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ROLE OF NANO FERTILIZERS IN AGRICULTURAL FARMING

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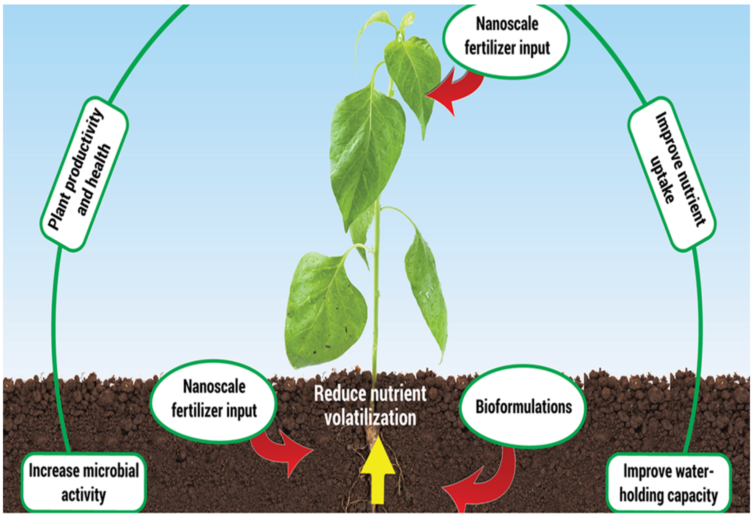

Introduction

Nanotechnology is a novel scientific approach that involves the use of materials and equipment capable of manipulating physical as well as chemical properties of a substance at molecular levels. On the other hand, biotechnology involves using the knowledge and techniques of biology to manipulate molecular, genetic and cellular processes to develop products and services and is used in diverse fields from medicine to agriculture. Nano biotechnology can improve our understanding of the biology of various crops and thus can potentially enhance yields or nutritional values, as well as developing improved systems for monitoring environmental conditions and enhancing the ability of plants to absorb nutrients or pesticides. Among the latest line of technological innovations, nanotechnology occupies a prominent position in transforming agriculture and food production. The development of nano-devices and nanomaterials could open up novel applications in plant biotechnology and agriculture.

Nano fertilizers and their roles

Fertilizers have an axial role in enhancing the food production in developing countries especially after the introduction of high yielding and fertilizer responsive crop varieties. In spite of this, it is known that yields of many crops have begun to depression as a result of imbalanced fertilization and decrease in soil organic matter. Moreover, excessive applications of nitrogen and phosphorus fertilizers affect the groundwater and also lead to eutrophication in aquatic ecosystems. Such cases along with the fact that the fertilizer use efficiency is about 20-50 percent for nitrogen and 10-25 percent for phosphorus fertilizers implies that food production will have to be much more efficient than ever before. According to Royal Society, "Nanotechnologies are the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale".

Nowadays, nanotechnology is progressively moved away from the experimental into the practical areas. For example, the development of slow/controlled release fertilizers, conditional release of pesticides and herbicides, on the basis of nanotechnology has become critically important for promoting the development of environment friendly and sustainable agriculture. Indeed, nanotechnology has provided the feasibility of exploiting nanoscale or nanostructured materials as fertilizer carriers or controlled-release vectors for building of so-called “smart fertilizer” as new facilities to enhance nutrient use efficiency and reduce costs of environmental protection. Encapsulation of fertilizers within a nanoparticle is one of these new facilities which are done in three ways a) the nutrient can be encapsulated inside nanoporous materials, b) coated with thin polymer film, or c) delivered as particle or emulsions of nanoscales dimensions. In addition, nanofertilizers will combine nanodevices in order to synchronize the release of fertilizer-N and P with their uptake by crops, so preventing undesirable nutrient losses to soil, water and air via direct internalization by crops, and avoiding the interaction of nutrients with soil, microorganisms, water, and air.

In addition to Cases where mentioned, some of advantages related to transformed formulation of conventional fertilizers using Nanotechnology are presented below smart fertilizers might become reality through transformed formulation of conventional products using nanotechnology. The nano structured formulation might permit fertilizer intelligently control the release speed of nutrients to match the uptake pattern of crop. Solubility and dispersion for mineral micronutrients cause Controlled release formulation. Nanosized formulation of mineral micronutrients may improve solubility and dispersion of insoluble nutrients in soil, reduce soil absorption and fixation and increase the bioavailability leads to increased Nutrient uptake efficiency. Nanostructured formulation might increase fertilizer efficiency and uptake ratio of the soil nutrients in crop production, and save fertilizer resource. Controlled release modes have properties of both release rate and release pattern of nutrients for water-soluble fertilizers might be precisely controlled through encapsulation in envelope forms of semi-permeable membranes coated by resin-polymer, waxes and sulphur. Effective duration of nutrient release has desirable property of Nanostructured formulation, it can extend effective duration of nutrient supply of fertilizers into soil. Nanostructured formulation can reduce loss rate of fertilizer nutrients into soil by leaching or leaking.

Conclusion

The emerging new science and enabling technology, working with the smallest particle, the nanotechnology raises hope for new innovations in the field biology, especially in agriculture. Many unsolved and bottle necks in the field of life sciences and agriculture could be addressed through this technology. More focused research is required in the area of energy, environment, crop improvement, disease management and efficient resource utilization for increasing the productivity, profit, without hampering the natural ecosystem.

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ADVANCE PRODUCTION TECHNOLOGY OF LETTUCE AND PEST MANAGEMENT (*Lactuca Sativa* L.)

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Abstract: Lettuce (*Lactuca sativa*) is an annual plant of the daisy family, Asteraceae. It is most often grown as a leaf vegetable, but sometimes for its stem and seeds. Lettuce is most often used for salads, although it is also seen in other kinds of food, such as soups, sandwiches and wraps.it can also be grilled. One variety, the *woju* or asparagus lettuce (celtuce), is grown for its stems, which are eaten either raw or cooked. In addition to its main use as a leafy green, it has also gathered religious and medicinal significance over centuries of human consumption. Europe and North America originally dominated the market for lettuce, but by the late 20th century the consumption of lettuce had spread throughout the world. World production of lettuce and chicory for calendar year 2015 was 26.1 m tones, 56% of which came from China.

Lettuce was first cultivated by the ancient Egyptians who turned it from a weed whose seeds were used to produce oil, into a food plant grown for its succulent leaves and oil-rich seeds. Lettuce spread to the Greeks and Romans, the latter of whom gave it the name *lactuca*, from which the English *lettuce* is ultimately derived. By 50 AD, many types were described, and lettuce appeared often in medieval writings, including several herbals. The 16th through 18th centuries saw the development of many varieties in Europe, and by the mid-18th century cultivars were described that can still be found in gardens.

Generally grown as a hardy annual, lettuce is easily cultivated, although it requires relatively low temperatures to prevent it from flowering quickly. It can be plagued by numerous nutrient deficiencies, as well as insect and mammal pests, and fungal and bacterial diseases. *L. sativa* crosses easily within the species and with some other species within the genus *Lactuca*. Although this trait can be a problem to home gardeners who attempt to save seeds, biologists have used it to broaden the gene pool of cultivated lettuce varieties.
Lettuce is a rich source of vitamin K and vitamin A, and a moderate source of foliate and iron. Contaminated lettuce is often a source of bacterial, viral, and parasitic outbreaks in humans, including *E. coli* and *Salmonella*.

Introduction

- It is the world's most used salad crop, "queen of salad plants" or "Green Gold"
- It is an annual plant of the aster or sunflower family Asteraceae.
- The Romans referred to lettuce as *lactuca*(*lac* meaning milk in Latin), an allusion to the white substance, now called latex, exuded by cut stems.
- This word has become the genus name, while *sativa* (meaning "sown" or "cultivated") was added to create the species name.
- It is produced in most temperate and subtropical area of the world.

- Grown commercially in many countries, North America, Western Europe, the Mediterranean basin, Australia and parts of Asia.

Evolution and Crop History

Lindqvist (1960) advanced three theories on the origin of *Lactuca sativa:*

1) From wild form of *Lactuca sativa*
2) By direct descent from *Lactucaserriola*
3) From hybridization between two species

High levels of diversity of *Lactuca*species found in the Mediterranean basin and southwestern Asia indicate that those regions should be seriously considered as hot-spots for lettuce conservation (Beharav*et al*. 2008)

Taxonomy

The species was first described in 1753 by Carl Linnaeus in the second volume of his *Species Plantarum.*

- Species of Lactuca have basic chromosome numbers of 8, 9, and 17, the n = 17 species may be neutral amphidiploids.
- *Lactuca sativa* is one of four inter-fertile species having nine pairs of chromosomes.
- There are several species of *Lactuca*which are:

L. sativa ***L. serriola*** ***L. salignaL. virosa***

Lactuca sativa is not found wild and is believed to have been derived from *Lactucaserriola*either alone or in combination with one of other species.

- The species of lettuce's gene pool (those of the breeders' main interest), *L. serriola, L. saligna and L. virosa*, are weedy and occur on waste places, along roads, highways and ditches.
- *Lactuca sativa* and *Lactucaserriola*are cross fertile, crosses are easily made, and progeny share some characteristics. some cultivated lettuces have been derived from *L. sativa x L. virosa and L. sativa* x *L. saligna*crosses.
- Wild- type germplasm will likely continue to be used, especially for the transfer of disease resistances.

