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MAXIMUM PRODUCTION FROM MINIMUM LAND

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An effort has been made to commercialize agriculture through the introduction of HYV seeds, chemical fertilizers, pesticides, irrigation and mechanization. These components were implemented without considering their side effects into account. Agriculture policy makers have given emphasis on to increase and maximize production, while on the one commercial cultivation increases the yield, it disrupts the environment and quality of life of society on the other. Estimates indicate that Indian population will increase by 130 million by 2020 AD needs production of 325 million tones of food grains. Taking the current food grain productions production scenario into consideration, India has a compulsive need to raise food production by five million tones per year as against 3.1 million tones per year achieved over the past 40 years. This is certainly not a easy task. On the basis of present trend of consumption, estimated requirement for food grain in three years will be around 243.2 million tones and this will further increase afterwards. This is a great challenge before the Indian agriculture. Since the land to man ratio is narrowing rapidly, there is almost no scrope for horizontal expansion to meet the future demand of production.

The unilateral approaches viz., intensive use of agro-chemicals, high yielding varieties, resources, monoculture, etc., followed for increasing the production have generated environmental and biological imbalance which are the major challenges to be met for a sustainable agricultural system. The declining trend in carrying capacity of land and other natural resources have drawn the attention of environmental, agricultural and social scientists in present time to look for an alternative approach for sustaining the

resources supporting the ecosystem and human life as a whole. Also, the ever growing population of India triggers the transition from traditional practices to modern biotechnological-based agriculture. In the doorsteps of 21st century, Indian agriculture is facing challenging task to provide food security as well as nutritional security for all.

Agricultural practices have begun to integrate emerging technologies like biotechnology and biofertilizers with traditional practices like organic farming. Biofertilizers ware very useful when used in combination with organic manure and inorganic fertilizers in a balanced proportion. Among biofertilizers, the mycorrhizae (AM), the most common fungal association formed nearly in all cultivated plants whether they are agricultural, horticultural or forestry plant species is gaining importance. Success in promoting sustainable agriculture can be achieved on by many ways. In agricultural research the sustainability may be summarized in their briefest form as maximum plant production with a minimum of soil loss. Within this context of balanced agro system (inputs and outputs), the role mycorrhizal fungi have been found as integral and fundamental link between plant and soil. Sustainable agriculture is the successful management of resources for agriculture to satisfy the changing human needs, while maintaining the quality of environment and conserving the natural resources.

A sustainable system uses its inputs most efficiently and judiciously to maximize the productivity and profitability with least adverse impact on ecological balance. Augmentation of the mycorrhizal fungi along with traditional practices and integration with inorganic fertilizers is one of the important approaches in sustaining plant productivity.

Integrated Nutrient Management (INM): A Potential Component of Sustainable Agriculture

Integrated Nutrient Management (INM) is a broad term encompassing the nutrient cycle among the soil, the crop and livestock, balancing the fertilizer use cum organic recycling, combined use of organic manures and chemical fertilizers, exploiting biological nitrogen fixing and phosphate solubilizing potential, and taking holistic view of crop management system. According to the levels of plant nutrition, even if single nutrient deficiency remains uncorrected, obtaining maximum yield or sustaining present yield level is

difficult. INM also includes a suitable variety, use of optimum cultural management, soil and water use for efficient and sustainable crop production.

Fertilizers, farmyard manure, compost residues, green manure, biofertilizers including mycorrhiza are the mian components of INM besides management practices. The major steps in INM are given below:

a. System approach to INM of particular crops and cropping systems in a appropriate manner have been found to be useful and productive because of the integrity of various components influencing the input use efficiency.
b. Based on soil analysis/tests amendments and correction of nutrient deficiencies will result high yield. In phosphorus deficient soils, application of nitrogen will not be much use but combination of nitrogen and phosphorus would be packaged involving mycorrhizalbiofertlizer for sustaining the growth and yield.
c. Agronomic approaches like selection of appropriate varieties, optimum cultural practices, split application of fertilizers at different growth stages, use of coated fertlizers, methods and placement of fertilizers, integration of crop specific biofertilizers, organic and inorganic combinations will provide better returns.
d. Use of green manure is a major practices to be followed in problematic soils to sustain the productivity.
e. Continuous use of farm waste and minimum tillage practices ensures the long-term productivity, stability and sustainability.
f. Adoption of water management techniques including maintenance of farm drains is also a component of INM.

Mycorrhizal Fungi and Its Types

Infact, most of plants growing in normal soil have emycorrhizae, or literally fungus roots,. The fungi grows within the cortex of the roots and send thread-like hyphae out into the soil. These greatly aid the plant roots in taking up the major nutrients phosphorus and trace elements zinc and copper. When we realize that phosphorus is the second most important element after nitrogen for crop growth and that insufficient uptake of trace element can have drastic effects on plant growth, then the importance of these fungi realized on us. The mycorrhiza is a symbiotic association with plant roots which means that

both the plant and the fungus benefit from the relationship. Thus fungi extract nutrients from the soil, which they provide to the plant. The plant, in return, supplies the fungus carbon compounds/carbohydrates. Mycorrhizal colonization of the plant roots is quite common in nature; in fact its occurrence is more of a rule than an exception.

