

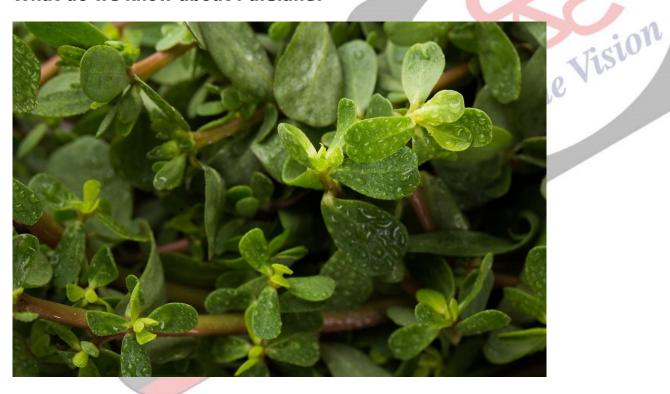
# **Drought Tolerant Crop**

### 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?



- 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, CO<sub>2</sub> 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 <u>Nobel Prize</u> 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 CO<sub>2</sub> 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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