DETERMINATION of the rate of seed development is important since seed may reach physiological-maturity prior to harvest-maturity and such criteria as death of leaves or stems may not serve as good indicators. Little is known about the development of seed of safflower, *Carthamus tinctorius* L. For these reasons, this study was initiated.

**REVIEW OF LITERATURE**

Literature on seed development is voluminous, but an excellent review of the early literature was made by Amy and Sun (2). Known publications date at least as far back as 1880 (12).

Studies on barley (5, 11), wheat (4, 6), and oats (3, 9) seem to indicate that seed of all cereals develop similarly although each has its unique characteristics. Dry matter was accumulated most rapidly and uniformly the first 12 to 14 days after pollination. Moisture was highest (nearly 80%) immediately after fertilization and decreased uniformly until maximum dry matter had been accumulated in the seed after which seed moisture was lost rapidly. Whether dry matter increased in seed after the stem was severed from the roots was not clear, but nitrogen definitely appeared to be translocated during the drying period.

Early windrowing did not appear to be a means of reducing loss from ravages of rust in cereals, since yield and quality were reduced in proportion to the earliness of cutting. However, windrowing (swathing) was economically successful 7 to 10 days prior to maturity. In some cases, this was necessary to assure uniform ripening and to reduce losses due to the environment.

Germination tests indicated some seed viability in cereals 4 to 6 days after flowering although seedling vigor was much reduced. Percent germination and seedling vigor increased with maturity up to 20 to 28 days after pollination.

Investigators of corn (1, 17) have found that harvesting of seed before the moisture content had been reduced to approximately 25% reduced seed germination and seedling vigor even though maximum dry weight was achieved at about 65% moisture. Appearance of the corn plant was not a good criterion for estimating maximum dry matter of seed. Days after silking or tasseling was not a dependable criterion since different lines or hybrids mature at different rates.

Sorghum researchers (13, 14) have found that much the same results can be expected in development of sorghum seed as in that of cereals except that dry weight of seed may occur at more widely varying levels of moisture and seed do not germinate until 12 to 15 days after pollination. Seedling vigor and seed weight are closely correlated.

McAllister (16) concluded that, of several species studied, dough-stage seed were as viable as more mature seed and had a similar longevity under comparable storage conditions. However, seed of *Bromus marginatus* Nees and *Bromus polyanthus* Scribn. harvested in the milk and pre-milk stage were as viable as mature seed of the same species. Gräbe (10) found that 60% moisture in young seeds of *Bromus inermis* Leyss. decreased uniformly to 47% which was the point of maximum dry weight accumulation. Dillman (8) studied seed development of flax. He determined that oil first appeared in the seed between 4 and 6 days after pollination. The quantity of oil increased rapidly until 18 days after flowering and then more slowly for an additional 12 days. Seed were not considered ripe until 40 days after pollination.

Sims et al. (18, 19) examined development of fatty acid composition of flax and safflower seed in Canada. They concluded that the oleic fatty acid of safflower seed increased slowly during the first 30 days after fertilization and then leveled-off as maturity approached. Initially, linoleic fatty acid was present in the same amount as oleic fatty acid, but had increased to three times the concentration of oleic fatty acid by 20 days after pollination. However, this study included only one line introduced from India which had a low percent oil.

**MATERIALS AND METHODS**

Three safflower lines, 'US10', 'N6', and 'N4051', were selected for study because they differed in several agronomic characteristics. 'US10' is a variety of medium maturity, height, and head size. 'N6' is a line of medium maturity and height, but has large heads and seed. 'N4051' is a taller line with medium head size, but its bloom period is extended several days as compared with that of US10 or N6. Branching habits differ considerably between the three lines. N6 is composed mainly of primary branches with few, if any, secondary branches. US10 produces some secondary branches while N4051 produces abundant secondary branches with several tertiary branches.

Individual heads of all three lines were tagged at time of flowering in sufficient quantity to allow periodic harvest of individual heads until maturity. Since an individual safflower head "blooms" over a period of 4 to 5 days (15), flowering is herein used to mean that period when the earliest 50% of the florets of a head have completed pollination.

A split-plot design with four replications was employed during both years of this study. In 1960, 4 row plots 25 feet long were used. A total of 120 individual heads per plot were tagged on the same day at random at time of flowering. Twenty heads from each plot were sampled every week beginning 1 week after tagging and continuing at weekly intervals thereafter until all tagged heads were harvested. In 1961, 12 rows plots 20 feet long were used so that an increased number of samplings could be made. Also in 1961, 50 heads were harvested at each date to achieve a more adequate sample of seed. Sampling of individual heads began 4 days after flowering in 1961 and continued at 2-3, and 4-day intervals for 12 sampling dates. The seed was air-dried for later analysis.

Information was recorded on accumulation of dry weight (weight per 100 seed), percent oil content, seed viability, iodine number, and loss of moisture from developing seed. Hull percentage was recorded only in 1961.

Percent moisture was determined on an oven-dry basis. Percent hull was determined by terminating the seed for 24 hours, separating the cotyledons from the hull, and then drying and weighing the hull. Hull weight was expressed as percent of whole seed. Weight per 100 seed was determined on an air-dry basis.

**RESULTS AND DISCUSSION**

Weight per 100 Seed

Weight per 100 seed was the measurement used to estimate accumulation of dry matter. Line estimates in 1960 were highly significantly different (P = .01) but nonsig-