Growing seasons of Arizona and Sonora

Y. M. Ibrahim and R. E. Dennis

ABSTRACT

The climates of Arizona, USA and Sonora, Mexico have been divided into 20 types in this study. Descriptions of climates and divisions of land areas according to climate were based upon recorded mean maximum, mean, and mean minimum monthly temperatures. Elevation and latitude were found to be highly correlated with temperature. In this study a preliminary method of matching climates was described. Careful matching of climates will facilitate sharing of research and related information concerning the production of agronomic and horticultural crops.

Additional index words: Climate matching, Year-long season, Lapse rate, Frost-free period.

The climate of any region is a composite of many meteorological elements and their periodic variation. Many methods have been used to define these climatic patterns. Among the most widely known classification systems are those proposed by Koppen (1918) and Thornthwaite (1931, 1933, 1948). Trewartha (1954, 1968) modified previous classification methods and used both temperature and rainfall criteria. Fairbridge (1967) suggested the use of only one climatic variable, thereby avoiding overlapping and transition zones.

Many attempts have been made to study climatic regions in relationship to temperature (Brown and Cocheme, 1973). Utaakar (1980) discussed the impact of elevation on temperature differences. The average decrease of temperature with elevation (lapse rate) was found to be 6 C for every 1000 meters according to Brown and Cocheme (1973). McColm and Dennis (1980) found that growing seasons in Arizona were shortened 30 days for each increase of 300 meters in elevation. Baier (1977) studied the impact of climate on crop yields and Skaar (1980) observed the effect of climate on the frost-free period. More recently, temperature as evaluated by heat units or growing degree days was found to be highly correlated with temperature extremes. Matching climates will facilitate sharing of research and related information concerning the production of agronomic and horticultural crops.

MATERIALS AND METHODS

The Extension and Resident Instruction components of the Land-Grant System seek to transmit useful information to the people, from wherever it may have been developed. Temperature is one of the most important factors affecting adaptation and cultural practices, especially for crops in irrigated areas. The objective of this study was to classify the climates of Arizona and Sonora on the basis of temperature, thereby facilitating the transfer of research and related information between Arizona and Sonora and from other areas to these states.

Data for average monthly temperatures from 72 weather stations in Arizona and Sonora were used in this study. A modified terminology for the criterion used by McColm and Dennis (1980) provided a means of evaluating temperatures reported for each station. Numerals and letters were used to characterize the growing season of each area. The terminology was divided into two parts, depending on the mean maximum, mean, and mean minimum monthly temperatures. The first part consisted of general features identified with numerals representing the approximate length of the growing season (Table 1). The second part of the terminology identified temperature characteristics of the season with letters (Table 2). The assigned letters provided a clue to the amount of heat usually available during the growing season. Matching cli-

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Table 1. General features of terminology used in growing season classification (Average monthly temperature).

<table>
<thead>
<tr>
<th>Climatic type</th>
<th>Terms</th>
<th>Description</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year-long</td>
<td>I</td>
<td>Extremely hot</td>
<td>Minimum not less than 10 C, mean not less than 18 C all year</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Very hot</td>
<td>Minimum not less than 5 C, mean not less than 13 C all year</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>Hot</td>
<td>Minimum not less than 1.7 C, mean not less than 10 C all year</td>
</tr>
<tr>
<td>Hot-moderate</td>
<td>IV</td>
<td>--</td>
<td>8 months or more but less than 12, minimum 1.7 C or above, mean 10 C or above</td>
</tr>
<tr>
<td>Moderate</td>
<td>V</td>
<td>--</td>
<td>5 months or more but less than 8, minimum 1.7 C or above, mean 10 C or above</td>
</tr>
<tr>
<td>Moderate-cool</td>
<td>VI</td>
<td>--</td>
<td>2½ months or more but less than 5, minimum 1.7 C or above mean 10 C or above</td>
</tr>
<tr>
<td>Cool</td>
<td>VII</td>
<td>--</td>
<td>Less than 2½ months, minimum 1.7 C or above, mean 10 C or above</td>
</tr>
</tbody>
</table>

Table 2. Extremes of temperature used for classification of climate.

<table>
<thead>
<tr>
<th>Climate classification based upon temperature extreme</th>
<th>Terms</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot summer growing season</td>
<td>A</td>
<td>2 months or more with mean 25.6 C or above, 2 months or more with maximum 35.0 C or above</td>
</tr>
<tr>
<td>Moderate growing season</td>
<td>B</td>
<td>Less than 2 months with mean 25.6 C or above, at least 3 months with minimum 8.9 C or above, mean monthly 18.3 C or above, and 1½ months or more with mean 22.2 C</td>
</tr>
<tr>
<td>Cold growing season</td>
<td>C</td>
<td>2 months or more with minimum 8.9 C or above and mean 15.6 C or above, 1½ month or less with mean 22.2 C</td>
</tr>
<tr>
<td>Short spring and fall when occur with I, II, III, IV</td>
<td>c</td>
<td>2 months or more with minimum below 8.9 C, 2 months or more with mean below 15.6 C</td>
</tr>
<tr>
<td>Summer suitable for cold tolerant crops when appear with VI</td>
<td>w</td>
<td>Range of 10 C between maximum and minimum during the growing season</td>
</tr>
</tbody>
</table>

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1 A contribution from the Dep. of Plant Sciences, College of Agriculture, Univ. of Arizona, Tucson.
2 Graduate student and extension agronomist, respectively, Univ. of Arizona, Tucson, AZ 85721.
mates of stations from locations outside the study area may be
done by comparing mean maximum, mean, and minimum
temperature data for these stations with similar data for repre-
sentative Arizona and Sonora sites.

