected by the different dates of planting.

Various dates of planting greatly influenced the straw yield of wheat and barley. The earlier plantings of wheat and barley produced more straw than those planted after November 1. The yields of straw of the wheat and the barley varieties were greatly influenced by season. In wheat, Senator Capelli produced the greatest amount of straw in 1965 in comparison to the two other varieties. On the other hand, in 1966, F.A.O.-6726 produced more straw than Florence Aurore and Senator Capelli. In barley varieties, Athinais produced the greatest amount of straw in comparison to Baladi and F.A.O.-7028.

The protein percentages of wheat and barley were affected by the different planting dates. The protein content of wheat and barley was the highest for the grain obtained from the later plantings and lowest for the grain from the earliest plantings. Varieties of wheat varied significantly in protein content in 1965, but not in 1966. Senator Capelli contained higher protein percentage in the grain than that obtained in either Florence or F.A.O.-6726 in 1965. The grain of Baladi, a two-row barley, was higher in protein content than the grain of Athinais and F.A.O.-7028. The relative protein content of the varieties of both wheat and barley were influenced by the different dates of planting.

The plant heights of wheat and barley were influenced by the various dates of seeding. The tallest plants of both crops were obtained from the early plantings while the shortest plants were produced from the later plantings. In 1965, F.A.O.-6726, an early wheat variety, produced shorter plants than did either Florence Aurore or Senator Capelli. However, in 1966, the shortest straw was produced by Senator Capelli. In barley, F.A.O.-7028 produced the tallest plants while the shortest straw was produced by Athinais in 1965 and Baladi in 1966. An interaction was found between the plant heights of the varieties and dates of planting in both wheat and barley.

Differences were found in the average 100-kernel weight of wheat and barley when planted on different dates. In wheat, the seed size was influenced very little by plantings made on four different dates. In barley the largest seeds were obtained from the later plantings made in 1964-1965. However, in the 1965-66 crop, the largest seeds were produced from the earlier plantings. Senator Capelli produced larger size seeds while the grain of F.A.O.-6726 was smaller than that of the other two varieties. Florence Aurore produced seeds intermediate in size in 1965. Small differences were found in seed size of the three varieties of barley studied.

Planting dates significantly effected the average number of days from planting to heading and maturity of

wheat and barley. As the dates of planting were delayed the number of days to heading and maturity in wheat and barley were reduced. In wheat, Senator Capelli required the most days while F.A.O.-6726 required the least number of days from planting to heading and maturity. In barley, Baladi and F.A.O.-7028 required more days between planting dates to heading and maturity than Athinais.

From the environmental conditions present in the Beqa'a Plain, Lebanon, during 1964-65 and 1965-66, it appears that the highest grain yields of wheat and barley can be obtained from plantings made between November 15 and November 30. However, freezing temperatures of -4°C to -7°C during the last two weeks in March occurred at the Agricultural Research and Education Center only in three of the past 10 years. Therefore, further trials are recommended to determine the best planting dates that will involve seasons when spring frost injury is not a hazard.

LITERATURE CITED

1. Anonymous. Third World Food Survey. F.A.O. FFHC basic study, No. 11. Food and Agricultural Organization of the United Nations. Rome. 1963.

2. Anonymous. Wheat study for the Near East. World Crops. 14, 27, 1962.

3. Beuter, L.K., and W.H. Foote. Influence of date of seeding and nitrogen rates on winter wheat varieties in Eastern Oregon. Agron. J. 55, 4, 1963.

4. Choudhry, M.S. and S.A. Khalid. Determination of the most optimum seed rate, spacing, and sowing date for the newly evalued wheat strain H-68 for Hyderabad Region. Agric. Pakistan. 12, 709, 1961.

5. Donaldson, N.C. Cereal experiments at the Judith Basin Substation, Moccasin, Montana. U.S. Dept. Agric. Bul. 298, 1917. Abstracted in Exp. Sta. Rec. 36, 33, 1917.

6. Ehlers, P. Winter wheat planting dates tested. Neb. Agr. Exp. Sta. Quarterly 8, 19, 1961.

7. Fernandez G.R., and R.J. Laird. Yield and protein content of wheat in Central Mexico as affected by available soil moisture and nitrogen fertilization. Agron. J. 51, 33, 1959.

8. Florrell, V.H. Effect of date of seeding on yield, lodging, maturity and nitrogen content in cereal varietal experiments. J. Amer. Soc. Agron. 21, 725, 1929.

9. Horwitz, W. (Chairman). Official Methods of Analysis. Association of Agricultural Chemistry, Incorporated. Washington, D.C., 9th ed., 1960.

