EFFECT OF SPRING MOISTURE AND MONTHLY RAINFALL ON WHEAT YIELDS IN SOUTHWESTERN SASKATCHEWAN

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We have been talking about means of increasing the amount of moisture in the soil in the spring. What does the extra moisture mean in the ultimate measurement - yield of grain? Before the forage experts get upset, I want to point out that there is no question about what extra moisture will do for forage - it increases the yield. With grain it is a bit more complicated because we are not concerned only with plant growth in the early stages, but must have moisture available until the kernels are filled.

In a weekly letter from the Dominion Experimental Station, Swift Current, April 12, 1947, it was stated that 10.5 inches of water (267 mm) are required to produce a 12 to 14 bushel crop (800 to 900 kg/ha) of wheat. When the total water used was over 10.5 inches there was an increase of approximately 7 bushels per acre per extra inch of water (18.5 kg/ha/mm). Staple and Lehane (6) showed that if evapotranspiration was less than 5 or 6 inches (125 to 150 mm) there was no crop produced, but there was an increase of approximately 4 bushels per acre for each additional inch of water used (10 kg/ha/mm). Others (1,2,3,4,5,7) have come up with figures for the Great Plains region ranging from 8.3 to 0.8 bushels increase per inch of stored moisture (24 to 2 kg/ha/mm). Those are only a few of the many reports on effects of moisture on yield.

To check out the effect that spring moisture and seasonal rainfall had on yield of wheat in southwestern Saskatchewan in the last 14 years the data from 306 tests including stubble and fallow were used. The data were from fertilizer tests at various locations in the southwest and from rotation studies at Swift Current. The yield data used were from the highest yielding fertilizer treatment from each fertilizer test and from plots that had received the amount of fertilizer recommended by soil tests. The soil was sampled to 120 cm for available moisture at seeding time. The rainfall was measured near each test site.

To take a look at other factors that could affect yield, the monthly average mean temperature and the monthly total evaporation from an open pan at Swift Current were included. The average of the measurements followed by the difference between the maximum and minimum values encountered are shown in Table 1. From this you can see that the tests were conducted under a wide range of conditions.

Table 1. Average values for the 306 tests 1967-1979 with differences in brackets

	May	June	July	August
Rainfall - mm	33 (122)	57 (212)	39 (110)	28 (122)
Mean temperature C^{o}	10.4 (5.5)	15.3 (4.4)	18.2 (5.4)	17.8 (8.0)
Total monthly evaporation - mm	213 (188)	244 (67)	274 (157)	266 (182)
Wheat yield - kg/ha		1600 (2847)		
May + June + July rainfall - mm		129 (237)		

Linear regressions for the relationship between yield and each of the variables were calculated and plotted (Fig. 1-5). The variables used were available spring moisture (H_2O), monthly rainfall and combinations of months, combination of H_2O and rainfall, monthly temperature and evaporation. The B value for the equations or slope of the line is shown on each line ( ).

Figure 1 shows the marked increase in yield from increased July rain, almost as much from May rain followed by June rain than spring moisture which gave about one-third as much yield increase per mm of moisture as obtained from July rain.

Figure 2 - These combinations of rain for different months of H_2O and rain showed little differences, all giving 3.08 to 4.77 kg/ha yield increase per mm increase in moisture.

Figure 3 with the cumulative moisture - H_2O and rainfall for different periods, the H_2O + May + June + July rain gave the best response.

Figure 4 - Increased temperatures in May and June increased the yield while increased temperatures in July and August reduced it.

Figure 5 - There was little effect from increased evaporation for May, June, or August but a drastic yield decrease from increased evaporation in July.

Using a stepwise multiple regression analysis on the original data with no combinations included showed that the July evaporation was the variable which gave the greatest reduction in sums of squares but only accounted for a small part of the variability ($P^2 = 0.15$).

The data from the tests were separated into those with less than 100 mm rainfall for the period May, June and July, and those with more than 100 mm rainfall. The mean rainfall for this period was 129 mm. The average yield was determined for the tests with different amounts of available spring moisture for each of the rainfall groups. Table 2 shows the increased yield for each 25 mm increase in spring moisture.

