Ask The Expert

Editor's Note: How often have you been faced with reading or hearing a topic that sounds interesting, but you do not quite understand some of the detail? We have selected such a question and have had an expert on the topic provide an answer.

QUESTION:

“Warm-season and cool-season plants are frequently called C4 and C3 plants. What does this terminology represent and how do the plants differ?”

Carly Dorman, Fort Collins, Colorado

RESPONSE:

We usually think of warm-season plants as those that grow more during the warmer part of the year: mid-summer to early fall. Cool-season plants usually grow better in the spring and fall when temperatures are cooler. The terminology of warm- and cool-season plants indicates their most active growth periods as related to air temperatures. The other terms (C4 and C3) for these plants come from plant physiology and indicate the photosynthetic pathway type that each of these plants use in fixing carbon dioxide in the air into carbohydrates in the plant through photosynthesis. Warm-season plants use the C4 cycle in the fixation of carbon dioxide. This pathway type was discovered in tropical grasses in the 1960s by researchers Hatch and Slack and is sometimes referred to as the Hatch and Slack pathway. Until

then, we assumed that all plants followed the “normal” C3 pathway (also known as the Calvin and Benson cycle) in carbon dioxide fixation. The names C4 and C3 arise from the number of carbon atoms that are in the first stable product that is produced in carbon dioxide fixation; in C4 plants, it is malic or aspartic acid (which contain 4 carbons in the initial product) as compared with phosphoglyceric acid (PGA) that has only 3 carbon atoms in the product.

So, why are the differences between these two pathways important to a range manager? Each of these pathways involve different enzymes, chloroplasts, and cellular locations, which results in different responses to a number of environmental variables. These differences make C3 plants better adapted to certain conditions, whereas C4 plants respond differently to these same conditions. The table below shows some ecophysiological differences between C4 and C3 plants.

The characteristics in the table indicate that in warmer climates, with drier conditions and less soil nitrogen available for growth, C4 plants should perform better than C3 plants. In cooler locations, with more soil water and nitrogen available, C3 plants should do well. In some areas, there can be mixtures of both C4 and C3 species, which can help extend the green foliage period through the growing season and allow grazing animals to use the C3 species early in the growing season, then use the C4 species during

Table 1. C3 and C4 plant responses to various conditions

Characteristics	C3 Plants	C4 Plants
Optimum light	Low intensity	High intensity
Optimum temperature	Low (20°–35°C, 68°–95°F)	High (30°–45°C, 86°–113°F)
Water use efficiency	Low	High
Nitrogen use efficiency	Low	High
Nutritional Value	Good (higher protein)	Fair (lower protein)

the middle of the growing season, and then, possibly, use the C3 species again in the fall if there is a “green up” of these plants. These mixtures of C4 and C3 plants can occur together or each may be in separate pastures. The mixtures may also include grasses, forbs, and shrubs because all 3 of these life forms have both C3 and C4 species representatives. Obviously, we may wish to consider which of these pathway types (or both) fit the environment better when we are reclaiming or restoring an area and are selecting plant species to use.

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If you have a question on a topic, please send a short note to: Gary Frasier, Rangelands Editor-in-Chief, 7820 Stag Hollow Rd., Loveland, CO 80538 or email: gfrasier@aol.com. If selected, we will attempt to locate an expert for an answer and publish it in a future issue of Rangelands.

CALL FOR PAPERS AND POSTERS ABSTRACTS AND SYMPOSIA PROPOSALS

The deadline to submit abstracts and proposals is approaching for the **59th Annual Meeting of the Society for Range Management**, 11-17 February, 2006 in Vancouver, British Columbia. The theme of the meeting is “Rangelands to Rain Forests”. We welcome submission of symposia and papers that are applicable to rangeland resource sciences and issues at national or international levels. The following deadlines apply:

- Symposia Proposals – 30 May 2005 ▪
- Workshop & Specific Program Proposals – 30 June 2005 ▪
- Oral and Poster Presentations – 31 July 2005 ▪

For more information or to submit abstracts for technical sessions and symposia, go to

<http://www.rangelands.org>

or

<http://abstracts.co.allenpress.com/rama/index.html>

For questions please contact Bill Krueger (541-737-1615
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