10. Kiesselbach, T.A., and W.E. Lyness. Growing the winter wheat crop. Neb. Agr. Exp. Sta. Bul. 389, 1954.

11. Kiesselbach, T.A. The relation of seeding practices to crop quality. J. Amer. Soc. Agron. 18, 661, 1926.

12. Kiesselbach, T.A. Winter wheat investigation. Neb. Agr. Exp. Sta. Res. Bul. 31, 1925. Abstracted in Exp. Sta. Rec. 55, 135, 1926.

13. Knoch, G. Sowing date and variety problems of winter barley in Mountain Foot-Hill Region. (German) Alb. - Thaer. - Arch. 6, No. 10, 751-63, 1962. Abstracted in Field Crops Abstracts (1139). Vol. 16, No. 3, August 1963.

14. Leclerg, E.L., W.H. Leonard, and A.G. Clark. Field Plot Technique. Burgess Publishing Co. Minnesota, 2nd. ed., 1962.

15. McMurdo, G.A. Cereal experiments at the Akron Field Station, Akron, Colorado, U.S. Dept. Agr. Bul. 402, 1916. Abstracted in Exp. Sta. Rec. 36, 33, 1917.

16. Merrill, L.A. Field experiment with wheat, oats and barley. Utah Agr. Exp. Sta. Bul. 56, 1898. Abstracted in Exp. Sta. Rec. 10, 634, 1898.

17. Mihajlov, G. and A. Karaivanov. Results from tests for determining the interdependence between sowing terms and sowing rate and their effect on yield of No. 301 and No. 3147 wheat varieties. Bulgarian IZO, Dobrudz, Selskostop. Naucizsled. Inst., (Tolbuhin, Bulg. Acad. Sci) 1961 1962 1, 43-54, Russian and English Summaries. Abstracted in Field Crops Abstract (539). Vol. 16, No. 2, May 1963.

18. Nuttonson, M.Y. Barley-Climate Relationship and the Use of Phenology in Acertaining the Thermal and Photo-Thermal Requirements of Barley. American Institute of Crop Ecology, Washington, D.C., 1957.

19. Nuttonson, M.Y. Wheat-Climate Relationship and the Use of Phenology in Acertaining the Thermal and Photo-Thermal Requirements of Wheat. American Institute of Crop Ecology, Washington, D.C., 1955.

20. Pittman, U.J., and J.E. Andrews. Effect of date of seeding on winter survival, yield, and bushel weight of winter wheat grown in Southern Alberta. Can. J. Plant Sci. 41, 71, 1961.

21. Rao, M.L. Gupta, V.N.S. Shishodia, and P.N. Kapoor, Response of wheat varieties to different sowing dates and seed rate. Ind. J. Agric. Sci. 26, 351, 1956.

22. Robertson, D.W., O.H. Coleman, J.F. Brandon, H. Fellows, and J.J. Curtis. Rate and date of seeding Kanred winter wheat and the relation of date of seeding to dry-land foot rot at Akron, Colo. J. Agric. Res. 64, 339, 1942.

23. Reberts, H.F. The relation of protein content to variety types in American wheat. J. Agric. Sci. 10, 121, 1920.

24. Salib, A.J. Physical and chemical properties of soil in Beqa'a Plain. M.S. Thesis. Faculty of Agricultural Sciences. American University of Beirut. 1961.

25. Schafer, E.G., E.F. Gaines and O.E. Babbee. Wheat production as influenced by variety, time of seeding, and source of seed. Washington Sta. Bul. 159, 1921. Abstracted in Exp. Sta. Rec. 45, 436, 1921.

26. Sidky, A.R. Forward. F.A.O., Near East Regional Office Newsletter, No. 3, July-Sept. 1965.

27. Slykhuis, J.T., J.E. Andrews, and U.J. Pittman. Relation of date of seeding winter wheat in Southern Alberta to losses from wheat streak mosaics root rot, and rust. Can. J. Plant Sci. 37, 113, 1957.

28. Sukhatme, P.V. (Director). Production Year Book. 17, 36, 1962/63. F.A.O., U.N. Rome. 1963.

29. Swanson, A.F. Cereal experiments at the Fort Hays Branch Station, Hay, Kans. 1912-1923. U.S. Dept. Agr. Tech. Bul. 14, 1928. Abstracted in Exp. Sta. Rec. 58, 532, 1928.

30. Thatcher, L.E. Wheat cultural notes. Ohio. Agr. Exp. Sta. Mo. Bul. 7, 1922. Abstracted in Exp. Sta. Rec. 48, 135, 1923.

31. Williams, C.G., and F.A. Welton. Wheat experiment. Ohio Agr. Exp. Sta. Bul. 231, 1912. Abstracted in Exp. Sta. Rec. 26, 43, 1912.