Table 2. Increased yield of wheat from different amounts of available spring moisture

Available spring moisture	May + June + July rainfall			
	Less than 100 mm		More than 100 mm	
	kg/ha/mm	bu/ac/inch	kg/ha/mm	bu/ac/inch
0 - 25 → 25 - 50	5.6	2.1	-9.5	-3.6
25 - 50 → 50 - 75	14.7	5.5	14.9	5.6
50 - 75 → 75 - 100	9.8	3.7	8.2	3.1
75 - 100 → 100 - 125	1.7	.6	7.4	2.8
100 - 125 → 125 - 150	15.8	5.9	6.5	2.5
125 - 150 → 150 - 175	-13.4	-5.1	-8.5	-3.2
150 - 175 → 175 - 200	27.2	10.3	- .3	- .1
175 - 200 → 200+	12.8	4.8	2.8	1.0
Average	9.3	5.3	2.7	1.0

Probably what this table shows most clearly is, if you want a neat package of results only do the test once, then you do not have this amount of variability; you also do not get a very correct picture of what is really happening. The yield increases for specific soil moisture ranges is wider than those mentioned in the literature. It does indicate that soil moisture is more important where there is limited rainfall in the growing season.

The variables are listed in order of the magnitude of the yield increase per increased unit of moisture (Table 3) and temperature (Table 4).

Table 3. Yield increase per mm increase of moisture

Moisture measurement	Yield increase	
	kg/ha/mm	bu/ac/inch
July rain	8.3	3.1
May rain	5.5	2.1
H_2O + (May + June + July rain)	5.2	2.0
July evaporation	-5.1	-1.9
May + June rain	4.8	1.8
June + July rain	4.5	1.7
H_2O + (May + June + July + August rain)	4.5	1.7
H_2O + July rain	4.4	1.6
H_2O + (May + June rain)	4.0	1.5
H_2O + May rain	3.8	1.4
June rain	3.5	1.3
H_2O + June rain	3.1	1.2
H_2O (spring moisture)	2.9	1.1
June evaporation	-1.0	- .4
August rain	- .5	- .2
August evaporation	- .4	- .2
May evaporation	.3	.1

Table 4. Yield increase per C° increase in temperature

Temperature	Yield increase	
	kg/ha/C°	bu/ac/C°
May	113	43
June	104	39
July	-66	-25
August	-17	- 6

To me this information points out one thing: the production of wheat in southwestern Saskatchewan is a complex problem, influenced by many factors, few of which we can control. We can do something about controlling available soil moisture in the spring, and methods to increase this moisture should be encouraged. Extra moisture in the spring will not guarantee a good crop, but it will increase the chances of getting one.

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Figure 1. Effect of moisture on yield of wheat.

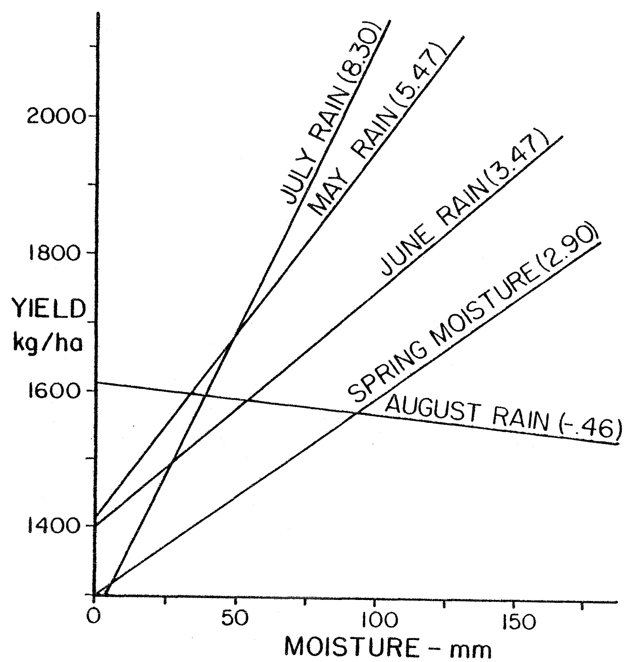

Figure 2. Effect of moisture on yield of wheat.

