Wheat Irrigation Affects Flour Yield & Quality

by A. D. Day*

The wheat acreage in Arizona has been increasing significantly in recent years. Arizona wheat is grown for grain to be used for milling purposes, or livestock feed. This increased interest in wheat has stimulated questions on possible effects of irrigation on milling and baking qualities of wheat flour.

Effects of stressing wheat for water at different periods during growth on flour yield and quality were studied under field conditions for a two-year period (1966 and 1967) at Tucson, Arizona. Detailed materials and methods used in this experiment were reported in Progressive Agriculture in Arizona 21(5):8-10, 1969. At maturity, the grain was harvested and sent to the Western Wheat Quality Laboratory where 250-gram samples were used to obtain the following flour data: (a) yield, (b) protein (c) alkaline water retention capacity (A.W.R.C.), (d) viscosity, (e) mixing curve peak (60% absorption), and (f) mixing curve area. All data were analyzed using the standard analysis of variance and means were compared using Duncan's multiple range test.

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Flour Yield

Stressing wheat for soil-moisture at the jointing and dough stages of growth significantly reduced flour yields (Table 1). The greatest reduction in yield occurred when water was withheld at jointing, followed by moisture stress at the dough stage. Wheat with a high flour yield is worth more to a miller, because he sells flour for about twice what he receives for bran and shorts.

Flour Protein

Plants stressed for water at the flowering stage produced flour with the highest protein and its protein content was significantly higher than flour from wheat grown with optimum irrigation (Table 1). Withholding water from wheat at any stage of growth tended to increase flour protein. Since low protein is required in high quality pastry flour, stressing wheat for moisture lowers the value of its flour for this purpose. In addition, lower protein wheats are preferred for livestock feed, because cattle obtain less energy from protein than from carbohydrates.

Alkaline Water Retention Capacity

Witholding moisture during the jointing stage resulted in wheat flour with the highest alkaline water retention capacity, and moisure stress at flowering produced flour with the lowest A.W.R.C. (Table 1). Alkaline water retention capacity is a measure of pastry quality because there is a negative correlation between A.W. R.C. and cookie diameter.

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Table 1. Yield, protein, alkaline water retention capacity (A.W.R.C.), viscosity, mixing curve peak, and mixing curve area for flour from Maricopa wheat grown under four irrigation treatments at Tucson, Arizona in 1966 and 1967.

Irrigation treatment	Flour yield (%)	Flour protein (%)	A.W.R.C. (%)	Viscosity (deg.)	Mixing curve peak (min.)	Mixing curve area (cm.^{2})
Optimum irrigation throughout the growing season	65.30 c+	9.95 a	60.03 ab	77.50 a	1.45 ab	72.13 a
Plants stressed for water at the jointing stage	62.25 a	11.98 ab	60.40 b	139.75 b	1.35 a	82.15 c
Plants stressed for water at the flowering stage	66.73 c	12.23 b	59.65 a	141.25 b	1.55 b	83.95 c
Plants stressed for water at the dough stage	63.78 b	10.88 ab	59.98 ab	89.50 a	1.80 c	77.70 b
C. V. (%)	1.21	3.60	0.49	12.40	5.08	2.51

+Means followed by the same letter are not different at the 5% level of significance.

Wheat . . .

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Viscosity

Stressing wheat for soil-moisture at the jointing and flowering stages resulted in flour viscosity ratings that were significantly higher than flour viscosities from wheat stressed at the dough stage or grown with optimum irrigation (Table 1). These data indicate that when soil-moisture was withheld from wheat it resulted in flour with higher viscosity and stronger gluten. Wheat with these characteristics and that which is produced in this manner is less desirable for milling.

Mixing Curve Peak

In evaluating wheat flour, the length of time required to reach the mixing curve peak and the total area under the mixing curve are measures of flour quality. Normally, anything that increases the mixing curve peak or area tends to lower the quality of wheat for milling purposes.

When wheat was stressed for water at the dough stage, it required a longer time to reach the flour mixing curve peak than when wheat was grown under any other treatment (Table 1). The shortest time required to reach the flour mixing curve peak was obtained when water was withheld from wheat at jointing, and the longest time was obtained when moisture stress occurred at the dough stage.

Mixing Curve Area

Stressing wheat for moisture at any stage of growth significantly increased the flour mixing curve area (Table 1). The lowest flour mixing curve area was obtained when wheat was grown with optimum irrigation, followed by moisture stress at the dough, jointing, and flowering stages, in increasing order. The flour mixing curve data also suggest that when wheat was grown under soil-moisture stress, it resulted in stronger gluten flour, which would have to be blended differently by the miller or baker.

Increases in viscosities and mixing curve areas of flour from grain from stressed plants were due to the increases in flour protein content. However, changes in A.W.R.C. and mixing curve peak values were not related to changes in protein content and must be due to other factors resulting from water stress.

Onion Seed Production

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of desert flora that may be more attractive to bees. For example, peak onion bloom occurs in April and May; the duration and exact time depends on the variety. This is when several desert plants such as mesquite (*Prosopis juliflora*) salt cedar (*Tamarix pentandra*), arrow weed (*Pluchea serica*), and creosotebush (*Larrea tridentata*) also bloom. These desert plants appear to be attractive to honey bees as sources of both pollen and nectar, so problems of poor bee visitation to onion seed fields are probably related to the lower relative attractiveness in onion flowers.

One problem observed was that the bees were slow to start working the onion flowers after the colonies were placed in the field resulting in poor seed set on the early heads. This seemed more of a problem in 1969 than in 1970. Attempts at encouraging the bees by spraying the onions with artificial attractants have given variable results. Until the onion flowers can be made more attractive we suggest that growers continue the practice of bringing in more honey bee colonies when bees are working in the field poorly.

In addition to poorer seed set on early blooms there were some fields in 1969 where the seed crop failure could be attributed mainly to poor bee activity. Bee activity in 1970 was considered good enough for adequate pollination in most fields.

Harvest.

The most common method of harvest was by specially adapted combines (Figure 1) which removed the heads and passed them through a widely spaced cylinder and then transferred them to a large especially-built wagon being pulled along beside the combine (Figure 2). From the wagons the onion heads were dumped onto polyethylene tarps where they were dried in the open for a few weeks before threshing (Figure 3). Such mechanization of the harvest has reduced the cost compared with hand harvesting methods used previously. Also, harvest is completed in a shorter time, thus preventing unnecessary shattering of seed from mature plants ready for harvest.

Conclusions.

Onion seed production in Yuma County can be a profitable enterprise and in general satisfactory cultural practices have been developed. Two areas of uncertainty remain:

- control of plant diseases during cool wet years, such as occurred in 1970
- assurance of an adequate pollinator population in the fields during the time of bloom.

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