Survey of wild Lactuca species described as a sources of resistance to the most important pathogens and pests of lettuce: Lebeda*et al* 2009		
Wild Species	**Pathogens and pests**	**References**
L. serriola	Lettuce Mosaic Virus (LMV) Corky Root *Bremialactucae*	Mou and Bull (2004) Beharav *et al*. (2006), Hooftman *et al*. (2007), Kuang *et al*. (2006)
L. saligna	Lettuce Mosaic Virus (LMV) Cucumber Mosaic Virus (CMV) *Bremialactucae*	Maisonneuve *et al*. (1999) Provvidenti *et al*. (1980) Kitner *et al*. (2008) and Zhang (2008)
L. virosa	Lettuce Mosaic Virus (LMV) Corky Root *Bremialactucae*	Ryder (2002) Mou and Bull (2004) Beharav (2006)
L. indica	*Bremialactucae*	Petrzelova (2001)

Botany

The genus *Lactuca*includes annual, biennial and perennial herbs, and rarely shrubs, with bundant latex.

Lettuce is an annual polymorphic plant, especiallywith regard to foliage characteristics.

Plants rapidly develop a deep taproot accompanied with thickening and extensive development of largely horizontal lateral roots.

The leaves are colorful, mainly in the green and red color spectrums, with some variegated varieties.

Lettuces have a wide range of shapes and textures, from the dense heads of the iceberg type to the notched, scalloped, frilly or ruffly leaves of leaf varieties.

Interior leaves of leafy cultivars tend to be lighter in color, whereas those of heading types are blanched.

Flower Development

At the earliest stages of flower development, according to Jones the corolla primordial whorl is first to appear, followed by those of the stamens and pappus, and the carpels.

The microspores develop earlier than the megaspore.

The elongating seed stalk produces a single terminal capitulum (composite flower) and a series of branches with many capitula forming the panicle.

Each capitulum is composed of involucres of overlapping bracts surrounding several florets: as few as 10 to over 20.

The elongating style with two stigmatic lobes sweeps the pollen along as it emerges from the top of the stamen tube and cause self-pollination.

Seed develop simultaneously in the same flower head, each floret producing a single seeded dry fruit called an achene.

Seeds are prone to shattering and are small, ribbed and topped with pappus hair.

Types of Lettuce

1.Butter head **2.Crisp head**
3.Cos or Romaine **4.Loose leaf**
5. Stem lettuce **6.Latin lettuce**

Production And Nutritional Value

In India, lettuce is cultivated on an area of about 0.12 M ha with an average productivity of 6.58 t /ha.

The Food and Agriculture Organization of the United Nations (FAO) reports that world production of lettuce and chicory (the two plants being combined by the FAO for reporting purposes) for calendar year 2010 was 23,622,366 metric tons.

This came primarily from China (53 %), the US (17 %) and India (4 %).

Although China is the top world producer of lettuce, the majority of the crop is consumed domestically.

Spain is the world's largest exporter of lettuce, with the US ranking second.

Nutritional Value

Lettuce is rich in vitamin A and in minerals like Calcium and Iron.

It also provides some dietary fiber (concentrated in the spine and ribs), carbohydrates, protein and a small amount of fat.

It naturally absorbs and concentrates lithium.

It is twenty sixth on the list of common fruits and vegetables arranged in order of nutritional value.

It is a staple food places fourth, behind tomatoes, oranges, and potatoes, in the rating scheme.

Production Technology of Lettuce

Climatic Requirement

It is a cool season crop and thrives well in a relatively cool growing season with monthly mean temperature of 12.8 to15.60C

Higher temperature (above 22oC)induces bolting and cause bitter taste in the leaves and accelerate the disorder ‘tip burn’.

The seed germinate quickly at 18-200C. Both lower and high temperature is harmful for germination.

Seeds tend to loose their viability rather rapidly in the tropics.

Soil Condition:

Lettuce grown well in light, well manure, well-drained soils with adequate watering.It is slightly tolerant to acid soils (pH 6.8-6.0), but highly susceptible to high acidic soils.

Sowing Time: September to October. **Seed Rate:** 400-500g/hectare

Methods of Sowing: Sowing of the seeds should be done in the rows 15-20cm apart at 1cm deep with transplanting distance**:** 45x45 or 45x30 or 60x30 cm

Nutritional Requirement:

FYM: 100-500 Quintals/Hectare, Nitrogen: 85kg /Hectare
Phosphorus and Potash: 60 Kg/Hectare

Interculture Operations:

First hoeing is done after 15 to 21 days of planting.

Weedicides like propyzamide at 1.5 kg/ha and chlorpropham + sulfallate at 1.4 kg per hectare.

Water Management:

Pre-sowing irrigation is done for seed germination in case of direct sowing. After transplanting, the lettuce crop should be irrigated, it will help in established of newly planted seedlings. Subsequent irrigations are done at 8 to12 day interval.

Harvesting, Yield and Storage:

It is allowed to develop a full size. **Yield**: 100400q/ha.

Lettuce can be stored for a period of three to four weeks under refrigeration.

The freshness of the lettuce is maintained with the pre-harvest spray of BA at 5-10 ppm and also the post harvest treatment with BA helps in delaying senescence.

Uses

Lettuce leaves are used as a raw product in salad and sandwiches.

1)Value added products: lettuce is harvested in bulk bins, cored, chopped, washed and packed in various sized plastic bags. These are shipped in containers to fast food chains and other restaurants, and to institutions such as hospitals and schools.

2) **Mesclun:** a mixture of different type of baby leaves.

- A wild lettuce, *Lactucabrevirostris*Benth from South America, used for manufacturing nicotine-free cigarettes.
- The milky juice or latex of several *Lactuca*species contains two sesquiterpene lactones called lactucin and lactucopicrin. These have a sedative or narcotic effect.
- Extracts from *Lactucavirosa*especially are used as sleep inducers and cough suppressants in Europe.
- Lettuce-seed oil has also shown analgesic and sedative properties.

Diseases

Disease	**Causal Organism**	**Control Measures**
Damping off and Root Rot:	*Rhizoctoniasolani*	seed is treated with 2 % cerasan and nursery soil is drenched with 0.2 % captan at an interval of 10-12 days.
Downy Mildew	*Bremialactucae*	Spraying of 0.2 % diathane Z-78 can control it.
Lettuce Drop	*Sclerotiniasclerotium*	Single spray of benomyle at high concentration (3-4kg/ha) has been found effective.
Botrytis Rot	*Botrytis cinera*	1) Control of humidity by restricting irrigation 2) Treat the seeded with brassicol to reduce soil burn inoculums.
Bacterial Rot	*Erwiniacarotovora*	Apply copper hydroxide
Lettuce Mosaic	*Lactuca virus 1* or *Marmorlactacea*	Aphids are vector of the virus. i)Eradicate hosts, sonchus, lathyrus, zinnia, tagetes, and gomphrina.
Big Vein Of Lettuce	*Olpidiumbrassicae* (soil borne)	Avoid moist conditions of soil and ii) Fumigate soil any one of the chloropicrin, methyl bromide, etc
Pest		

Cabbage Looper		i) Spraying of malathion at 0.1 % ii) Uprooting of severely affected plants.
Aphids	*Aphis gossypii*and *Myzuspersicae*	1) Spray any systemic insecticides

Conclusion

Major reasons of the low productivity of lettuce may be attributed to faulty irrigation methods, improper fertigation and lack of knowledge regarding optimum crop geometry. Presently, entry of multi-national companies into Indian food and catering industries and economic growth has dramatically changed the eating habits and consumption pattern of people. This has resulted into more use of salad crops like lettuce in the Indian diet. Because of this, the lettuce crop may have a greater demand in domestic market in future. Besides, it has a good export potential.

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ISSN: 2456-2904

CONOWEEDING: AN EFFECTIVE WEED MANAGEMENT PRACTICES IN DIRECT SEEDED RICE

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Abstract- Heavy weed infestation in direct seeded rice remains the single largest constraints limiting growth & development resulting in reduced yield & productivity. A direct seeded rice crop generally lacks the alternate wetting & drying conditions making the crop more vulnerable to weed competition during early stages of growth cycle. Use of chemical weed control is feasible and applicable while their indiscriminate use drives the ecosystem towards environmental pollution. Therefore there is need of sustainable management of weeds in direct seeded rice by adoption of efficient non-chemical practices with ecological balance. Cono weeding may become good option to control weeds in direct seeded rice in a well defined sustainable manner.

Introduction

Rice is one of the most important staple foods of India which has the largest area of 43.19 million hectare in the world and production of 110.15 million tons next to China with productivity of 2.55 tons per hectare. Weeds are the single most biotic factor which causes yield reduction and productivity decline by competing for water, nutrients, solar radiation, space and other natural resources throughout the growing season of direct seeded rice which is more critical in direct- seeded rice than in transplanted rice as the competitiveness of transplanted rice against weeds become more assured due to the use of 25- 30 days old seedlings and flooding causing anaerobic conditions for weeds. More over chemical based weed management strategies are becoming more popular in India because of labour scarcity, rising wages but indiscriminate use of these chemicals (herbicides) is driving the system towards herbicide resistance, weed shift as well as environmental pollution. Hand weeding is most popular non-chemical weed management in direct seeded rice but becoming tougher because of labor scarcity. At this, cono-weeding may provide remunerative advantages by controlling weeds, increasing productivity without causing harm to the ecosystem.

What is cono-weeding?

Conoweeding is weed control practice which is usually done with the help of the cono-weeder, a rotary type hand drawn tool with push/pull motion for uprooting the weeds and burying them into the soil. This ensures in the weeds dying and becoming manure for the crops.

Advantages The cono weeding improves root growth of the direct seeded rice by pruning some of the upper part of the roots resulting in encouraged deeper root growth.

- The cono weeding by rotating hoe with small toothed wheels increases the soil pores so as to provide ample opportunities to the roots and microbes including fungi to get sufficient amount of oxygen for growth and development (Verma *et al*., 2017 b)
- Weeding by mechanical devices like cono-weeders reduces the cost of labor and also saves time (as approximately 10- 15 labors per hectare are required) as compared to hand weeding.

