Miracles of Agricultural Science

Brought out on the occasion of Institute Agriculture Education Day

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Hybrid Rice

Hybrid rice technology involving the exploitation of hybrid vigour or heterosis in the F1 hybrids is the best practicable option available to achieve the required jump in productivity to meet the food demands of the burgeoning population in the country. In a self pollinated crop like rice, a reliable genetic tool is essential to produce hybrid seeds on a commercial scale. The cytoplasmic-genetic male sterility system involving three parental lines, CMS line, maintainer line and restorer line has been effectively used in the country to develop 59 hybrids which are commercially grown mostly in the Eastern Indian states. The hybrids have a yield advantage of more than 1.0-1.5 t/ha over the best commercial inbred varieties. The Cenral Rice Research Institute has developed several CMS lines and three promising hybrids, Ajay, Rajalaxmi and CR Dhan-701 for irrigated and shallow lowlands which are gaining popularity because of their yield potential, good grain quality and tolerance to biotic/abiotic stresses.

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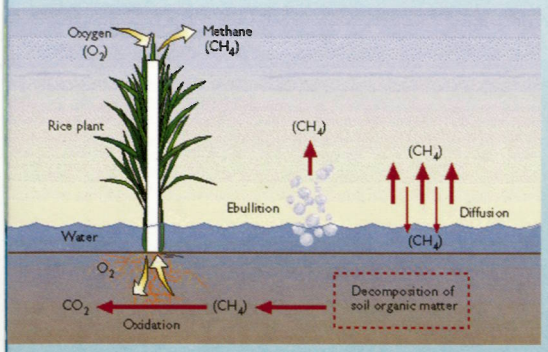
URL: http://www.crri.nic.in



Methane production and emission from rice field

Methane sampling from rice field

Methane emission from rice ecosystem

The "Greenhouse gases" like carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) is increasing in the atmosphere that cause global warming. Agricultural activities contribute about 20% to the total greenhouse gases emissions. Rice contributes approximately 10–13% to the global CH4 emission and its current concentration in the atmosphere is 1.82 parts per million (ppm). Biogenic CH4 is produced in the anoxic environments of submerged soils and sediments including rice paddies during anaerobic degradation of organic carbon compounds by methanogenic bacteria. The main bio-chemical process that occurs in the soil for the generation of CH4 are:

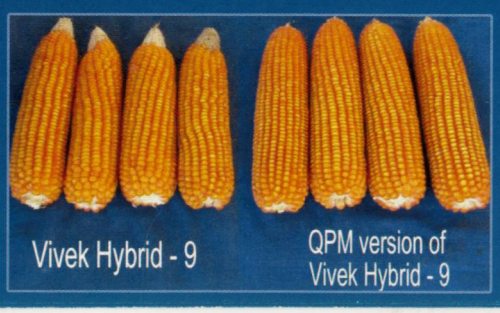
4 H 2 + CO2 ----------→ CH4 + 2H2 O

4 H COO- + 4 H + ----------→ CH4 + 3 CO2 + 2 H2O

The collection of CH4 is generally done by closed chamber method in the field followed by its concentration measurement by Gas chromatography (GC) in laboratory. Modern equipment like Open path Eddy Covariance system is also helpful for continuous measurement of CH4. The Central Rice research Institute is actively working in the research on CH4 monitoring and its mitigation strategies. The cultivation of suitable rice variety, mid season drainage, application of proper dose of fertilizer can really helps to reduce CH4 emission from rice field.

Quality Protein Maize Hybrid

Conventional maize proved to be a poor-quality staple food for most of the people in the developing world. Opaque 2, developed in 1963 with high protein, gave low yields and was susceptible to disease. Scientists removed chalky appearance and enhanced protein content in Opaque 2 variety, which gained a widespread acceptance in 1980s. The improved varieties, also known as quality protein maize (QPM) with much higher levels of lysine and tryptophan, offer 90% nutritional value of skim milk; the standard for adequate nutrition. They produce 70-100% more lysine and tryptophan than most of the modern varieties of the tropical maize. Worldwide QPM hybrids yielding 10% higher than other hybrids have been developed and tested for varying climatic and growing conditions. Scientists at the Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora employed biotechnological approach, known as marker-aided selection (MAS), to transfer QPM traits to popular maize hybrid Vivek 9. The new hybrid named as Vivek QPM 9 has been released for cultivation.



Bacteria to fight disease and global warming

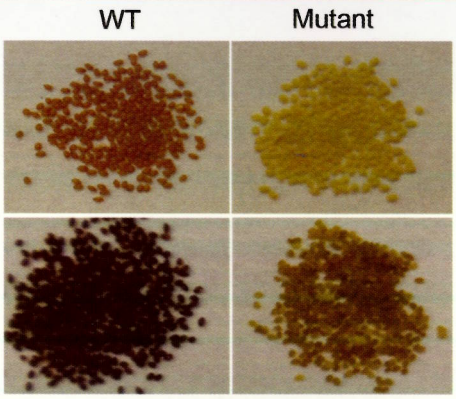
Scientists have been able to create strains of genetically enhanced bacteria, Bionic bacteria, that glow under microscope when exposed to light. These bacteria have shown promise for controlling diseases, manufacturing synthetic drugs and for biofuels production. Bionic bacteria carry "unnatural" amino acids (Uaas) in addition to 20 naturally occurring amino acids in proteins at multiple sites.

