GMO and biological pollution

DR MD SHAHJAHAN ALI

MONTHS back a renowned columnist cautioned us about the danger of cultivation of golden rice in Bangladesh and its direct impact on our environment. He has narrated briefly the detrimental effect apprising us the importance, harmfulness and beneficial aspects of genetic engineering, genetically modified organism (GMO). According to him there should be proper application of sciences in order to derive proper blessings for all of us living in this environment. It is assumed from his write up that some international conspiracy in Bangladesh is going on to popularise cultivation of golden rice which could definitely bring disaster for other herbs, shrubs and plants of our country and can pollute the other varieties of rice grown here.

But before drawing a final conclusion on this matter a clear picture of genetic engineering, molecular biology and GMO should be brought into light and then let us measure their impact on biological system and the need for further research. However, with the advent of twentieth century biological science has made its landmarks in every decade and within a few years Mendle's hypothetical 'factors' could be translated into 'genes' whose chemical nature was also known as early as 1953. Thereafter, research work in biological sciences has advanced rather 'fast'. Scientists have learned very quickly to isolate, analyse, clone and engineer the particular gene or genes and study their property. This along with other modern biology like tissue culture, protoplast culture and fusion have ushered a new era of modern science namely biotechnology with tremendous potentialities. The need for advanced genetic technology is imperative which includes methods of plant breeding. This evolved new varieties of rice and is mostly confined to food crops.

Next tissue culture could be given priority when this technique in which a single cell or tissue from animals or plants can be induced or inducted to undergo repeated *in vitro* divisions to produce large quantities of same materials within a shorter period. By following this method of cell propagation, besides the quick multiplication of normal tissues, endangered genetic resources can also be rescued to propagate in mass materials from preselected plant, animal and microorganisms. The science of genetic engineering has revolutionised the field of biology. Starting with the production of insulin by E. coli through the insertion of corresponding gene synthesised in the test tube, the technique is acclaimed for any gene controlled system. Gene cloning will certainly open the door for industrial production of other raw materials.

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It is very important to learn the behaviour of such genes first and then transfer them to other suitable plants for better expression. In Bangladesh, the introduction of advanced genetic technologies for the improvement of plant genetic resources is a prime need and attention be given to this aspect. The understanding of molecular mechanism of growth development and flowering processes in plants is also important for overall plant improvement including biomass production. Hormones play a very vital role in plant growth and development including flowering. The area of flowering hormones is a very promising one to this effect. It is expected that spectacular gains or at least a promise for such a gain in many tropical plantation crops will be achieved through new technologies.

But plantation crops have always suffered from a lack of breeding attention. Very little attention has been paid for the identification of improved lines and their breeding. The new technologies should be a supplement rather than an alternative to the old practices.

Now it is advisable to discuss more important phases which have been disclosed by the renowned columnist, if the cultivation of golden rice starts immediately in our country. He has given very important information regarding the induction of colour of Daffodil flower and bacteria. Then it is being sent as golden rice to Bangladesh and the people are having it with pleasure in the hope of getting vitamin A in rice. According to him this gene of Daffodil flower and also bacteria are alive and can pollute other plants and living beings including trees. Specially this golden rice imported from IRRI may cause deformity of other varieties of rice. It is a matter of great concern to us that if this variety starts polluting environment it would be very difficult to take remedial measure and a time will come when our country will face a serious crisis with production of other cereal crops.

But it seems very surprising that Dr. Mahboob Hossain, head of the department of social science of IRRI, Philippines has been taking initiative to introduce GMO in agricultural sector in our country. This is also a matter of astonishment to note that neither IRRI nor CPD has taken research on biodiversity based on production system considering environment and ecology. The reason lies on the inability of our farmer to pay them for this purpose. Dr Mahboob has categorically admitted that there may be perceived risk in GMO then the question arises why he is interested in what brings no good for us.

It should be very specifically clear to all why GMO is considered dangerous. There are lots of reasons behind it. First there is possibility of extinction of animals. Secondly during induction of gene of one organism to other this may pollute the whole environmental system which is called biological pollution. In other words the gene which is not supposed to be present in a particular animal may pollute it with the presence of peculiar characteristics which are not at all desirable.