Plate 1: cono weeder for weed control and its application in field

- Cono weeding increases the amount of ammonical and nitrate nitrogen in the rhizosphere at grain filling and harvest stages while does not have any notable significance in rest of the growth stages.
- Conoweeding contributes for grain yield of direct seeded rice by reducing the percentage of sterile spikelets.
- However if cono weeding is combined with some of the pre emergence herbicides like pendimethelin and other selective herbicides can increase weed control efficiency to a considerable extent and yield of direct seeded rice (Verma *et al*., 2017 a)

Disadvantages:

- Rotary weeding or cono weeding can control the weeds present in inter row spaces of the crop while not able to control the weeds in intra row space or those in the vicinity of the crop (Verma and Singh, 2019)
- While operating it, there must be sufficient amount of water present in the field as not suitable when no irrigation sources available
- Appropriate technical knowhow and expertness is required while operating the device as there are difficulties in acquiring the necessary skills

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ISSN: 2456-2904

ZINC (ZN): MOST ESSENTIAL MICRO-NUTRIENT FOR RICE CROP

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Introduction

Zinc is essential for the growth in animals, human beings, and plants it is vital to the crop nutrition as required in various metabolic processes, and oxidation reduction reactions. In addition, Zn is also essential for many enzymes which are needed for nitrogen metabolism, energy transfer and protein synthesis. Zinc deficiency not only retards growth and yield of plants, but it also has effects on human beings. Beside its role in crop production, Zn plays a part in the basic roles of cellular functions in all living organisms and is involved in improving the human immune system, due to its insufficient intake, human body will suffer from hair and memory loss, skin problems and weakness in body muscles.

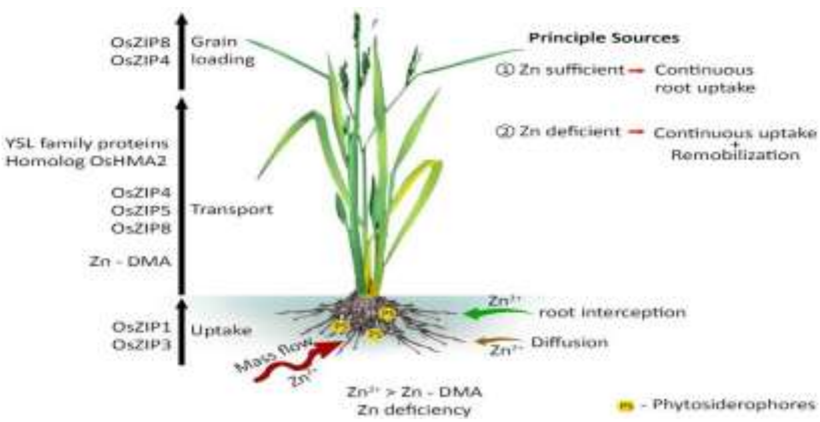
What is the role of Zinc (Zn) in plants?

Zinc is an essential plant nutrient required for several biochemical processes in the rice plant, including chlorophyll production and membrane integrity. Thus, Zn deficiencies affect plant color and turgor. Zn is only slightly mobile in the plant and quite immobile in soil.

Structure and function of Zinc in plants

The essential micronutrient zinc occurs in plants either as a free ion, or as a complex with a variety of low molecular weight compounds. Zinc may also be incorporated as a component of proteins and other macromolecules. As a component of proteins, zinc acts as a functional, structural, or regulatory cofactor of a large number of enzymes. Many of the physiological perturbations resulting from zinc deficiency are associated with the disruption of normal enzyme activity, thus zinc-deficiency induced inhibition of photosynthesis is coincident with a decrease in activity of key photosynthetic enzymes.

Zinc deficiency also increases membrane leakiness by inhibiting the activity of enzymes involved in the detoxification of membrane damaging oxygen radicles. Recent evidence suggests that zinc plays a key role in stabilizing RNA and DNA structure, in maintaining the activity of DNA synthesizing enzymes and controlling the activity of RNA degrading enzymes. Thus, zinc may



play a role in controlling gene expression.

Why apply Zinc to Rice plants

Zinc limits plant growth when the soil supply of Zn is low or adverse soil conditions (such as continuous flooding) prevent plant uptake of Zn. In such cases, Zn needs to be applied as required. Other nutrients need to be applied in balanced amounts to ensure a good crop response to fertilizer Zn application and to achieve a healthy and productive crop.

How to manage Zinc in rice plants

Zinc deficiency symptoms:

Stunted plants and dusty brown spots on upper leaves patches of poorly established plants; symptoms appear 2−4 weeks after transplanting higher levels of empty grains delayed maturity and lower yields Zn deficiency leaf symptoms resemble Sulfur (S) and Iron (Fe) deficiency in alkaline soils and iron toxicity in poorly drained organic soils.

Occurrence of Zn deficiency:

Zn deficiency is not very common, but can occur in neutral and calcareous soils; intensively cropped soils continuously flooded paddy soils or very poorly drained soils sodic and saline soils peat soils, soils with high available Phosphorus (P) and Silicon (Si) status sandy soils highly weathered, acid, and coarse-textured soils, soils derived from serpentine and laterite; and, leached, old acid sulfate soils with a small concentration of Potassium (K), Magnesium (Mg), and Calcium (Ca).

How much Zn to apply?

If Zn deficiency symptoms are observed in the field, apply 10−25 kg $ZnSO_4 \cdot H_2O$ or 20−40 kg $ZnSO_4 \cdot 7H_2O$ per ha on the soil surface, or dip roots of rice seedlings in a 2−4% ZnO suspension before planting (i.e., 20−40 g Zn O L^{-1} water). Rice plants can recover from Zn deficiency if the field is drained - a dry fallow increases the availability of Zn. The crop only requires around 0.05 kg Zn ha^{-1} (both straw and grain) per ton of grain yield, but much more Zn fertilizer must be applied because Zn once applied is not very available to the plant.

When to apply Zn?

Apply the Zn fertilizer on the soil surface after last puddling and leveling in the main field or apply Zn fertilizer to the nursery beds 7−8 days before pulling seedlings. The effect of Zn application to soil can last 2−5 crop seasons on all soils except in alkaline soils. In alkaline soils, Zn may need to be applied to each crop.

What are the sources of Zinc

The commonly used Zn fertilizers are soluble zinc sulfate (23−36% Zn), soluble zinc chloride (48−50% Zn), and insoluble zinc oxide (60−80% Zn). Vermicompost and poultry manures are also good source of zinc content that is approximately 50 to 60 ppm and 180 to 210 ppm in range respectively.

Conclusion

Thus in micronutrients zinc plays a key role in several biochemical processes in the rice plant, including chlorophyll production and membrane integrity stabilizing RNA and DNA structure, in maintaining the activity of DNA synthesizing enzymes and controlling the activity of RNA degrading enzymes.

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SYSTEM OF RICE INTENSIFICATION (SRI) FOR IMPROVED PRODUCTIVITY AND PROFITABILITY OF RICE

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Rice is the staple food for more than half of the world population. Rice is the *King crop of Asia*, because 90% of rice is being produced and consumed in Asia alone. In our country India, rice is grown in about 43.0 mha area with the production and productivity of 154.5 mt and 2.41 t/ha, respectively (USDA, 2016). Rice crop is known to have very low water use efficiency and under irrigated conditions it consumes about 3,000 to 5,000 litres of water to produce one kilogram of rice (Geethalakshmi *et al.*, 2011). So water becomes one of the most important components for sustainable rice production in major rice producing areas of country as well as world. It is unequivocal that over past 3-4 decades, wide spread exploitation of groundwater had helped to overcome country's food security problem but, for sustainability of production system in future, we cannot depend consistently on it, owing to its diminishing levels especially in Punjab and Haryana regions of the country.

The total water requirement for human and animal uses, industrial production and irrigated agriculture would be 104.50 million hectare meter in the year 2025. A comparison of water requirement and utilizable supplies showed that, by the year 2025, the magnitude of the scarcity would be 26.20 million hectare meter. Thus, there will be greater competition between various sectors for the scarce water. It is projected that the global population would be 8 billion and Indian population would reach 1.33 billion by the year 2025. On the other hand, projected global rice demand for such huge population would be 800 and 130 mt across the globe and India, respectively. Thus to safeguard and sustain food security in India as well as in world, it becomes pivotal to increase productivity of rice. Under such conditions, there is need to grow rice with less water without compromising yield. For this, production technologies namely direct seeded rice, aerobic rice and system of rice intensification (SRI) can be advocated as an alternative to traditional transplanted rice.

SRI: History and origin

The SRI methodology was developed in early 1983 by Henri de Laulanie, a French Jesuit working with Madagascar farmers and formed a NGO "Association Tefy Saina", who spent more than three decades in Madagascar trying to devise better production methods that might improve the lives of rural household, who were impoverished and heavily dependent on rice (Laulanie, 1993). With little dependence on external inputs, he sought a methodology that would be both accessible to poor and marginal farmers and environmentally friendly. Cornell International Institute for Food, Agriculture and Development (CIIFAD), New York, in 1994, started working with Association Tefy Saina (ATS) to introduce SRI as an alternative to slash and burn cultivation. From 1998, CIIFAD has become increasingly active in drawing attention to the potential of SRI also in other major rice growing areas in particular Asia.

