Consumptive Use & Irrigation Management

for High-Yielding Wheats in Central Arizona

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Abstract

In Arizona, high-yielding Mexican varieties of wheat used 25.8 inches of water for consumptive use, representing an increase of at least 3.0 inches over previously produced varieties. When a normal rainfall of 3 inches occurs in the winter following a preplant irrigation, four additional irrigations are recommended — the first one in early March, the second about 3 weeks later, and the remaining two at 2-week intervals. At least 4.5 inches of water should be stored per irrigation.

Within the last several years, new varieties of high-yielding wheats have been released for commercial use in the Southwest, as well as in other arid regions of the world. These new varieties of wheat are being planted earlier than in the past, and can be successfully produced in beds, rows, or on the flat, using modern, precision-planting equipment (1). Yield has been increased as much as threefold in some areas, with only minor changes in cultural practices.

With an increased demand for more wheat acreage, a 2-year study was initiated on new varieties to measure consumptive use (CU) and to check irrigation management practices for maximum production.

Field Studies

Previous CU studies have been conducted on Ramona 50 wheat (2). New studies were then conducted at the University of Arizona's Mesa Experiment Farm, in Mesa, Arizona, incorporating the new varieties, using Maricopa, Siete Cerros 66, and Sonora 64 for the first year, and these same varieties plus Inia 66 and Ramona 50 for the second year. Ramona 50 is an old variety produced in the Southwest, whereas Maricopa is a more recent Arizona wheat. Siete Cerros 66, Sonora 64, and Inia 66 wheats are newer varieties developed in Mexico.

Wheat was planted on 22 November 1968 and 18 November 1969 in a randomized, complete-block, six-replication design. A precision planter was used, planting in rows 12 inches apart on the flat, and the plot was border-irrigated.

Timing of irrigations was based on previous studies and close observation of plant symptoms and soil-moisture measurements. CU was measured gravimetrically for each variety. The average soil moisture depletion in the top 3 ft. of soil before irrigation was 67% for the 2-year study.

In 1968-69, a preplant irrigation was given, plus three additional irrigations. The first irrigation was not given until 25 February, because 1.9 inches of rain fell in January and February. Two additional irrigations were given on 21 March and 12 April. Total rainfall for the first year was 4.2 inches. For the 1969-70 season, a preplant irrigation was given, followed by the first irrigation on 10 February. Rainfall of 2 inches delayed the second irrigation until 20 March. The third irrigation was given on 7 April, and the fourth on 28 April to all varieties

Table 1. Average yield and consumptive use of wheat by variety for a 2-year trial.

VARIETY	*YIELD (lbs./acre)*		*CONSUMPTIVE USE (inches)*	
	1968-69	*1968-69*	*1969-70*	*1969-70*
Maricopa	**5990**	**5300**	**27.2**	**25.7**
Siete Cerros 66	**6830**	**4840**	**28.4**	**25.9**
Sonora 64	**4550**	**4940**	**26.2**	**22.1**
Inia 66		**4930**		**25.1**
Ramona 50		**——****		**21.2**

***Excessive bird damage — no yield taken.*

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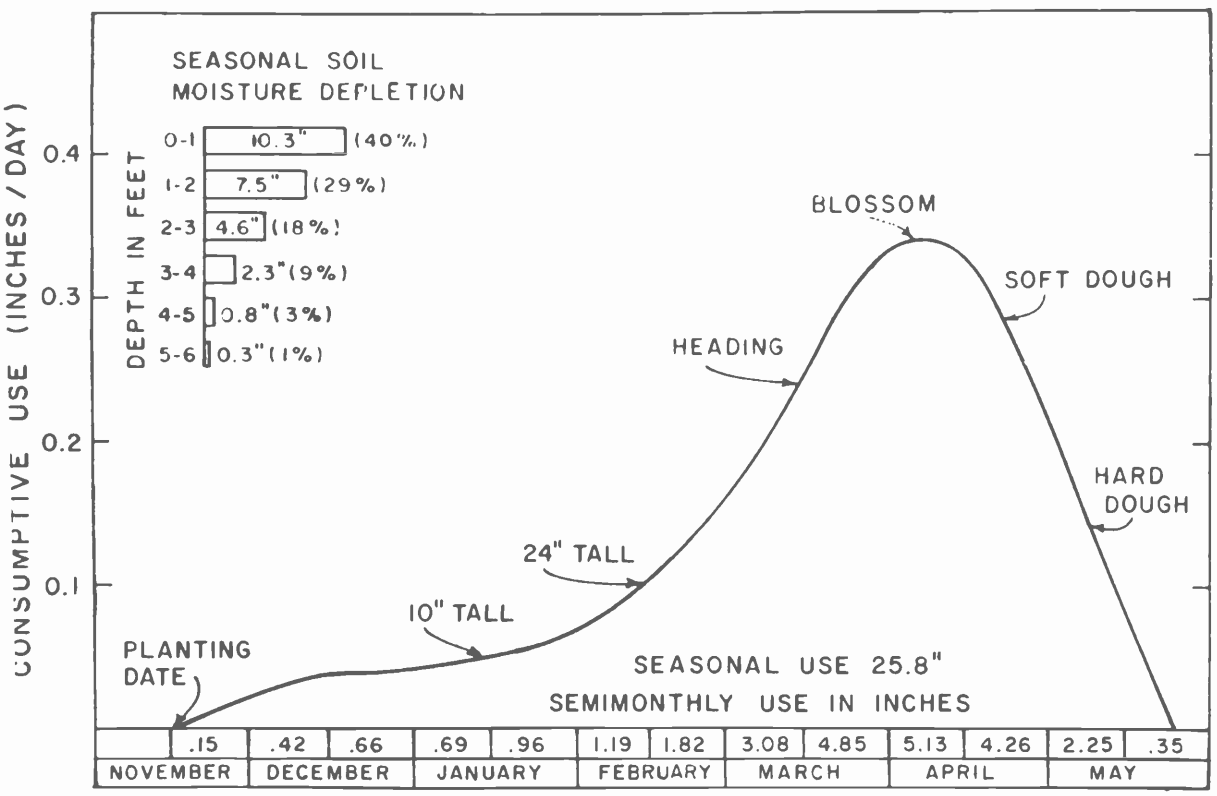