RESULTS AND DISCUSSION

Twenty different climatic classifications for Arizona
and Sonora were developed using mean maximum,
mean, mean minimum temperatures. These climate
classes are illustrated in Fig. 1. Examples of classes
representing different growing seasons in the areas are
shown in Fig. 2 and 3.

Where year-long growing seasons occur, double and
other multiple cropping is often practiced (Fig. 2).
Three distinct climatic groups were found in this cate-
gory:
a) Extremely hot, year-long growing season. Cotton
and sorghum are adapted to this area and other heat
tolerant crops may also be grown. Hardy agronomic
crops like alfalfa, sugarbeets, and winter and spring-
wheats are used, with much of their growth occurring
during the cooler times of the year. This area is charac-
terized by great differences between day and night
temperatures (class Iw) and with very hot summers
(class IAw).

b) Very hot, year-long growing season with minimum
monthly temperatures that never fall below 5 C. This
area includes class IIAcw with a hot summer growing
season, class IBcw with a moderate season and short spring
and fall, class Ilcw with cold spring and fall
growing conditions. Heat-tolerant crops, such as
cotton, sorghum, eggplant, and watermelon can be
grown in this climatic area. Hardy agronomic crops like
alfalfa, sugarbeets, and winter and spring wheat are
suited to classes IIbcw and IIcw.

c) Hot, year-long growing season with mean mini-
mum monthly temperature not less than 1.7 C. Spring
and fall vegetables and cold-tolerant crops like small
grains, safflower, lettuce and hardy grasses can be
planted in classes IIIbcw, IIIccw, and IIIcw and, to
some extent, in classes IIIAcw and IIIAw. Citrus is well
adapted to class IIIAcw. Crops like sugarbeet, carrots,
and onions may be planted in late August to mature be-
fore cold weather. Carrots and onions may also be
planted for harvest during the winter months, in this
area. During the summer, heat-tolerant crops may also
be grown.

The hot-moderate growing season has a length rang-
ing from 8 to 12 months, with summer temperatures
either hot (IVAcw) or moderate (IVBcw). Class IVAcw
is suitable for small grains, sugarbeets, alfalfa, sa-
flower, ryegrass, and other cold-tolerant crops. There is
a relatively short spring and fall for hardy crops like
lettuce in this climatic class. Class IVBcw is suited for
tender crops like corn, beans, tomatoes, melons, and
hardy forage crops.

A moderate temperature growing season has a length
of 5 to 8 months. Class VAcw has warm summer
temperatures suited to heat tolerant crops. Class VAcw,
with similar features as Vaw, is warmer with summers
suitable for heat-tolerant crops. The climatic class VBw
has moderate temperatures suited for hardy crops like
alfalfa, sugarbeets, irrigated pasture, and winter and
spring wheats. Tender crops, such as corn, sorghum,
and cantaloupe, are also adapted to this climatic class.
Class VCw has a cold growing season that is best suited
to hardy crops. In class Vcw, summers are cold and
short-season varieties of sweet corn, tomatoes, peppers,
and cantaloupe are grown.

The climatic area that has 2½ to 5 months frost-free
is classified as moderate-cool (VIcw) and is unsuited for
many crops. However, summer temperatures are suit-
able for hardy, cold-tolerant crops such as potatoes and
irrigated forages. Winter-hardy varieties of alfalfa and
other cool-season legumes and hardy grasses are recom-
mended for this climatic area.

Climate matching of areas in Arizona and Sonora
with those elsewhere is possible using criteria suggested
in this study. Extension demonstrations and farmer ex-
perience have shown the feasibility of this practice.
Intermediate dormant alfalfas from Utah, Nevada and
other states fit areas of Arizona having a similar
climate. The winter wheats of Washington and Oregon
are now used in the irrigated areas of southeastern
Arizona. Spring wheats developed at Ciudad Obregon,
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Fig. 2. Locations representing year-long growing season climates.

Fig. 3. Locations representative of cool-moderate growing season climates.
Sonora Mexico have been introduced to Arizona and state average yields have more than doubled as a result of this introduction. Land areas that have similar mean maximum, mean and mean minimum temperatures are suited to similar crops, crop cultivars and cropping practices. Careful matching of climates will facilitate sharing of research and farmer experiences relative to the production of agronomic and horticultural crops, and, ultimately, such sharing will help farmers and others improve their efficiency of production.

LITERATURE CITED