The SRI methodology: Basic principle and practices

SRI changes the management of rice plants and of the soil, water and nutrients that support them, in simple but specific ways to create optimal growing environment for rice plants so that their genetic potentials can effectively express. The SRI method encompasses the following agronomic managements:

1. **Transplanting of young seedlings:** SRI methodology gives the highest yield when young seedlings of less than fifteen days duration are transplanted and preferably 8-12 days before the start of the 4th phyllochron (Stoop *et al.*, 2002). This preserves plants potential for tillering and root growth that is compromised by later transplanting.
2. **Transplanting of single seedling per hill:** Planting of one seedling per hill is done within 15-30 minute of uprooting to avoid trauma to the plants. Under SRI, early transplanting provides a longer vegetative growth period and single seedling per hill reduces the competition among the rice plants and helps to minimize the shading effect of lower leaves. Mishra *et al.* (2006) have linked single transplanting per hill to increases in root length, density and activity and their inter-dependence with above-ground canopy development, particularly resulting in prolonged photosynthetic activity by older leaves.
3. **Square pattern of transplanting:** Seedlings are transplanted in square pattern (25×25 cm^2). Square planting not only facilitates weeding operation but also promotes the root growth. It also ensures efficient use of all the growth factors like sunlight, nutrient, water and space. Seedlings are transplanted into the puddled fields rather than flooded.
4. **Water management:** During the vegetative phase of crop, soil is kept moist, but not continuously flooding as it creates hypoxic soil condition that causes root degeneration of rice. Under SRI, from transplanting to panicle initiation stage intermittent irrigation is given and after panicle initiation stage a thin layer (1-3 cm) of standing water is maintained in the field.
5. **Weed management**: For weed control the manual weeding or use of mechanical weeder (cono-weeder) is recommended. Mechanical weeding starts from 10 days after transplanting and repeated 2-4 times at 10-12 days interval until the canopy closes. Soil aeration and incorporation of weed biomass *insitu* caused by mechanical weeder stimulates the growth of various soil micro flora.
6. **Preferable use of Organics for nutrient management:** Organic sources of nutrients like farmyard manure, compost and vermin-compost are preferred to inorganics. If organics are not available, SRI practices can be used successfully with fertilizers (Satyanarayana *et al.*, 2007).

A brief comparison between SRI and conventional rice cultivation practice is given below in the table 1:

Table 1. Comparison between SRI and conventional irrigated rice production

Parameter	SRI method	Conventional transplanting
Nursery area	100 m^2/ha	700-800 m^2/ha
Seed requirement per acre	3-4 kg	25-30 kg

Time of seeding transplanting	8-12 days old	21-25 days old
Spacing	25×25 cm	15×10 cm
No of plants per sq.m	16	66
No. of seedlings per hill	2	1
Recommended water management	Irrigate to 2.5 cm depth (after hairline crack formation up to panicle initiation and after disappearance of Ponded water).	Irrigate to 5 cm depth one day after the disappearance of ponded water
Recommended weed management	Using rotary / cono weeder in between rows in both directions at 10, 20, 30 and 40 DAT and hand removal of left out weeds.	Pre-emergence herbicide + hand weeding at 30 DAT (or) hand weeding at 15,30 DAT

Source: *http://www.agritech.tnau.ac.in/expert_system/paddy/riceecosystem.html#SRI*

Productivity and profitability with SRI method of rice cultivation

Rice shoot and root growth

The above and below ground growth and development of rice plant is affected by method of rice planting. It has been found that under SRI early seedling transplanting gives comparatively longer growing duration to crop, and also planting of sole seedling per hill reduces the intra-specific competition between young rice plants. This practice thus makes lower leave physiologically active for longer time which in turn enhances root growth owing to enhanced supply of oxygen and carbohydrates to them (Horie *et al.*, 2005). Moreover, as a result of higher root activity cytokinins are supplied to lower leaves that help in delaying senescence and maintaining the photosynthetic efficiency in plant during later growth stages.

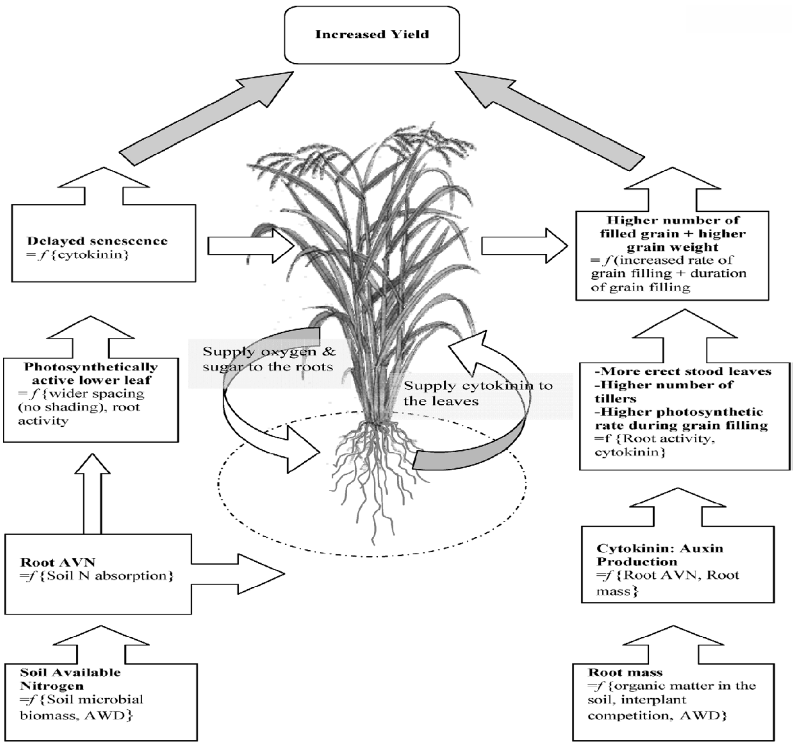

Figure 2 Integrated model of the high yielding rice plant under SRI management practices

All variables are shown as functions (f) of the variables that drive them (AVN = available nitrogen, AWD = alternate wet and dry). *Source: Mishra et al., 2006*

Gani *et al*., (2002) recorded more vigorous vegetative growth in 7 to 14 days old seedlings of rice plant over 21 days old seedlings. They further noticed that such seedlings produced higher number of effective tillers, biological yield, tall plants and root growth. Lokanadhan *et al*. (2007) found higher leaf area index (LAI) i.e., 1.82 at tillering, 3.65 at panicle initiation, and 4.44 at flowering in SRI over standard rice cultivation method (4.40, 4.78, and 4.16 in the respective stages).

Water savings

Water is the precious natural resource thus it's saving and efficient utilization becomes very much important. Rice is the water hungry crop and consumes a huge quantum of available water resources of our country. Moreover, the farmers are highly habituated flood irrigation in rice crop and maintain high submergence throughout crop growth cycle. It is also reported that consistent submergence of in rice paddies alters soil's physical, chemical and microbiological properties. Adoption of SRI rice cultivation technique lowers water demand of rice crop and improves the water use efficiency of rice crop. The investigation conducted at Indian Institute of Rice Research during 2006 and 2007 revealed that water saving in SRI could be up to 25-38% (Kumar *et al*., 2009). It was also observed that SRI method received only 91.89 m^3 of water which is around 38% less as compared to standing transplanting of rice (149.3 m^3). Similarly the total water productivity was around 29% higher in SRI over the standard transplanting method of rice growing (Table 2).

Table 2. Water requirement and total water productivity of SRI and conventional rice transplanting

	Method	**Irrigation (m^3)**	**(%) increase**
Water requirement	ST*	149.33	38.0
	SRI	91.89	
Total water productivity (kg/m^3)	ST	0.48	29.0
	SRI	0.68	

**Standard Transplanting*

According to Mevada *et al*. (2016) average water saving under SRI is around 406 mm over farmer's practice (FP). Thus for production of per kilogram of rice nearly 2426 litre of water is found sufficient in SRI, as against 3743 litre under the FP about 35 % higher efficiency of water under SRI over FP.

Yields and economic performance

Various on-farm experiments conducted at farmer's field in Telangana state showed improvement in productivity of rice crop grown by SRI method over conventional transplanting. A perusal of data in table 3 highlights significant yield advantage of 18% under SRI rice cultivation over conventional paddy growing methodology. Moreover, it also decreased the total expenditures by 32%, and due to yield increase farmers' net returns were improved by on an average by 52% over conventional returns.

Table 3. Yield and economics of alternative rice cultivation methods

Parameter	**Conventional method mean**	**SRI method mean**	**SRI compared To conventional Difference**
Total cost (Rs./ha)	28,476	19,289	-9,187 [-32%]

	(10,622)	(5,851)	
Grain yield (t/ha)	4.55 (0.65)	5.39 (1.06)	8.38 [18%]
Straw yield (t/ha)	2.87 (1.21)	2.32 (1.53)	-5.45 [-19%]
Straw value (Rs./ha)	10,261 (4,825)	6,825 (3,000)	-3,436 [-34%]
Grain value (Rs./ha)	45,472 (6,524)	53,853 (10,623)	8,381 [18%]
Gross returns (Rs./ha)	55,732 (8,861)	60,678 (12,002)	4,946 [9%]
Net returns (Rs./ha)	27,257 (8,508)	41,389 (11,619)	14,132 [52%]

Figures in parenthesis are standard deviations; figures in brackets are the differences, in percent, between SRI and conventional method of cultivation *Source: Adusumilli and Laxmi (2011)*

Insect pest influences

A variety of pests including different insects, fungus and other influence rice crop and cause severe reduction in overall yield of crop. Only handfuls of studies are available on the insect pests and disease scenario in SRI system (Karthikeyan *et al.*, 2007). It has been reported that under SRI incidence of pest is low owing to healthy and vigorous plants. Under wider spacing the individual plant gets more space for prober growth and development. Visalakshmi *et al.* (2014) studied the occurrence of yellow stem borer (*Scirpophaga incertulas* (Walker)) at tillering and reproductive stages whereas; the incidence of gallmidge (*Orseolia oryzae* (Wood Mason)) was recorded only at tillering stage. In their investigation they found lower incidence of stem borer in SRI method (6.1% dead hearts and 7.2% white ears) than conventional rice transplanting (15.6% DH and 11.9% WE). The same trend continued in case of gall midge too with 4.1% silver shoots in SRI method against 7.1% in conventional method.