Bionic bacterial strains with Uaas incorporated at one site (Bottom) and at multiple sites (Top)

The trained bacterium inserts Uaas to produce new types of synthetic chemicals or proteins with changed chemical properties. Genetically modified bacteria have already been used for producing medicine such as synthetic insulin, used by diabetic patients. This recombinant DNA technology could use only natural amino acids, which limits possible functions of the resulting protein products. The ability of bionic bacteria to insert Uaas can dramatically expand the possible use of such a technology.

Golden rice

Golden rice is a variety of Oryza sativa rice produced through genetic engineering to biosynthesize beta-carotene, a precursor of vitamin A, in the edible parts of rice. The research was conducted with the goal of producing a fortified food to be grown and consumed in areas with a shortage of dietary vitamin A, which is estimated to kill 670,000 children under 5 each year. Golden Rice was created by transforming rice with 2 Beta-Carotene biosynthesis genes. The scientific details of the rice were first published in Science in 2000, the product of an eight-year project by Ingo Potrykus of the Swiss Federal Institute of Technology and Peter Beyer of the University of Freiburg. At the time of publication, golden rice was considered a significant breakthrough in biotechnology, as the researchers had engineered an entire biosynthetic pathway. In 2005, a new variety called Golden Rice 2, which produces up to 23 times more beta-carotene than the original golden rice, was announced.



Cloning of Tan1 gene in sorghum. Anthocyanin and tannin accumulation in wild type (WT) and mutant as indicated by (a) seed colour and (b) bleach test in sorghum seeds

Anti-cancer and anti-obesity gene cloned from sorghum

Sorghum, an ancient old-world cereal grass, is the dietarystaple of over 500 million people in more than 30 countries. Its drought-resistance character coupled with wide adaptation and high nutritional value hold the promise to alleviate hunger in Asia and Africa. Pigmented testa of some sorghum cultivars contain condensed tannins and have recently been shown to promote human health because of their high antioxidant capacity and ability to fight obesity through reduced digestion. Using molecular techniques the gene (Tanl) controlling tannin biosynthesis in sorghum has been cloned. Studies have indicated that tannins from sorghum are beneficial to human health because of anticarcinogenic activity against human melanoma cells and as anticaloric agents for obese individuals. Isolation and cloning of Tan I gene Fig.1 has opened the possibility of genetic research to produce different levels and combinations of phenolic compounds in crop plants. These results have facilitated breeding efforts to combine tannin compounds and agronomic properties in unique sorghum lines for potential nutraceutical applications.

Why fruits ripen and flowers die?

The power of fruit ripening had been harnessed by ancient Egyptians by discovering that scratching figs hastens the ripening process. This was an enigma in plant biology why fruits ripen, mature and set seeds while flowers wither. A single molecule, gas known as ethylene, governs both the events in plants. This gaseous hormone best known for its fruit ripening and flower fading, shortens shelf-life of many fruits and plants by putting their physiology in fast-forward. It influences various physiological and morphological responses in plants such as seedling development including triple response that helps seedlings to germinate, grow and push obstructions. It also regulates root hair growth, nodulation in nitrogen fixing legumes, floral sex determination, stimulates fruit ripening, floral fading and abscission which allows plants to drop leaves, flowers and fruits. In cucumber and other members of the melon family, male and female flowers develop from the same immature flowers with primordial for both male and female reproductive organs. Under the influence of ethylene, bisexual immature cucumber flowers undergo programmed cell death in the stamens, resulting in the formation of female flowers with functional mature pistils whereas male flowers form in the absence of ethylene.

A developing cucurbitaceous fruit along with a flower

Cloning of Buffalo

Shresth

The country needs to increase its milk production from current level of 105 million tonnes to 170 million tonnes by 2020. In a significant boost to country's research on developing superior milch buffaloes for augmenting milk production, scientists at National Dairy Research Institute (NDRI), Kamal cloned buffalo calf 'Shresth', through advanced 'hand-guided cloning technique'. The calf was cloned from the ear somatic cell of a two-week-old buffalo calf. Further, the embryo remained frozen for a week at -196 degree Celsius in liquid nitrogen before returning to life on thawing at room temperature. The hand-guided cloning technique was an advanced modification of the conventional cloning technique. The cryopreservation of embryos could be used to transport them to other places. This cloning technology could go a long way in helping for faster multiplication of superior milch buffaloes in country.

Bt Cotton

Cotton is the major fibre crop of the world. India is famous since time immemorial for its finest cotton and cotton textiles. Cotton is well known for the excessive consumption of pesticides which are used to manage a variety of insect pests and also because of the commercial importance of the crop. Many pests attack the crop, the major ones being cotton bollworm, pink bollworm, spotted bollworm and tobacco caterpillar. It is necessary to employ eco-friendly technologies to manage insect pests and thereby reduce the consumption of harmful pesticides. Such technologies should be very effective against target pests and at the same time harmless to human beings, other mammals, non-target organisms, biodiversity and environment in general.

Bacillus thuringiensis (Bt) is a soil bacterium that synthesizes insecticidal proteins, which are highly effective against the larval stages of insect pests. Bt proteins are harmless to human beings, mammals, beneficial insects and other non-target organisms. Bt has been extensively used as a biopesticide since 1938 in agriculture, horticulture, forestry, mosquito control and animal health. The advent of plant genetic engineering has made it possible to develop genetically modified (GM) crops, which express Bt insecticidal proteins to confer protection against insect pests. Government of India approved cultivation of genetically manipulated Bt-cotton in 2002. Bt cotton is currently cultivated in an area of 9.4 million hectares. About a thousand hybrids and one variety belonging to six different types of Bt cotton are available to the farmers.

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