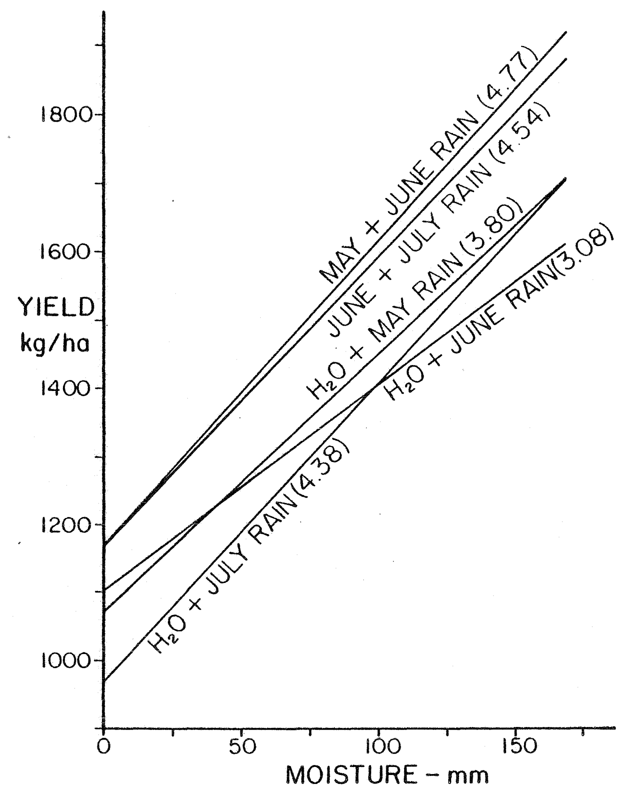

Figure 3. Effect of moisture on yield of wheat.

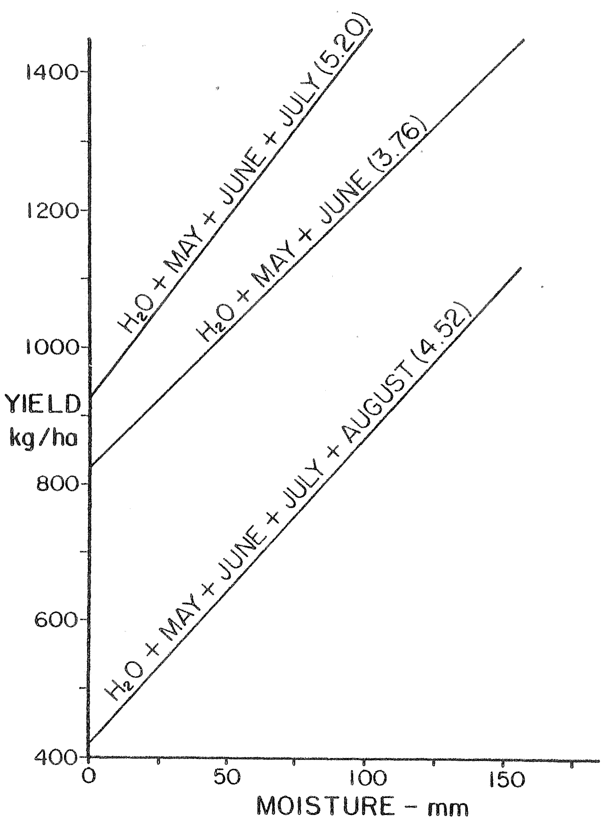

Figure 4. Effect of temperature on yield of wheat.

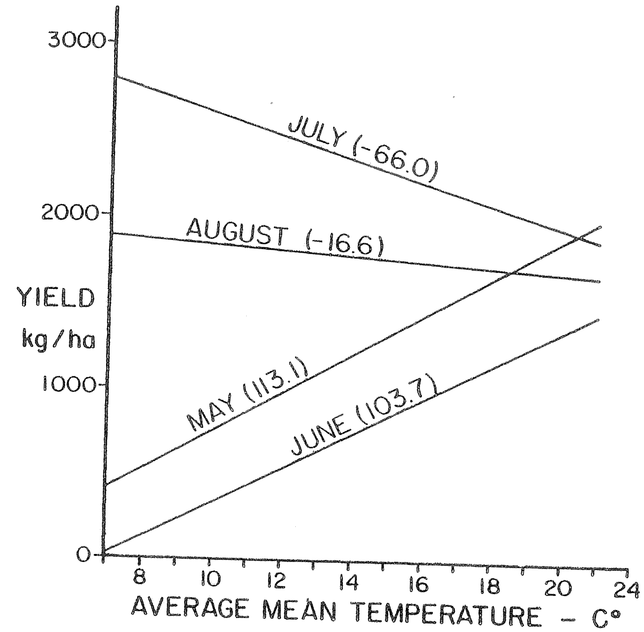

Figure 5. Effect of evaporation on yield of wheat.