Issues in adoption of SRI

As many new techniques proposed by SRI are often greeted with scepticism by farmer who has been cultivating rice for decades. Therefore, in order to bring the SRI at farmer's door we must convince them through demonstrations and training. In present time, labour shortage is becoming a serious problem. Thus the fragmentary mechanisation in SRI must be enhanced further to mitigate labour requirements. In areas where agricultural labourers are still dependent on rice cultivation, efforts to train them in SRI are essential. Some of the common problems faced by farmers in adopting SRI are:

- SRI demands more personal attention and constant involvement by farmers.
- Apprehensions about the new way of raising seedlings, handling young seedlings and square planting.
- Difficulties in leveling the main field properly.
- Resistance of contract labourers to planting.
- Labour scarcity for transplanting.
- Drudgery of using a weeder.

- Unsuitability of weeder for some soils.
- Unavailability of weeders.
- Potential pest attack due to lush growth of the crop.

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Available online at www.marumegh.com
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ISSN: 2456-2904

FOREWARNING OR ASSESSMENT OF DISEASE IMPORTANT FOR CROP PRODUCTION MANAGEMENT

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Diseases Forecasting

Forecasting involves all the activities in ascertaining and notifying the growers of community that conditions are sufficiently favourable for certain diseases,that application of control measures will result in economic gain or on the other hand and just as important that the amount expected is unlikely to be enough to justify the expenditure of time, energy and money for control (Miller and O'Brien 1952)

Pre-requisites for developing a Forecast System

The crop must be a cash crop (economic yield), the disease must have potential to cause damage (yield losses), the disease should not be regular (uncertainty), effective and economic control known (options to growers), reliable means of communication with farmers, farmer should be adaptive and have purchasing power.

The principles of disease forecasting based on

The nature of the pathogen (monocyclic or polycyclic), effects of the environment on stages of pathogen development, the response of the host to infection (age-related resistance), activities of the growers that affect the pathogen or the host

Model for disease prediction

Empirical models- based on experience of growers, the scientist or both.

Simulation models - based on theoretical relationships.

General circulation models (GCM)- based on fixed changes in temperature or precipitation has been used to predict the expansion range of some diseases- not successful.

Problems with use of such models-

Model inputs have high degree of uncertainty.

Nonlinear relationships between climatic variables and epidemic parameters.

Potential for adaptation of plants and pathogens.

Expert system in plant pathology

These are computer programme in which expert professionals solve the problem provide solution for forecasting of economic important plant disease of crops. Expert provide suggestion and recommendation for control measure

S. No	Experts system s	Plant Diseases
1.	EPIDEM	Early blight of tomato and potato
2.	BLIGHTCAST	Late blight of tomato
3.	EPIVEN	Apple scab

4.	CONSELLOR	Wheat disease
5.	CALEX	Peach disease
6.	CERCOS	Cercospora blight of celery
7.	FAST	*Alternaria solani*
8.	EPICORN	Sourthern corn leaf blight
9.	MYCOS	*Mycosphaerella* blight of chrysanthemum

Uses of diseases forecasting

Forewarning or assessment of disease important for crop production management, for timely plant protection measures, for making strategic decision, Prediction of risks involved in planting of certain crop, deciding about the need to apply strategic control measures (soil treatment, planting a resistant cultivar, etc).

For making tactical decision-

Help grower's to make economic decision for managing disease. Determine cost and benefits for applying pesticides, selecting seed or propagation materials, or whether to plant a crop in a particular area

History of forcasting system

1911- One of the first attempts at predicting LB was made by **Lutman** who concluded that epidemics were favoured in wet and cold conditions.

1926- **Van Everdingen** in Holland proposed the first 'model' based on four climatic conditions necessary for LB development: night temperature below dew point for at least four hours minimum temperature not lower than 10°C, cloud cover the following day, rainfall in excess of 0.1 mm.

1933 -In England, **Beaumont** and **Stanilund** emphasized the importance of humidity for late blight occurrence. They considered a day humid when the relative humidity at 3:00pm was higher than 75% Conditions were even more favourable for LB development with two consecutive humid days and when the minimum temperature was not lower than 10°C.

1953- Burke described the 'Irish rules' that minimum temperature not less than 10°C and relative humidity not lower than 90% for 12 hours

1956- Smith period that the two consecutive days with minimum temperatures above 10°C and at least 10 hours with relative humidity above 90%

Successful plant disease forecasting system

Reliability -use of sound biological and environmental data

Simplicity - The simpler the system, the more likely it will be applied and used by producers

Importance -The disease is of economic importance to the crop, but sporadic enough that the need for treatment is not a given

Usefulness -The forecasting model should be applied when the disease and/or pathogen can be detected reliably

Availability -necessary information about the components of the disease triangle should be available

Multipurpose applicability -monitoring and decision-making tools for several diseases and pests should be available.**Cost effectiveness** -forecasting system should be cost affordable relative to available disease management tactics.

Stewart's disease forecasting system

Stewart's disease of corn, or 'Stewart's wilt,' caused by *Erwinia stewartii* economically important because its presence within seed corn fields can prevent the export of hybrid seed corn to countries with phytosanitary (quarantine) restrictions.

The corn flea beetle (*Chaetocnema pulicaria)* plays an important role in this pathosystem for two reasons: the bacterium survives the winter period in the gut of adult corn flea beetles that are overwintering at the soil surface in grassy areas surrounding fields life cycle. The corn flea beetle is the primary means for dissemination of the bacterium from plant to plant, Warmer winter temperatures during December, January, and February generally allow greater numbers of the insect vector to survive, thereby increasing the risk of Stewart's disease epidemics due to higher levels of initial inoculum (infested beetles) that will be present during the ensuring growing season.

Stevens-Boewe Stewart's disease forecasting system

Stewart's wilt forecasting using the average monthly temperatures of December,January and February

Average monthly tempreture	**Early season wilt probably will be**	**Late season blight probably will be**
<27 ^{0} F	Absent or nearly so	A trace, at most
27-30 ^{0} F	Light	Light to moderate
30-33^0 F	Moderate	Moderate to severe
>33^0 F	Severe	severe

Sclerotinia Stem Rot forecasting

Sclerotinia stem rot (*Sclerotinia sclerotiorum)* is one of the most important diseases on spring-sown oilseed rape. Forecasting method of Sclerotinia stem rot has been developed in Sweden.

The method is mainly based upon a number of risk factors, such as crop density, crop rotation. Level of previous Sclerotinia infestation (estimation of inoculum in soil), time for apothecia formation from sclerotia, rainfall during early summer and during flowering and weather forecast.

Prediction of a polycyclic pathogen that complete very few disease cycles in a growing season

Apple scab induced by *Venturia inaequalis*

1. Amount of initial inoculum is high (ascospores)
2. Only young leaves are susceptible
3. Film of water on the leaves and proper temperatures are needed for infection

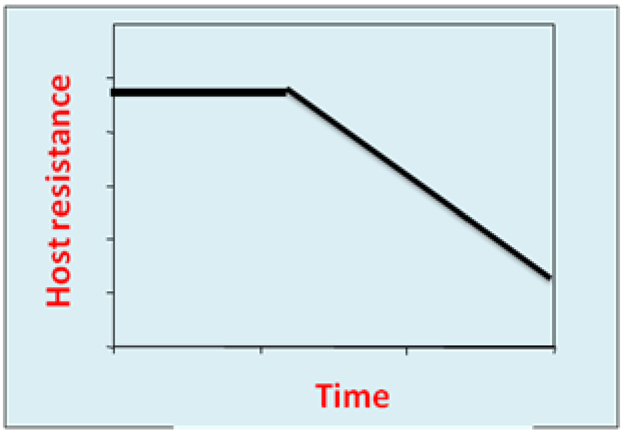
Prediction of a polycyclic pathogen

Potato late blight induced by *Phytophthora infestans*. Amount of initial inoculum is very low (infected tubers). Disease progress rate may be very high. Potential loss - high. Preventive sprays are highly effective. The time of disease onset is governed by the environment.

Prediction of disease development in relation to host response to the pathogen.

Early blight of potato induced by *Alternaria solani*. Amount of initial inoculum is very high (infected plant debris), The pathogen develops at a wide range of conditions, Potential loss - low

Disease progress is governed by the response of the host



Botrytis rot in basil induced by *Botrytis cinerea*

The pathogen invades the plants through wounds that are created during harvest. The wounds are healed within 24 hours and are not further susceptible for infection. A drop of water is formed (due to root pressure) on the cut of the stem.

Botrytis rot in basil induced by *Botrytis cinerea*

If humidity is high, the drop remains for several hours. During rain, growers do not open the side opening of the greenhouses. Disease outbreaks occur when harvest is done during a rainy day.

Consequences from predicting grey mold outbreaks in basil on disease management

To minimize the occurrence of infection, harvesting should be avoided during rainy days.

If harvesting is done during rainy days, apply a fungicide spray once, soon after harvest

Success of forecasting

The success of a forecasting system depends on, the commonness of epidemics (or need to intervene), the accuracy of predictions of epidemic risk (based on weather in this example), the ability to deliver predictions in a timely fashion, the ability to implement a control tactic (fungicide application, for example), the economic impact of using a predictive system.

Status of Forecasting In India

Thought it is well develop in other countries but in India it is not so well develop. There are few example where the disease severity increases after the forecasting over observed forecasting.

Ex. Phytophthora blight in Kanpur, bacterial blight in of cotton in Akola, late leaf spot and rust in groundnut. In shimla the model for potato disease is preparing

Conclusion

It help in protecting our crop from the heavy loss, so it should be accurate and reliable. Forecasting is done for disease which cause economically significant damage in terms of quality and quantity in the area for which forecasting is intended. Forecasting maximise economic returns from the crop and provide useful tool to farmers in management. It help in identifying the lecuna in epidemiological information in a disease.

