2nd Feb 2008

# Food plants affected both ways

$CO_2$ and fertilizers, both are no good for food plants, says S.Ananthanaryanan.

Recent researches have made two discoveries – one that excess carbon dioxide, the gas that green plants use to make food, can jeopardize their survival. The other, that mildly rising nitrogen levels reduces the variety of plant species in an ecosystem, which levies its toll on the surviving species.

**$CO_2$ and C-4 grasses**

A study in University of Lausanne, Switzerland, has found that the major food plants that support human life, like corn, wheat, sugarcane, sorghum, millets, evolved about thirty million years ago, in a reaction to scarcity of carbon dioxide in the atmosphere. The list of this class, known as ***C-4 grasses***, includes plants used as bio-fuel and many components of the world's grasslands.

The Lausanne scientists used the molecular clock technique to date the evolution of C-4 grasses. The molecular clock method compares the genetic structure of a species as it evolves over a period of time whose length is known, for example by geological data or by carbon dating. The level of genetic change then provides a fair measure of how fast the changes occur, over time. Now, if samples of plant species at unknown times are examined, the extent of genetic change could provide an idea of the time taken those changes have taken.

In this way, C-4 grasses were found to have arisen just the time when carbon dioxide levels on the earth were low. Plants normally harvest energy through photosynthesis, using sunlight and carbon dioxide. But when carbon dioxide levels are low, for example when the leaves close their pores in hot and arid conditions, plants fall back on an alternative process called photorespiration, which uses oxygen in place of $CO_2$, but the process is energy inefficient. The C-4 grasses evolved to avoid this alternative procedure, by making use of $CO_2$ within the plant in times of $CO_2$ scarcity. Grasses not so evolved are the C-3 grasses, dessert shrubs, hardy, but not so useful to support animal populations.

As C-4 grasses evolved to combat reduced $CO_2$ levels, major increases in $CO_2$ concentration could set off ecological changes that would alter the distribution of C-4 grasses. Reversal of the conditions that gave rise to C-4 plants may lead to their extinction – a grim prospect, in times of increasing $CO_2$ levels and the substantial reliance of human populations on this category of plants.

**Plant diversity**

Studies have shown that having more species living together is good for all of them, rather than detrimental. Although more species vie for the same nutrition resources diversity of species evolves so that each supports the other, in controlling predators or maintaining nutrient mix.

Specialised plant species grown in isolation not only need custom-made fertilizer, but are also sitting ducks for infection and cannot resist minor changes in conditions.

Scientists at University of Minnesota, USA, in a twenty three year-long experiment in neighbouring grasslands, have found that low levels of nitrogen for extended periods seriously reduces plant species numbers in sample plots. Happily, they have also found that diversity reappears when the earlier nitrogen levels are restored.

The use of fossil fuels and chemical fertilizers have increased nitrogen levels to two to seven times the pre-industrialised levels in developed countries. A similar rise is expected in industrialized areas of Asia and South America in the next fifty years. The effect of such high nitrogen levels on plants have been studied and are documented. What has not been studied is the effect of low level, but chronic increase of nitrogen, which is found in the large underdeveloped parts of the globe.

The two-decade study in Minnesota shows that while higher nitrogen levels result in lower numbers of species co-existing, it is when the nitrogen addition is at low levels that the species number depletion is the highest. This is perhaps because the prairie dominated by C-4 grasses has the highest uptake of nitrogen at low nitrogen levels.

The added nitrogen aids specific species to prosper, at the cost of other species, without the automatic controls that develop over centuries in natural ecosystems. But when nitrogen levels are higher, the C-3 dominated, species-poor plant community loses extra nitrogen and is not affected to the same degree. Large tracts of agricultural land receiving low doses of fertiliser may thus be modified to their disadvantage.