32. Worzella, W.W., S. Abu Shakra, and H. Nasr. Varietal and cultural trials with small grains and oil crops in the Beqa'a, Lebanon. Faculty of Agricultural Sciences. American University of Beirut. Pub. No. 23, February 1964.

33. Zavitz, C.A. Wheat and rye. Ontario Dept. Agr. Bul. 261, pp. 31. 1918, Abstracted in Exp. Sta. Rec. 40, 333, 1919.

APPENDIX

Table 8. Rainfall and average temperature at the Agricultural Research and Education Center, Beqa'a Plain, Lebanon.*

Month	Rainfall (mm.)		Mean Temperature (C°)	
	1964-1965	1965-1966	1964-1965	1965-1966
September	0.0	23.2	20.2	20.2
October	0.0	46.8	17.8	13.2
November	167.2	24.8	12.4	10.0
December	22.1	155.7	6.8	6.7
January	114.6	68.7	4.2	5.7
February	102.2	70.9	5.6	6.4
March	46.3	96.7	8.2	7.1
April	59.1	0.0	9.3	11.8
May	3.0	2.6	14.1	14.5
June	3.0	0.0	20.7	19.6
July	0.0	-	22.5	-
August	0.0	-	23.8	-
Total	517.5	489.4		

* Metrological data, collected by H. Amirmokri and F.M. Maloaf, Agricultural Research and Education Center, Beqa'a Plain, Lebanon.

Table 9. Analysis of variance for grain yield of wheat and barley, 1965, 1966.

Source		Mean Square			
		Wheat		Barley	
	D.F.	1965	1966	1965	1966
Rows	3	1952.3	295.8	2629.7	11.8
Columns	3	493.7	1214.4	16678.3	32.7
Dates	3	3249.5	9837.7**	71156.1	23561.5**
Error (a)	6	767.6	539.0	23944.1	2080.0
Varieties	2	37413.6**	8791.2**	49781.8**	3975.0
Varieties x dates	6	2585.2**	4666.8**	11310.2**	4197.4*
Error (b)	24	582.9	345.4	2057.3	1190.4

* Denotes F values significant at the 5% level.
** Denotes F values significant at the 1% level.

1965	Wheat		Barley	
LSD	5%	1%	5%	1%
Dates	N.S.	N.S.	N.S.	N.S.
Varieties	17.6	23.9	33.0	44.9
Varieties x dates	35.2	47.8	66.1	89.8
1966				
LSD	5%	1%	5%	1%
Dates	23.2	35.1	45.6	69.1
Varieties	13.5	18.4	N.S.	N.S.
Varieties x dates	27.1	36.8	50.2	N.S.

Table 10. Analysis of variance for straw yield of wheat and barley, 1965, 1966.

Source	D.F.	Mean Square			
		Wheat		Barley	
		1965	1966	1965	1966
Rows	3	15738.2	5989.6	15405.4	12998.1
Columns	3	13509.4	28919.3*	17571.7	68793.0
Dates	3	28037.1*	251907.4**	41415.8	252798.9**
Error (a)	6	5841.8	5045.2	37894.5	16225.0
Varieties	2	438446.4**	96208.1**	49083.9*	175994.0**
Varities x dates	6	18329.1	11575.4	21972.0	35506.2
Error (b)	24	8206.8	12508.6	9557.7	25554.3

* Denotes F values significant at the 5% level.
** Denotes F values significant at the 1% level.

1965	Wheat		Barley	
LSD	5%	1%	5%	1%
Dates	76.4	N.S.	N.S.	N.S.
Varieties	65.9	89.6	71.2	N.S.
Varieties x dates	N.S.	N.S.	N.S.	N.S.
1966				
LSD	5%	1%	5%	1%
Dates	71.0	107.6	127.4	192.9
Varieties	81.4	110.7	116.4	158.2
Varieties x dates	N.S.	N.S.	N.S.	N.S.

Table 11. Analysis of variance for protein percentage of wheat and barley, 1965, 1966.

Source	D.F.	Mean Square			
		Wheat		Barley	
		1965	1966	1965	1966
Rows	3	.27	.41	1.07	.04
Columns	3	1.74	4.95*	.74	6.62**
Dates	3	1.78	3.38	2.09	2.22*
Error (a)	6	2.21	.91	.48	.11
Varieties	2	3.44*	1.14	4.92**	3.36*
Varieties x dates	6	2.06*	.70	1.50*	2.12*
Error (b)	24	.47	.77	.21	.57

* Denotes F values significant at the 5% level.
** Denotes F values significant at the 1% level.

1965	Wheat		Barley	
LSD	5%	1%	5%	1%
Dates	N.S.	N.S.	N.S.	N.S.
Varieties	.50	.68	.33	.45
Varieties x dates	1.0	1.36	.66	.91

1966				
LSD	5%	1%	5%	1%
Dates	N.S.	N.S.	.33	.49
Varieties	N.S.	N.S.	.55	.74
Varieties x dates	N.S.	N.S.	1.01	1.49

Table 12. Analysis of variance for plant height of wheat and barley, 1965, 1966.