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ISSN: 2456-2904

TOOLS FOR DEVELOPMENT OF HYBRIDS IN INDIAN MUSTARD (*Brassica Juncea* L. Czern. & Cross)

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Introduction:

Indian mustard [*Brassica juncea* (L.) Czern. & Cross.] belonging to the genus Brassica in the Cruciferae family, is an agriculturally and economically important crop that is widely cultivated in Asia and Europe. It is second most important edible oilseed crop of the world and India as well after groundnut. It is a plant of Asiatic origin with its major center of diversity in China (Vaughan, 1977). It was introduced in India from China and from where it spread to Afghanistan and other countries. Because of their ability to germinate and grow at low temperature, the oilseed Brassica can be grown in the cooler agricultural regions and at higher elevations, as well as winter crops in the temperate zones. Rapeseed-mustard comprises of eight different species, cultivated in 53 countries spreading all over the globe. Among these species, major area is under *Brassica juncea*, which contributes about 80% of the total rapeseed-mustard production in the country (Yadava *et al.*, 2011). Asia contributes around 46% of area and 35% of the world production. India holds a premier position for global oilseed production contributing 9% to the world's oilseeds with an area of 19%. India is the world's 3rd largest producer of rapeseed-mustard.

Origin and Taxonomy:

Indian mustard popularly known as rai, raya or laha and it occupies considerable large acerage among the *Brassica* group of oil seed crops. The genus *Brassica*, belongs to cruciferae family and includes many crop species. The tetraploid species *B. juncea* (AABB; 2n=4x=36) is derived from *B. campestris* (AA; 2n=2x=20) and *B. nigra* (BB; 2n=2x=16) (Nagaheru, 1935). Central Asia-Himalayas are a primary center of diversity for this species, with migration to China, India and the Caucasus (Hemingway, 1976). These relationships have been confirmed by the artificial synthesis of amphidiploids species by hybridizing basic diploid species and also by analysis of chloroplast and mitochondrial DNA restriction pattern of basic and amphidiploid species. It is largely self-pollinated crop (85-90 %) however, owing to insects, especially the honeybees, the extent of cross-pollination varies from 4.0 to 16.6 % (Rambhajan *et al.*, 1991). The Brassiceae currently contains approximately 235 species in 49 genera, 22 of which are monotypic. The genus Brassica has 38 species. Three characteristics separate the mustard family from all other plant families *i.e.* tetradynamous anthers, cross petals and the replum.

Hybrid Development Mechanism in Indian mustard:

To achieve circumvention of selfing in largely self pollinated crops, pollination control mechanisms like male sterility and chemical hybridization agents have been widely investigated in Indian mustard.

Chemical hybridizing agents: The chemicals those have ability to induce pollen sterility in the development of hybrids. Only three chemicals namely DPX 3778, ethrel and GA_3 have been evaluated in Indian mustard.

Functional male sterility: Functional male sterility (FMS) was derived from a spontaneous mutation in *B. juncea*. In FMS, the sterility is achieved through early and elongated extension of stigma, which is no longer receptive to pollination, when corresponding anthers are extruded from flowers and flower buds.

Genetic Male Sterility: Genetic male sterility has been considered for hybrid seed production in Brassica crops. In *B. juncea*, GMS systems have been recognized by monogenic or digenic epistatic. The GMS is more stable than CMS.

Cytoplasmic genetic male sterility: Many sources of cytoplasmic male sterility (CMS) have been developed in Brassica. Major constraints in CGMS systems are the absence of proper fertility restorer and unstable restoration.

Genetically engineered male sterility: The first success in developing genetically engineered male sterility in crop plants was by transforming tobacco and rapeseed plants with dominant gene *barnese* (Bac. RNase) driven by a tapetum–specific promoter TA29.

Commercial Heterosis in Indian mustard:

Commercial heterosis in Indian mustard over the most popular variety Varuna for seed yield and oil yield was estimated by Pandey and Zehr, 2010. Hybrids based on the functional male sterility system (FMS) has shown comparatively and significantly better seed yield as well as oil yield heterosis than hybrids based on cytoplasmic genetic male sterility system (CGMS).

Self-incompatibility:

Self-incompatible pollen grains fail to germinate on the stigma. In heteromorphic system, flowers of different incompatibility groups are different in morphology. In Primula, pin flowers have long styles and short stamens, while thrum flowers have short style and long stamens. In the homomorphic system, incompatibility is not associated with morphological differences among flowers. The incompatibility reaction of pollen may be controlled by the genotype of the plant on which it is produced (Sporophytic control) or by its own genotype (Gametophytic control).

Mechanism of self-incompatibility: Self-incompatibility takes place at different levels and stages *viz*. Pollen-stigma interaction, Pollen tube-style interaction, and Pollen tube-ovule interaction. Pollen tubes grow by unidirectional extension of the tip of pollen grain. The growing region at the tip is very active and contains many vesicles; those can be seen to fuse with the membrane, releasing wall components and enzymes. Some of the documented changes include increase in respiratory rate, auxin level and enzyme content, and cytological changes observed in the style of some species. Incompatible pollination in Brassica showing the inhibition of self pollen (Po) and the inability of the emerging pollen tube (Pt) to invade the wall of a stigma epidermal cell (SE). Pollen itself synthesized its inner and outer cell wall; the inner layer is gametophytic in origin. Tapetum is thought to be responsible for completing the formation of pollen outer wall. Some of the proteins have been identified as hydrolytic enzymes accumulate around the pores and are implicated the emergence of the pollen tube.

The exine cavities filled with variety of compounds such as carbohydrates, lipids and proteins.

Genetics of Self- incompatibility: Genetics of self-incompatibility (SI) in Brassicaceae family, where S locus controls the SI mechanism with number of alleles. The various naturally occurring, classically defined S-alleles those have been described in Brassica have been arranged in a dominance series based on their genetic behaviour relative to other alleles in heterozygous plants.

Molecular mechanism of self-incompatibility: Model for the mechanism of S-haplotype-specific pollen recognition and rejection in Brassica, S-haplotypes are all co-dominant. The pollen SCR_1($SP11_1$) protein is recognized, and binds to the extracellular receptor domain of SRK1, presumably inducing dimerization between SRK1 proteins and trans-phosphorylation on serines and threonines in their kinase domains. Activation of the SRK complex, which includes SLG in most S-haplotype-specific interactions, initiates an intracellular signaling cascade within the stigmatic papilla cell that culminates in localized rejection of pollen. SRK and SCR/SP11 alone are required for S-haplotype specific pollen recognition and rejection, but the strength of the SI response is enhanced by the presence of SLG in S-haplotypes that possess this protein. Signaling downstream of the activated SRK complex has yet to be characterized, however ARC1, an arm-repeat protein, that binds to the kinase domain of SRK in a phosphorylation dependent manner is essential for SI, but as yet its function is unknown.

Protogyny: Dichogamy refers to maturation of anthers and stigma of the same flowers at different times. Dichogamy is of two types: viz. i) protogyny and ii) protandry. When pistil matures before anthers, it is called protogyny. A study was conducted by Dadlani, 2011 in which they observed protogynous plants in F_3 generation in a cross between Agra Local and Varuna in Indian mustard. Results indicated that protogynous interval extended up to 9-11 days and stigma receptivity up to 3 days from its protrusion. Chakrabarty *et al.,* 2011 also identified protogynous plants from the different open pollinated cross combinations in Indian mustard. The duration of protogyny was up to 13 days in timely sown plants, while it was only 3 days in late sown plants. There was a difference in opening of protogynous flowers.

Conclusion:

Self-incompatibility and protogyny are two effective tools for commercial heterosis in Indian mustard. The levels of commercial heterosis observed by various scientists for seed yield and oil yield in hybrid oilseed Brassica ensures exploitation of heterosis in future. The protogyny can be used as morphological marker in a hybrid seed production plot. Protogyny along with self-incompatibility will prove to be an alternative to CGMS system in *Brassica juncea*. The self-incompatibility system of Brassica species is sporophytically controlled by a single locus (S locus) with different multiple alleles. At molecular level three important genes viz. SLG, SRK and SCR/SP11 are governing the SI system. The male and female S determinants of Brassica Self incompatibility were determined to be SP11/SCR and SRK, respectively. Morphological markers linked to self-incompatibility/CGMS will help in early identification of SI/ CGMS plants. Hybrid seed production programme can be strengthened, by using self-incompatibility in both male and female parents.

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EFFECT OF SODIUM FLUORIDE ON SEED GERMINATION AND SEEDLING GROWTH OF CROPS

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Seed germination is the most important phase in a plant's life cycle. Water, air, temperature and light are all crucial for the seed germination process starting from imbibition, activation and subsequent manifestation. Seed germination may be considered to be resumption of embryo growth resulting in seed coat rupture and emergence of the young plant. Seed germination is strongly inhibited by salts and, if salinity increases above a critical level, characteristic for each species, germination will not take place. Salinity can affect germination either by generating an osmotic potential which may prevent water uptake or by allowing the entry of ions which may be toxic to the embryo or developing seedlings. Fluoride is an anion of halogen family and 13th most abundant element of the earth crust and occurs at about 0.3 gkg^{-1} of earth's crust. Fluorides are naturally occurred in the form of sodium fluoride or hydrogen fluoride in rocks, coal, clay and soil and released into the environment through the weathering of minerals, emissions from volcanic ash and marine aerosols. In water, inorganic fluorides usually remain in solution (as fluoride ions) under conditions of relatively low pH and hardness. Though, fluoride is considered as absolutely non–essential element for plants, its presence in soil, air and water causes alterations in physiological, biochemical and structural activities in plants.

