



Drought Tolerant Crop

Why in News?

Recently, a study has noted that a common weed named “**Portulaca oleracea**”, commonly known as **purslane**, offers important clues about creating **drought-tolerant crops** in a world beset by **climate change**.

- Yale University scientists integrated **two metabolic pathways** to produce a novel type of **photosynthesis** that enables the weed to **withstand drought while remaining highly ‘productive’**.

What do we know about Purslane?

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- **About:**
 - **Purslane** possesses evolutionary adaptations that allow it to be **both highly productive and drought tolerant**.
- **Description:**
 - It is mostly **an annual, but it may be perennial in the tropics**.
 - **Stems** are glabrous, fleshy, purplish-red to green, arising from a taproot, often prostrate, forming mats.
- **Distribution:**
 - It is most common in the **temperate and subtropical regions**, although it extends into the **tropics and higher latitudes**.
- **Habitat:**

- **It is common in** fields, gardens, vineyards, lawns, driveways, dunes, beaches, salt marshes, waste areas, eroded slopes, bluffs and riverbanks.
- **Species Affected:**
 - It competes for resources with many field crops, particularly **herbaceous species** that are **germinating or growing in competition**.
 - **Affected crops include:** asparagus, red beets, celery, crucifers, cotton, maize, onions, potatoes, rice, soyabeans, sugarcane, tomatoes and wheat.
- **Ecology:**
 - **It has a wide tolerance of** photoperiod, light intensity, temperature, moisture and soil type.
 - Seeds germinate under conditions that **enhance the survival of seedlings**.
 - The species is **self-compatible**.

What are the Key Highlights of the Study?

- Plants have **independently evolved various mechanisms to improve photosynthesis**, the process by which green plants use sunlight to synthesise nutrients from carbon dioxide and water.
 - **Corn and sugarcane** evolved C4 photosynthesis, which allows the plant to **remain productive under high temperatures**.
- Succulents such as **cacti and agaves possess another type called CAM photosynthesis**, which helps them **survive in deserts and other areas with little water**.
- Both C4 and CAM serve different functions but **recruit the same biochemical pathway to act as 'add-ons' to regular photosynthesis**.
- The study conducted a spatial analysis of gene expression **within the leaves of purslane and found that C4 and CAM activity is totally integrated**.
 - They **operate in the same cells, with products of CAM reactions being processed by the C4 pathway**.
 - This system provides unusual levels of protection for a C4 plant in times of drought.

What are C3, C4, and CAM plants?

- **C3 Cycle:**
 - It is also known as **Calvin Cycle**.
 - It is a cyclic reaction occurring in the **dark phase of photosynthesis**.
 - In this reaction, **CO₂ is converted into sugars** and hence it is a process of carbon fixation.
 - The Calvin cycle was first observed by **Melvin Calvin in chlorella**, unicellular green algae. Calvin was awarded [Nobel Prize](#) for this work in 1961.
 - Since the first stable compound in Calvin cycle is a **3 carbon compound** (3 phosphoglyceric acid), the cycle is also called as **C3 cycle**.
 - **C3 plant examples:** Wheat, Oats, Rice, Sunflower, Cotton etc.
- **C4 Plants:**
 - The C4 plants show a **different type of leaf anatomy**.
 - The chloroplasts are **dimorphic in nature**. In the leaves of these plants, the **vascular bundles are surrounded by bundle sheath of larger parenchymatous cells**.
 - These bundle sheath cells have chloroplasts.
 - These chloroplasts of bundle sheath are larger, lack grana and contain starch grains.
 - The chloroplasts in mesophyll cells are smaller and always contain grana. This peculiar anatomy of leaves of C4 plants is called Kranz anatomy.
 - Examples of C4 plants: **Maize, Sugarcane, Amaranthus**.
- **CAM Cycle:**
 - CAM is a cyclic reaction occurring in the dark phase of photosynthesis in the plants of Crassulaceae.
 - It is a CO₂ fixation process wherein the first product is malic acid.
 - It is the third alternate pathway of Calvin cycle, occurring in mesophyll cells.
 - CAM plants are usually **succulents** and they grow under extremely xeric conditions. In these plants, the leaves are succulent or fleshy.
 - In these plants, the stomata remain open during night and closed during day time.

- The CAM plants are adapted to photosynthesis and survival under adverse xeric conditions.
- **Examples:** Sedum, Kalanchoe, Pineapple, Opuntia, Snake plant.

[Source: DTE](#)

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