It is, therefore, urgently felt that before the introduction of such variety of rice for cultivation, the authorities concerned kindly think over the matter again and again and take effective steps considering the fate of the poor farmers of Bangladesh.

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Ozone hole in Earth's atmospheric environment

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OUR planet EARTH'S atmospheric environment is unique in nature. Ozone layer and ozone hole is a minor but important part of this unique nature. Ozone was first discovered in 1839 by **German** scientist ***Christian Friedrich Schonbein***. In fact, the term /name '**ozone**' is derived from the Greek word '**OZEI**N' which means **"to smell"**. On the basics level let us see ozone hole without using a lot of chemical science.

Well, ozone is a relatively simple molecule that contains three atoms of oxygen bound together and thus has the formula O_3. It is a pale blue, relatively unstable molecule. Ozone molecule is angular, polar, and diamagnetic. Both oxygen bond lengths (1.28 angstroms) are identical. It is formed from molecular oxygen (O_2) by ultraviolet and extreme ultraviolet photolysis followed by recombination of atomic oxygen, O with O_2.ÊIt may also be formed by passing an electrical discharge through gaseous oxygen. It is characterized by a unique odour that is often noticed during electrical storms and in the vicinity of electrical equipment. The density of ozone is about 2.5 times that of O_2. At 112 °C, ozone condenses to a deep blue liquid. It is a powerful oxidizing agent and, as a concentrated gas or a liquid, is highly explosive. Excess oxygen atoms, also known as free radicals, oxidize materials that they contact and are associated with the aging process. Yet ozone has dramatically different effects depending on where ozone resides, it can **protect or harm life on Earth**.

High in the atmosphere about 15 miles (24 km) up ozone acts as a shield to protect Earth's surface from the sun's harmful ultraviolet radiation. Without this shield, we would be more susceptible to skin cancer, cataracts, and impaired immune systems. Closer to Earth, in the air we breathe, ozone is a harmful pollutant that causes damage to lung tissue and plants. Because it reacts strongly with other molecules, large concentrations of ozone near the ground prove toxic to living things. Motor vehicle exhaust, and industrial emissions, gasoline vapours, and chemical solvents are some of the major sources of NOx and VOC (volatile organic compounds), also known as ozone precursors.

Strong sunlight and hot weather cause ground-level ozone to form in harmful concentrations in the air. Many urban areas tend to have high levels of "bad" ozone, but other areas are also subject to high ozone levels as winds carry NOx emissions hundreds of miles away from their original sources. At higher altitudes, where 90 percent of our planet's ozone resides, it does a remarkable job of absorbing ultraviolet radiation. The amounts of "good" and "bad" ozone in the atmosphere depend on a balance between processes that create ozone and those that destroy it. An upset in the ozone balance can have serious consequences for life on Earth. Scientists are finding evidence that changes are occurring in ozone levels -- the "bad" ozone is increasing in the air we breathe, and the "good" ozone is decreasing in our protective ozone shield.

Ozone hole's discovery

In the 70s of the 20th century the ozone layer was observed from the British Antarctic Survey Station and a strong decline in ozone concentration measured. Legends entwine around the discovery of the hole. It is told that the first measurements in 1985 showed such low values, that the observing scientists did not believe in their instruments and the dramatic development had not been published, before newly installed instruments confirmed them. Also, the "total ozone mapping spectrometer" (TOMS) was already observing the ozone layer from the space. However, the hole, that's what legends say, was not discovered, because values below a certain limit were automatically assumed as error value. Later, the processing of the raw data confirmed what nobody wanted to believe. Within a few years very intensive research began, former warnings about the potential impact of chlorofluorocarbons (CFCs) were rediscovered and their reduction and finally ban was fixed in the Montreal Protocol and further treaties. The ozone hole was the first case that humans became aware of in a dramatic way, that we were able to disturb the world climate system on a global scale. Also for the first time a quick world-wide response followed, which was a good news indeed.

Ozone is one of the most interesting trace gases in EARTH's atmospheric environment. In the stratosphere it is essentially needed to protect us from the damaging UV radiation of the sun. On the other hand in our surrounding next to the Earth surface it is not desirable in higher concentrations because it is an irritant gas with negative influence on the respiratory tract.

