

## What's Wrong with the Julian Day?

R. C. Seem and S. P. Eisensmith

Department of Plant Pathology, New York State Agricultural Experiment Station, Cornell University, Geneva 14456.  
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The numerical expression, "day of the year," is often used as a measure of time for seasonal or temporally longer events. Expressing time on a continuous scale such as day of the year is better than the more discrete day-month convention because values can be used in a quantitative form. For example, growing degree days can be accumulated over days of the year (2) or phenological events of crop or disease development may be associated with a particular range of days of the year (5). In most cases, day of the year is calculated from 1 January, which is defined as day 1.

We, along with others (7), have noticed, with increasing frequency, that authors of technical papers that deal with the expression of time in days are often incorrectly using the term "Julian day" for day of the year. Because our present-day calendar is very similar to the Julian calendar, there is a tendency to erroneously assume that a Julian day is equivalent to a day of the year with 1 January being day 1. Although this oversight does not take away from the quality or usefulness of the published work, it is improper use of the term and we wish to set the record straight by describing the historical events leading to the present reckoning of day of the year (3,4).

The Julian calendar was introduced by Julius Caesar in 45 B.C. The Julian year consisted of 365 days and 6 hr, although it was known that 365.25 days was slightly longer than the true astronomical year (about 11 min longer). Based on the recommendation of an Egyptian advisor, Julius defined a year to have 365 days with every fourth year (intercalary or leap year) containing 366 days. The months and their length as we know them today received final adjustment in 8 B.C. by Julius' nephew, Augustus Caesar, who changed the day lengths of two months and, in a self-glorifying gesture, renamed the month Sextilis to August.

During the following centuries concern was raised by knowledgeable people about the growing error of the Julian calendar. Serious discussion of calendar reform started in the mid-16th century, but it was not until 1582 that reform occurred. In that year, Pope Gregory XII declared that 5 October was 15 October. The 10-day shift was based on the reckoning that since its start the Julian calendar was 7 days behind the astronomical year. The additional three days came from the fact that the Nicene Council, convened by emperor Constantine in 325 A.D. to fix the date of Easter for the Christian church, had shifted the vernal equinox from 25 March to 21 March. To correct future error, Pope Gregory's decree also ordained that of the centesimal years (i.e., 1600, 1700, 1800, etc.), only those exactly divisible by 400 could be leap years. Thus was established the Gregorian calendar, which is otherwise identical to the Julian calendar. Although the error of the Julian calendar was widely recognized, acceptance of the Gregorian calendar was slow due to the unwillingness of non-Roman Catholics to accept a papal order. It was not until 1752 that England and its North American colonies shifted to the Gregorian calendar and 3 September 1752 became 14 September 1752. As recently as 1927, Turkey adopted the Gregorian calendar. To date, the Julian calendar is 13 days behind our present (Gregorian) calendar.

Unfortunately, there are additional events that cloud the use of the term "Julian day." In an attempt to define a universal measure of chronology, Joseph Scaliger in 1582 defined a Julian day as the number of days since the beginning of the first Julian period. The Julian period is composed of 7890 years based on the combined solar (28-yr), lunar (19-yr), and indiction (15-yr) cycles ( $28 \times 19 \times 15 = 7890$ ). The indiction cycle was a Roman fiscal cycle used for accounting and taxation. Scaliger started the first Julian period at 4713 B.C., the year when the three cycles were coincident. According to this scheme, 1 January 1985 is represented by Julian day 2,446,065. In this case, the term "Julian" was used to honor the inventor's father, Julius Scaliger.

Our concluding point is simple. For those researchers who wish to associate a proper noun with day of the year designations, it should be Gregorian and not Julian. However, the argument can (and should) be made moot by simply calling the time period "day of the year" without any reference to Julius Caesar, Julius Scaliger, or Pope Gregory. Stone (7) has made the same suggestion, but we feel it needs to be reiterated for plant pathologists.

We wish to make one further suggestion to those who want to make precise year-to-year comparisons of events. The climatological day is a recent, but not widely accepted, day-of-the-year designation which was adopted by several regional research committees in the United States to uniformly describe climatological events such as probabilities of precipitation (1,6). The climatological calendar starts day one on 1 March of the Gregorian calendar. This permits each Gregorian calendar day to have a unique climatological day number since leap year's 29 February would occur as the last day of the year (366). Thus, 1 June is always day 93, 1 September is always day 185, and 1 February is always day 338. The climatological day designation obviously works best for seasonal events that initiate after 1 March.

### LITERATURE CITED

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