If fluoride contaminated ground water is used for irrigation it's harmfully affects crop growth exclusively in beginning of seedling growth. Fluoride affects the enzymatic activity and growth by slow the rate of cellular division and expansion. The seedling growth parameters (root length, shoot length, root weight, shoot weight, germination percentage and vigor index) and biochemical parameters i.e., chlorophyll, nitrogen and protein content as well as the Fluoride uptake. Response of fluoride depends upon some factors such as dose, duration of exposure, age and genotypes of plants. The high internal Fluoride concentration disturbs nearly all the physiological and biochemical process in plants. A number of cellular processes identified to cause toxic effects on plants include disruption of enzyme activity involved in metabolic processes, inhibition of protein secretion and synthesis, generation of reactive oxygen species, and alteration of gene expression. At micromolar concentrations, F acts as an anabolic agent and promotes cell proliferation, whereas at millimolar concentrations it acts as an enzyme inhibitor. F disrupts enzyme activity by binding to functional amino acid groups that surrounds the enzyme's active centre. Inhibition of protein synthesis and secretion interrupts the signaling pathways involved in cell proliferation and apoptosis. F can increase oxidative stress leading to the degradation of cellular membranes and reduced mitochondrial activity.

Effects of different NaF concentrations on the growth and metabolic parameters of almond seedlings (*Amygdaliscommunis*) were deliberate under controlled growth conditions in nutrient solutions containing increasing NaF concentrations ranging from 0 to 10 mM NaF. After 14 days, production of material measured as dry matter was significantly reduced in the root system, which accumulated large amounts of F. The chlorophyll, calcium, and magnesium content of the leaves showed a significant decrease, and the leaf content of starch and sugar was also reduced, especially at the higher F concentrations. Mineral concentration changes in the roots were minor except for manganese, which showed a major decrease at 2.5 mM NaF. Overall, the nutritional status of the leaves appeared to be affected more than that of roots (Elloumi *et al* 2005).

The effect of sodium fluoride (0.1, 0.25, 0.50, 0.75 and 1 mM NaF) was studied on germination behaviour, membrane stability and biochemical parameters in in-vitro grown seedlings of *Vigna radiata* L. After 7 days of treatment germination percentage, root length, shoot length, vigour index, percentage of chlorophyll stability index, membrane stability index and soluble protein content were decreased in seedlings under fluoride stress. Sodium fluoride (NaF) treatment resulted in a significant enhancement of osmolytes such as proline and total soluble sugars content. Thus, the results of this experiment indicate that NaF disturbed the seed germination, seedling growth and membrane stability whereas, increased proline and carbohydrates in Vigna seedlings (Gadi *et al*. 2012).The effect of 0, 10, 20, and 30 mg NaF/L in an aqueous nutrient solution on germination, seedling growth, and biochemistry of Bengal gram (*Cicerarieninum*) seeds and seedlings was studied under controlled conditions. At the end of 15 days, significant reductions were observed with increasing F concentration in the various parameters studied, including percentage of seed germination, root and shoot length, biomass, vigor index, chlorophyll, and ascorbic acid content. F uptake by the roots and shoots of the seedlings increased with increasing F concentration, and although F accumulation in the roots was higher than in the shoots of the seedlings, the root-to-shoot translocation factor was quite high (>0.80) (Chakrabarti *et al*.2012).

Fluoride contamination in water, soil and plants is a serious health problem throughout the world. We studied the effect of aqueous solutions of 0, 10, 20, 30, 40 and 50 ppm sodium fluoride on seed germination, seedling growth and biochemical parameters of Abelmoschus esculentus. The experiment was conducted as factorial with completely randomized design with five replicates. The percentage of seed germination decreased up to 62 percent with increasing sodium fluoride treatment. The seedling growth parameters (root length, shoot length and vigor index) and biochemical parameters i.e., chlorophyll, nitrogen and protein content as well as the Fluoride uptake by the germinated seedlings were estimated after 20 days of treatment (Iram2016).

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CARBON SEQUESTRATION AND IT'S IMPORTANCE

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Carbon sequestration: - Carbon sequestration is the process of capture and long-term storage of atmospheric carbon dioxide to mitigate global warming and to avoid dangerous impacts of climate change. In other words, it also refers to the process of removing carbon from the atmosphere and depositing it in a reservoir. This storage is also known as carbon pools. Carbon pool refers to a system or mechanism which has the capacity to accumulate or release. Examples are forest biomass, wood products, soils, and the atmosphere.

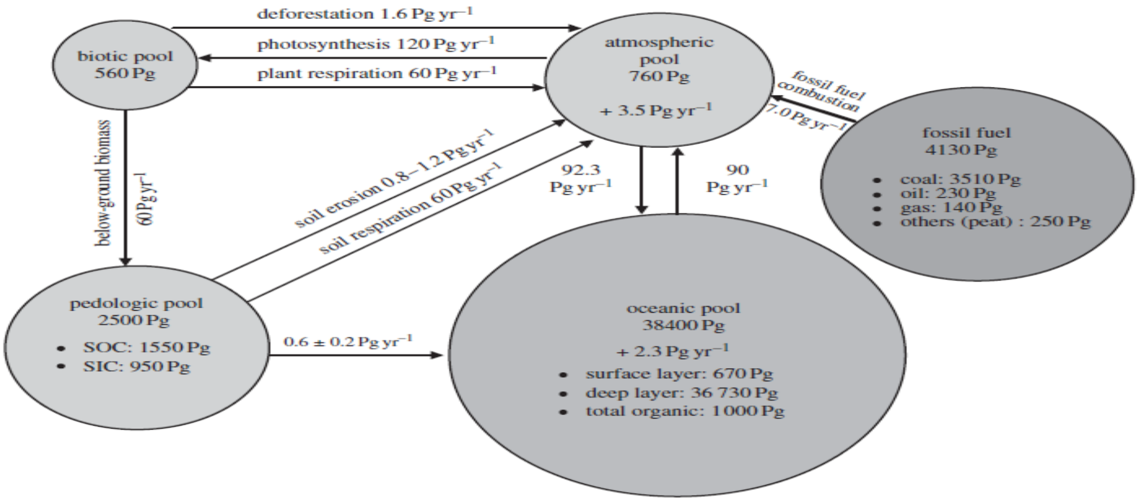


Figure 1. Principal global C pools and fluxes between them. The data on C pools among major reservoirs are from Batjes (1996), Falkowski *et al.* (2000) and Pacala & Socolow (2004), and the data on fluxes are from IPCC (2001).

Introduction: Earth is getting more and warmer than ever, reason is human activities. Human activities have caused an imbalance in natural carbon cycle, consequently greenhouse effect and global warming came into being. When fossil fuels are burnt for transportation, heating, cooking, electricity, and manufacturing, we are effectively realizing more carbon into the atmosphere than it is being removed naturally. Ultimately we are causing more carbon concentration into atmosphere. As a result we are proceeding on the path of global warming and climate change. Global warming and climate change refer to an increase in average global temperatures. Natural events and human activities are believed to be contributing to an increase in average global temperatures. This is caused primarily by increases in "greenhouse" gases such as CO_2.

Climate change: Global warming and climate change refer to an increase in average global temperatures over a very long period of time. As discussed in carbon cycle, natural events and human activities are believed to be contributing to an increase in average global temperatures, This is caused primarily by increases in “greenhouse” gases such as Carbon Dioxide (CO2) (Shah, 2013). Small changes in the average temperature of earth so far, can transform into large in coming hundred years. Moreover these climatic changes will have great potential to create negative impacts on environment and mankind. Therefore it is essential to mitigate climate change for advance minimization of its dangerous impacts. Current evidence suggests that to avoid the worst impacts of climate change, we should aim to limit the global average temperature rise to 2°C (35.6°F), not beyond that. This requires undertaking immediate reduction in global greenhouse gas emissions in all the sectors.

Indicators for climate change there are several indicators which are following:

Change in precipitation pattern	Change in sea surface temperature
Atmospheric concentration of green house gases	Glaciers melting
Tropical Cyclonic activities	Change in Ocean Acidity
Change in Sea level	Submergence of land into sea
Length of growing season	Change in Snow fall pattern
Heat related deaths	Change in Temperature pattern

Why need carbon sequestration:

1. Reducing pollution in air as well as improving natural carbon content in soil.
2. Improvement of soil structure and restoring degraded soil leading to increase yield in crops.
3. Carbon dioxide capture and sequestration could play an important role in reducing greenhouse gas emissions into the atmosphere.
4. It enables low-carbon electricity generation from power plants.
5. As reported by INCCA in their report, 'Green House Gas Emission 2007', 38% of CO_2 emissions in India is done from electric power generation. This carbon share can be reduced by using carbon sequestration technology.
6. Carbon sequestration technologies can dramatically reduce CO_2 emissions by 80-90% from power plants that burn fossil fuels.
7. For instance - if it is applied to a 500 MW coal-fired power plant, which emits roughly 3 million tons of CO_2 per year, the amount of GHG emissions avoided (with 90% reduction efficiency) would be equivalent to:

- Planting more than 62 million trees, and waiting at least 10 years for them to grow.
- Avoiding annual electricity-related emissions from more than 300, 000 homes

Source of carbon dioxide emission:

1. Man made sources

Industries, Transportation, Land use change, Soil cultivation, Biomass burning

2. Natural sources

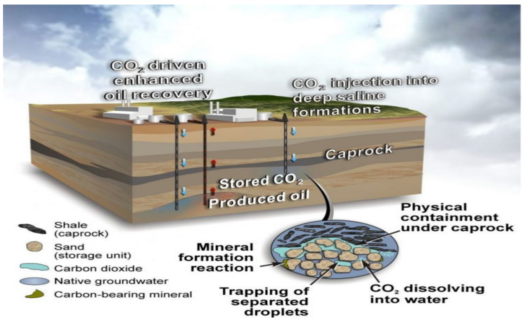
Volcanoes, Wild fires, Decomposition, Respiration

Methods of carbon sequestration:-

1. **Geological sequestration**: (Underground) Geologic Storage involves capturing anthropogenic CO_2 before it enters the atmosphere and injecting it into underground

formations. Once CO_2 is injected deep underground (typically more than 800 meters) it is trapped in minute pores or spaces in the rock structure. Impermeable cap rocks above the storage zones act as seals to ensure the safe storage of CO_2.