There are a number of different mycorrhizal fungi. Some types are visible to the naked eye, as they cover the root surface with a thick mantle of hyphae. These are known as ectomycorrhizal fungi. They associate predominantly with woody plants such as oaks,, birches, spruces and pines. Many form fruiting bodies that we recognize as mushrooms.

Another class of mycorrhizal fungi thoroughly invades the living cells of roots and is referred to as-arbuscularmycorrhizal (AM) fungi after the structures they form inside the roots. They are invisible without the aid of a microscope. These are the most abundant and agriculturally important types of fungi. Researchers are able to observe mycorrhizae by staining plant roots with a simple biological dye. The fungal filaments and spores become coloured and they are thus visible under the microscope.

Application of Mycorrhiza

Mycorrhiza can be applied in various forms. It may be applied either in spores and or colonized root pieces. Some commercial companies produce mycorrhiza and supply in the form of sheared root places blend with perlite or vermiculite as inert materials. Some of the inocula are available in active form (on going symbiosis) where one has to take caution and strictly follow the instructions given on the packet. For transplanted crops, the inculum should be applied in the root zone, not on the soil surface. Mycorrhiza can also applied in a layer below the seeds in mother beds in nursery. The inoculum applied or left on the suface will quickly die, and will be beyond the reach of the growing roots. In case of cereal crops, mycorrhizal inoculum may be applied either through with fertilizer banding implement/equipment, or incorporated as seed encapsulation.

Management of Mycorrhizae in Cropping Systems

In all types of mycorrhiza, fungal hyphae permeate soil and reach beyond the depletion zones developed around the non-mycorrhizal roots. Thus, mycorrhizal roots explore a larger soil volume and have greater absorptive area than non-mycorrhizal roots.

Indian soils are usually deficient in phosphorus, an element that is required more as compared to other major nutrients. Moreover, when applied to soils, phosphorus quickly gets fixed and is immobilized. Hence plants are unable to utilize it. Mycorrhizae help in mobilization/solublization and increase the uptake of phosphorus in plants. Inoculation of plants with mycorrhizal fungi during seeding stage and then transplantation in well-manured fields can certainly substitute the chemical fertilizer inputs, particularly P, to a large extent. This way the production achieved would be sustained without affective the soil productivity and fertility.

Some crop species do-not becaomemycorhizal, and so do not benefit from mycorrhizae. Among these are many species within the cruciferae-the cabbage family. However, most other crop species are mycorrhizal. Thicker rooted crop species are often extremely dependent on mycorrhizae for growth. Although finer rooted crops may not be as dependent on mycorrhizae for growth, they are also mycorrhizal and can function to build and propagate mycorrhizal populations to benefit coarser rooted subsequently grown in rotation, in agriculture, mycorrhizzae form a natural part of cropping systems and of value in phosphorus and zinc nutrition. They are particularly valuable when either phosphorus or zinc is in short supply in the soil because they can extract more nutrients and tip the balance from deficiency to sufficiency.

Mycorrhizal fungal population are not static, particularly in agricultural systems and there are many factors that influence their level in soil. Knowledge of these factor will enable a farmer to get the best value from fertilizer investments, in a phosphorus deficient soil, poor mycorrhizal colonization will produce a crop with nutritional problems, whereas a crop with good mycorrhizae in the same soil will ensure better growth. Mycorrhizae have a key role in determining the effectiveness of applied fertilizer.

Mycorrhizal Research at TERI

A centre for Mycorrhizal Research (recognized at national and international level) has been established at TERI to provides a unique opportunity to researchers and nursery growers to get training and obtain starter cultures for their use. One of the major bottlenecks for large-scale application of mycorrhiza is the unavailability of adequate inoculum, since AM fungus is an obligate sysmbiont and it requires a host of complete its life

cycle. At TERI, complete process have been developed by which these fungi can be grown in laboratory (axenic culture or in uitro) conditions. Some of the protocols are in the process of being patented and the technological know-how has been transferred to commercial companies.

Besides the pot culture multiplication, which is the conventional method of inoculums production, multiplication is also being carried out in soil-less conditions where a mist of solution consisting of essential nutrients is provided to trap plants (aeroponics). The on-farm inoculum production of VAM fungi has also been standardized by which the growers the production of transplanted seedlings in mother beds. Apart form this, the mycorrhizal centre is also involved in applied research. Thorough testing and efficacy examinations are done both under green house and nursery conditions and long term field experiments are conducted using appropriate statistical designs.

A large number of nursery and field trails have been conducted by TERI which confirms that the application of mycorrhizal (VAM) fungi increase the growth of plants at reduced fertilizer level. The mycorrhizal inoculation can save upto 25-50 per cent use of phosphatic fertilizers under the use of integrated nutrient management practices.

The centre has also been successful in growing various horticulture and silviculture plant species on abandoned fly ash ponds and arid wastelands and thus has demonstrated using the developed know-how to manage ash ponds in economically viable yet environment-friendly way. The CMR also imparts training in the area of mycorrhizal methods of application and study, information retrieval and modern analytical techniques. (IA)

Conclusions

Maximum Production From Minimum Land includes INM, Mycorrizal Fungi, poultry, fish, tree crops plantation crops, forestry sericulture etc. A combination of one or more enterprises with cropping, when carefully chosen, planned and executed, gives greater dividends than single enterprise especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of the enterprises to be combined with crop production activity.

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