Fate of CFCs in atmospheric environment

High energy ultraviolet radiation from the Sun is absorbed by stratospheric ozone and, as a result, it doesn't enter the troposphere. This means that the ultraviolet light which does reach the Earth's surface is too weak to break down the CFC's present there. However, because CFC's have such a long life time in the atmosphere, significant amounts entered the stratosphere where the ultraviolet radiation was strong enough to break them down into very reactive chlorine and fluorine radical species. These radicals are capable of destroying ozone. This process, however, doesn't necessarily lead to strong ozone depletion because chlorine radicals (which are mainly responsible for ozone removal) also undergo other reactions depending on the meteorological conditions. Although stratospheric ozone is removed at all latitudes by reaction with chlorine and fluorine radicals, the ozone hole is only formed at the poles, particularly over Antarctica and only in the spring. Why is this so?

1 One factor is the extremely low temperatures in the stratosphere. During the night temperatures can be as low as -80°C over Antarctica. Under these conditions, nitric acid and water form stratospheric ice clouds. On the surface of the ice, hydrochloric acid and $ClONO_2$ react with each other to form nitric acid and molecular chlorine (Cl_2).

2. Molecular chlorine (Cl_2) is a stable molecule which does not react with ozone. However, it is easily broken down by ultra-violet radiation from the Sun to form two chlorine radicals which can then attack and destroy ozone. So high levels of molecular chlorine (Cl_2) can be produced in the stratosphere at the poles during the winter. In the spring, the Sun reappears and levels of solar ultra-violet radiation increase. This ultra-violet radiation breaks down the Cl_2 into chlorine radicals, these then destroy ozone and an ozone hole forms. As a result, we see the ozone hole at the same time each year and ozone levels don't recover until the ice clouds thaw and the chlorine radicals are removed by other reactions.

3. Certain meteorological conditions are then required to allow the ozone hole to develop fully. Formation of the chlorine monoxide radical (ClO) usually occurs high up in the stratosphere, away from the most of the ozone molecules which are found at altitudes between 14 and 22 km high. So, chlorine radicals shouldn't really affect most of the ozone in the stratosphere. This isn't the case, unfortunately. Special meteorological conditions around the poles allow a polar vortex to form and this causes downward air movement. This transports ClO to lower altitudes where it plays a part in ozone destruction.

Future of ozone hole

Ozone hole's future is still totally not clear. CFCs were banned globally by the Montreal Protocol on substances that deplete the Ozone layer 1987Ê(and next amendments).Ê As they have such long atmospheric life times (the longest of the order of 100 years) it will take around another 50 years until all the CFC's released so far have been destroyed in the stratosphere and ozone concentrations stabilize. Maximum CFC concentrations in the stratosphere were predicted to occur in 2000 and the ozone hole has been rather constant in size over the past few years. However, there are exceptions to this trend. In 2002 no significant ozone hole was seen. The reason was simple: it was too warm and the polar vortex did not form as usual. Once again, an example that atmospheric processes sometimes ignore any prediction!

But in 2003 the hole was back to its previous size, the second largest ever observed. According to British Antarctic Survey Ozone Bulletin, in 2004, the ozone hole grew rapidly from mid August to early September to reach around 19 million square kilometers. It slowly decreased in area from a maximum of 20 million square kilometers in mid September to 15 million square kilometers in early October. A major spring warming commenced in mid October, when the area declined rather more rapidly to 6 million square kilometers. However, the warming subsided and the area affected slowly declined from around 10 million square kilometers in late October to around 8 million square kilometers in mid November. The ozone hole area rapidly dropped to zero after mid November. The area of the hole was generally a little below the average size of the last decade. The edge of the ozone hole passed over the southern tip of South America, the Falkland Islands and South Georgia from September 10 to 12. It did so again from September 18 to October 2, and October 11 to 15, with ozone hole over southern South America and the Falkland Islands on September 21 and 22. Values were also low over South Georgia on October 7 and 8. In the Northern Hemisphere there is currently significant ozone depletion over the Arctic Ocean. Then, let us see what happens in the ozone hole in 2005 and onward.

Conclusion

Ozone is one of the most interesting trace gases in our planet EARTH's atmospheric environment. In the stratosphere it is essentially needed in order to protect us from the damaging UV radiation of the sun. On the other hand in our surrounding next to the Earth surface it is not desirable in higher concentrations because it is an irritant gas with negative influence on the respiratory tract.

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