Source	D.F.	Mean Square			
		Wheat		Barley	
		1965	1966	1965	1966
Rows	3	.31	19.69	9.3	120.6
Columns	3	7.8	122.3	7.2	169.2
Dates	3	575.1**	1036.7**	290.9**	351.1*
Error (a)	6	6.7	28.4	7.0	46.4
Varieties	2	1078.6**	260.3**	1186.1**	951.4**
Varieties x dates	6	100.5**	117.2**	75.3**	116.4*
Error (b)	24	4.8	23.4	9.3	33.7

* Denotes F values significant at the 5% level.
** Denotes F values significant at the 1% level.

1965	Wheat		Barley	
LSD	5%	1%	5%	1%
Dates	2.6	3.9	2.6	4.0
Varieties	1.6	2.2	2.2	3.0
Varieties x dates	3.1	4.3	4.4	6.0
1966				
LSD	5%	1%	5%	1%
Dates	5.3	8.1	6.8	N.S.
Varieties	3.5	4.8	4.2	5.7
varieties x dates	7.0	9.6	8.4	N.S.

Table 13. Analysis of variance for 100-kernel weight of wheat and barley, 1965, 1966.

Sourse	D.F.	Mean Square			
		Wheat		Barley	
		1965	1966	1965	1966
Rows	3	.05	.02	.04	.08
Columns	3	.04	.01	.19	.15
Dates	3	.18	1.2	1.92**	.12
Error (a)	6	.15	.31	.09	.07
Varieties	2	5.07**	.48	.28	1.04**
Varieties x dates	6	.26**	.34	.30*	.07
Error (b)	24	.04	.22	.09	.15

* Denotes F values significant at the 5% level.
** Denotes F values significant at the 1% level.

1965	Wheat		Barley	
LSD	5%	1%	5%	1%
Dates	N.S.	N.S.	.30	.46
Varieties	.14	.19	N.S.	N.S.
Varieties x dates	.28	.38	.45	.61

1966				
LSD	5%	1%	5%	1%
Dates	N.S.	N.S.	N.S.	N.S.
Varieties	.28	.38	.55	6.3
Varieties x dates	N.S.	N.S.	N.S.	N.S.

Table 14. Analysis of variance for the number of days from planting to heading wheat and barley, 1965, 1966.

Source	D.F.	Mean Square			
		Wheat		Barley	
		1965	1966	1965	1966
Rows	3	5.52	.07	8.08	2.05
Columns	3	16.85	9.85	17.91	9.28
Dates	3	2537.24**	1712.68**	2465.02**	1547.06**
Error (a)	6	5.60	3.61	6.55	4.42
Varieties	2	750.27**	800.14**	210.33**	590.58**
Varieties x dates	6	10.16**	47.98**	4.33	11.81*
Error (b)	24	.02	3.24	3.33	3.75

* Denotes F value significant at the 5% level.
** Denotes F value significant at the 1% level.

1965	Wheat		Barley	
LSD	5%	1%	5%	1%
Dates	2.36	3.58	2.55	3.87
Varieties	.10	.14	1.33	1.81
Varieties x dates	.21	.28	N.S.	N.S.
1966				
LSD	5%	1%	5%	1%
Dates	1.89	2.87	2.1	3.18
Varieties	1.31	1.78	1.41	1.91
Varieties x dates	2.61	3.55	2.82	3.83

Table 15. Analysis of variance for number of days from planting to maturity of wheat and barley, 1965, 1966.

Source	D.F.	Mean Square			
		Wheat		Barley	
		1965	1966	1965	1966
Rows	3	2.25	.1	5.7	9.1
Columns	3	2.75	.4	9.8	13.1
Dates	3	4845.86**	4197.8**	4657.9**	3881.3**
Error (a)	6	.58	.2	14.9	3.1
Varieties	2	424.75**	494.6**	61.9*	366.3**
Varieties x dates	6	5.20*	5.9**	16.3	42.3**
Error (b)	24	1.42	.2	12.2	7.1

* Denotes F values significant at the 5% level.
** Denotes F values significant at the 1% level.

1965	Wheat		Barley	
LSD	5%	1%	5%	1%
Dates	2.42	3.66	3.85	5.84
Varieties	.86	1.18	2.54	3.45
Varieties x dates	1.73	2.36	N.S.	N.S.
1966				
LSD	5%	1%	5%	1%
Dates	.44	.70	1.76	2.67
Varieties	.34	.46	1.94	2.64
Varieties	.68	.92	3.88	5.28