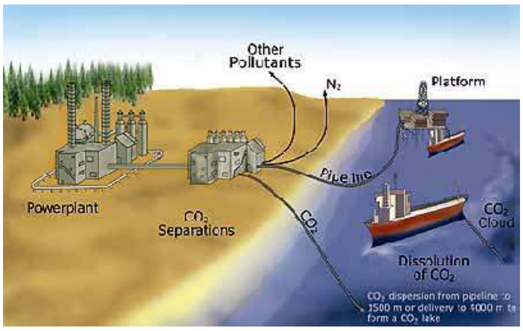
2. **Ocean Sequestration**: (Deep in ocean) Carbon is naturally stored in the ocean via two pumps, solubility and biological and there is analogous man made methods, direct injection and ocean fertilization, respectively. At the present time, approximately one third of human generated emission is estimated to be entering the ocean.



Terrestrial Sequestration: (In plants and soil) the process through which CO2 from the atmosphere is absorbed naturally through photosynthesis & stored as carbon in biomass & soils.

Carbon sources and carbon sinks

Carbon source: A forest is considered to be a carbon source if it releases more carbon than it absorbs. Anthropogenic activities such as the burning of fossil fuels have released carbon from its long-term geologic storage as coal, petroleum and natural gas and have delivered it to the atmosphere as carbon dioxide gas.



Carbon sink: The main natural carbon sinks are plants, the ocean and soil. Plants grab carbon dioxide from the atmosphere to use in photosynthesis; some of this carbon is transferred to soil as plants die and decompose. The oceans are a major carbon storage system for carbon dioxide. Marine animals also take up the gas for photosynthesis, while some carbon dioxide simply dissolves in the seawater.

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MUSHROOM CULTIVATION: A KEY SOURCE FOR DOUBLING THE FARMER'S INCOME

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Introduction

Mushrooms are a fleshy, macroscopic, saprophytic, spore-bearing fruiting structure of a fungus (edible fungus), epigeous or hypogeous, large enough to be seen with naked eyes and picked up by hand. Mushroom belonging to class Basidiomycetes except few which belong to Ascomycetes. It grows on dead and decaying organic materials derived from the waste of agriculture, horticulture, poultry, brewery etc. for its cultivation. It absorbs nutrients with the help of its thread like structures (mycelium) which penetrate into the substratum.

Mushroom cultivation is economically important for the food industry worldwide, which has expanded in the past few years and being commercialized in India past decades. Its cultivation is requires low temperature for its growth; however with the emerging of modern cultivation technology it is now possible to cultivate this mushroom seasonally under controlled conditions. India, being a developing country is fortunate to have a varied agro-climate, abundance of agro wastes, relatively low-cost labour and a rich fungal biodiversity. Mushrooms are nutritious rich food for all age group. Presently, mushroom farming is being practiced in more than 100 countries and increasing its production at an annual rate of 6-7%. China leads in mushroom production and China alone is reported to grow more than 20 different types of mushroom at commercial scale. China produces approximately 70% of world mushroom production, Sharma *et al.*, 2017. The USA is the second largest producer of mushroom sharing 16% of the world output and India sharing 4-6% in mushroom production. In the last decade, large numbers of commercials units have been built by the entrepreneurs/farmers throughout the country for the production of button mushrooms. Among different agri-based enterprises, mushroom cultivation is one of the enterprises which has the vast potential to double the existing income level of farmers and this enterprise can easily be adopted by any category of farmers irrespective of their landholding size. Mushroom cultivation provides option for income and employment generation especially for the unemployed youths and women without any major arable resources, Kumar *et al.*, 2013.

Why Cultivate Mushroom?

❖ **Major problems**

• Malnutrition	• Marginal farmers
• Youth unemployment	• Water scarcity for agriculture
• Huge agricultural waste	

❖ **Solution by Mushroom cultivation**

- Source of protein, minerals and vitamins
- Employment through mushroom production.
- Agricultural waste management use as substrate for mushroom production
- No need of land requirement
- Less water requirement than agricultural crops
- Increasing popularity
- High value crop
- Grow quickly with higher yield
- Cash flow throughout the year
- Profitable even on small scale
- Good for human kind and Environment
- Scope for entrepreneur or self employment

Mushroom cultivation in India

India has varied agro-climate, abundance of agricultural residues and plenty of manpower making it suitable for cultivating different mushrooms. Major part of agricultural waste produce to India is let out to decompose naturally or burnt *in situ.* This can effectively be utilized to produce highly nutritive food such as mushrooms and spent mushroom substrate can be converted into organic manure. Mushrooms are grown seasonally as well as in state-of-art environment controlled cropping rooms all the year round in the commercial units. Mushroom growing is a highly labour, oriented venture and labour availability is no constraint in the country and two factors, that is, availabilities of raw materials and labour make mushroom growing, economically profitable in India. Moreover, scope for intense diversification by cultivation of other edible mushrooms like oyster, shiitake, milky and other medicinal mushrooms are additional opportunities for Indian growers. At present, four mushrooms *viz.*, button mushroom *(Agaricus bisporus),* Oyster Mushroom *(Pleurotus* spp.), paddy straw mushroom *(Volvariella* spp.) and milky mushroom *(Calocybe indica)* have been recommended for round the year cultivation in India. India produces about 600 million tonnes of agricultural byproducts, which can profitably be utilized for the cultivation of mushrooms. Currently, researchers are using 0.04% of these residues for producing around 1.2 lakh tons of mushrooms of which 85% is button mushroom, Shirur *et al*., 2017. Mushroom being an indoor crop, utilizing vertical space offers a solution to shrinking land and better water utility. The current Indian estimates, mushroom production in India is about 1.2 lakh metric tons, which is 3-4% per cent of world production. Underprivileged small farmers and landless labourers, the Indian Council of Agricultural Research established the National Research Centre for Mushroom (NRCM) in 1983 at Solan (Himachal Pradesh) to conduct research programmes and transfer of technologies on various aspects of mushrooms culture. Himachal Pradesh is premier state of commercial mushroom cultivator and known as land of mushroom. Initially, AICRP- Mushroom was started with six centres one each at Tamil Nadu Agricultural University (Tamil Nadu), Punjab Agricultural University (Punjab), GB Pant University Technology (Uttarkand), CS Azad University of Agriculture and Technology (Kanpur), Bidhan Chandra Krishi Vishwa Vidyalaya (West Bengal) and Mahatma Phule Agricultural University (Maharashtra). After establishing the All India Coordinated Research

Projects on Mushroom (AICRP-Mushroom) at Solan, the research on this mushroom was intensified. Production and consumption of mushrooms have tremendously increased in India mainly due to increased in awareness of the commercial and nutritional significance of this commodity. The states, Punjab, Uttrakhand, Haryana, Uttar Pradesh, Tamil Nadu, Himachal Pradesh, Orissa, Andhra Pradesh, Maharashtra, Kerala and North eastern regions of India and are being major contributors of mushroom production in the country.

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ROLE OF PRE BREEDING IN CROP IMPROVEMENT

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What is pre breeding: Transfer of desirable traits and genes from unadapted materials that cannot be used directly in breeding populations, to an intermediate set of materials that breeders can use further in producing new varieties for farmers is known as pre breeding.

Why pre breeding is esseintial: Genetically uniform modern varieties, modern agriculture practices, evolving pest and pathogen populations and changing are serious threat to our rich biodiversity. Increased genetic uniformity, climate change and increased demand for food and nutrition necessitate the identification and utilization of diverse germplasm sources to develop new high-yielding cultivars with a broad genetic base. This factor also motivates the plant breeders to look for new sources of desirable genes. Wild relatives of any crop are great sources of genetic diversity for crop improvement. Pre-breeding provides a unique opportunity, through the introgression of desirable genes from wild germplasm into genetic backgrounds readily used by the breeders with minimum linkage drag.

Approaches of pre breeding

1. Introgression: Making crosses between the donor and the recurrent parent.
2. Incorporation: Incorporation refers to a large scale programme aiming to develop locally adapted population using exotic / un-adapted germplasm.
3. Participatory plant breeding: make use of indigenous knowledge of farmer in association with breeders to develop new varieties using landraces.
4. Convergent breeding: transfer of gene from two or more donor species to a cultivated variety through simultaneous backcrossing.
5. Use of biotechnology in genetic enhancement through marker-assisted selection, somatic hybridization and doubled haploids etc

Applications of pre-breeding in crop improvement:

1. Broadening the genetic base of crops which to reduce vulnerability to different biotic and abiotic stress.
2. Identification of important genes and transfer them from wild species to cultivated species helps them to cope with the changing climate.
3. Identifying desirable traits from exotic materials and transfer those genes into material which is more readily accessed by breeders.

Limitation of pre breeding

1. Lack of characterization and evaluation data make it impossible to use this accession in the pre breeding
2. Linkage drag: High degree of difficulty and length of time often associated with separating the desirable genes from the undesirable ones.

3. Cross incompatibility in inter-specific crosses is the major factors which limits the use of different species in transferring gene of importance across the species.
4. Restricted genetic recombination in the hybrid population.

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