Figure 1. A two-year average consumptive water use curve for four high-yielding wheats.

except Ramona 50. Total seasonal rainfall was 2.8 inches.

Wheat Yields

Table 1 shows yield potentials to be greater than 6000 lbs. per acre, for the new varieties. Although Sonora 64 yielded only about 4500 lbs. per acre the first year, a heavier seeding rate in the second year than was used for the other varieties resulted in a comparable yield for the Sonora 64. Overall yields were down in 1969-70 for all the new varieties. Ramona 50 was planted the second year; however, yields were not taken because of excessive bird damage. Expected average for Ramona 50 is approximately 5500 lbs. per acre.

Consumptive Use

Consumptive use is defined as the amount of water used on a given area in transpiration, building of plant tissues, and evaporation from adjacent soil. Average CU by each variety is shown in Table 1. Disregarding differences between the new, high-yielding varieties, the average CU for each season was 27.3 and 24.7 inches, respectively. Sonora 64 used less water than the other high-yielding varieties. It is shorter, matures earlier, and produces less plant material. The CU for Ramona 50 reported previously was 22.9 inches (2). This figure should be increased approximartely 3.0 inches for the new varieties. Fig. 1 depicts the 2-year average CU curve for all four new varieties, with a seasonal use of 25.8 inches. The new curve represents approximately a 30-day longer growing season, with 87% of the moisture used in the top 3 ft. of the soil profile. The average peak CU is 0.34 inch/day, which is slightly less than that recorded for the older wheat variety.

Irrigation Management

Consumptive use should not be confused with irrigation water requirement, which includes water application efficiency, leaching, deep percolation and other unavoidable losses associated with irrigations. The water requirement is the amount of water that must be pumped or purchased. However, the CU curve can be used as a guide for estimating an irrigation schedule.

For example, at Mesa, Arizona, a preplant or planting-date irrigation on a high water-holding capacity soil will store at least 8 inches of water for plant use. From Fig. 1, the amount of irrigation water needed for plant use would be about 18 inches (25.8 – 8 = 17.8), or about 15 inches if a normal 3-inch rainfall were received. This quantity can be applied, logically, in four irrigations, since we know that 4 to 5 inches of water can be stored with each irrigation. The question is, when should the first spring irrigation be given? This most important decision is dependent upon winter rainfall and temperatures. If no winter rainfall occurs, nearly 3 inches of water will have been used from the top 2 ft. of soil by 1 February, necessitating an irrigation in early February, because the plant still has a shallow root system. However, if 3 inches or more of rain has fallen during the early-season growth period, which is normal for Mesa, Arizona, no irrigation would be necessary until the first week in March, when temperatures increase and plant growth begins. After the initial irrigation during March, the CU indicated by the curve would program the next irrigation of 4 to 5 inches in 3 weeks, followed by two subsequent irrigations at 2-week intervals. On the other hand, if the soil has a low-water-holding capacity, the frequency should be increased and quantity per irrigation decreased accordingly.

Conclusions

Several new, high-yielding varieties of wheat are being produced in the arid regions of the world. Yields of over 6000 lbs. per acre are being reported. The average consumptive use as measured for 2 years on four fall-planted wheat varieties at Mesa, Arizona, was 25.8 inches. This represents an increase of only slightly more than 3.0 inches as compared with previously grown varieties, even though yields are nearly threefold higher.

The consumptive-use curve can be used as a guide in scheduling irrigations for wheat. A preplant irrigation plus four irrigations during the growing season would be adequate for soils that have a high water-holding capacity. The time for the first spring irrigation will depend upon rainfall and temperatures during the winter. If about 3 inches of rainfall occur in January and February, the first irrigation will not be necessary until early March. This should be followed by a second irrigation in 3 weeks, and two subsequent irrigations at 2-week intervals, storing at least 4.5 inches per irrigation. This measured consumptive use, recommended number of irrigations, and proposed schedule, have been shown to comprise a successful irrigation regime for Arizona.

References Cited

1. **Dennis, R. E., and A. D. Day. 1967. Growing Wheat in Arizona. Ariz. Coop. Ext. Serv. and Agr. Exp. Sta. Bul. A-32, University of Arizona, Tucson. 19 pp.**
2. **Erie, L. J., O. F. French, and K. Harris. 1968. Consumptive Use of Water by Crops in Arizona. Ariz. Agr. Exp. Sta. Bul. No. 169. University of Arizona, Tucson. 46 pp.**