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P-ZN INTERACTION IN GROUNDNUT-WHEAT CROPPING SYSTEM

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Introduction- Phosphorous (P) and zinc (Zn) deficiencies are widespread nutritional constraints on crop production in many parts of the world, and phosphorous-zinc interactions have been widely investigated (Marschner, 1995). Both the elements are important for obtaining more yields although they have antagonistic in nature to each other. This antagonism is known to cause yield reduction in many crops. Increasing the availability of P in the growth medium can induce Zn deficiency in plants by altering soil and plant factors *i.e* antagonastic effect, but little is known about specific mechanisms.

Zn and P are reported to interact either antagonistically or synergistically depending upon a number of physico-chemical characteristics of the soil. Application of higher doses or presence of higher levels of either of them in soil may reduce or enhance the availability of the other. Antagonism may be due to- increase negative surface charge on soil, high P induced less mychorrhizal root infection, slower translocation of Zn in plants, dilution effect *etc*.

Many studies have shown that a low Zn supply but a high P supply markedly enhance P concentration in plant tissues, which may cause P toxicity and contribute to symptoms resembling Zn deficiency (Loneragan *et al.*, 1982).

Causes of low availability of phosphorous are, nature and amount of soil minerals, soil pH, ionic effects, extent of P saturation, organic matter, temperature and agricultural management. Whereas causes of low availability of zinc are, water logging/flooding of soils, low zinc content in soil, soil with restricted root zones, soil pH, low organic matter, cool soil temperature, high P fertilization and zinc interaction with other nutrients.

Role of Phosphorous- Most essential function of P in plants is in energy storage and transfer. It stimulates root development necessary for the plant to get nutrients from the soil. Phosphorus is required for photosynthesis and also in the storage and transportation of the nutrients throughout the plant. It responsible for crop maturity at the right time. Legumes help in fixing nitrogen in the soil through their roots. This function cannot be carried out well without phosphorous which boost the development of the roots and essential element in DNA and RNA that contain genetic code of plant to produce proteins and other compounds. Deficiencies symptoms like plants are stunted and show purple tints on their dark green leaves, veins and stems. The older leaves affected first, often senescence prematurely. Plants with P deficiency are smaller than the normal and show purple tints on their middle of leaf blade. Leaf colour is a slightly paler than normal.

Role of Zinc- Zinc influences the activity of hydrogenase and carbonic anhydogenase, stabilization of ribosomal fractions and synthesis of cytochrome. Plant enzymes activated by Zn are involved in carbohydrate metabolism, maintenance of the integrity of cellular membranes, protein synthesis, regulation of auxin synthesis, chlorophyll synthesis and pollen formation. It is essential for the tryptophane synthesis. The regulation and maintenance of gene expression required for the tolerance of environmental stresses in plants are Zn dependent. Deficiencies symptoms like mature leaves exhibits irregular light brown lesions, bordered by a dark brown margin. Affected plants are paler in colour than the leaves have a purplish tint. Necrotic spots (often light brown with dark margin) occur on the older leaves. Internodes are stunted. Median leaves show interveinal chlorosis.

Groundnut-Wheat cropping system

In wheat-groundnut, maize- groundnut and mustard-groundnut cropping systems, the groundnut crop was observed to thrive on residual effect when wheat, maize and mustard received recommended fertilizer and the total monetary return in this sequence was higher when 75% recommended fertilizer was applied to both the crops.

Maliwal (1990) reported that in groundnut-wheat cropping system in calcareous soil, the P should be applied to groundnut at 13.2 kg P/ha and to wheat at 26.4 kg/ha every season for obtaining high yield and net profit. In groundnut-wheat rotation, there was no carry-over effect of N and very little response of P applied to groundnut on wheat crop. But the reverse was true in case of wheat-groundnut rotation. The groundnut as compared to wheat absorbs native P more efficiently and hence if 60 kg P_2O_5 /ha has been applied to wheat, there is no need of fresh P application to the following groundnut crop.

Arshad *et al.* (2016) revealed that the application of phosphorus @ 90 kg/ha along with zinc @ 15 kg/ha significantly increased the spike length (12.1 cm) of wheat. While, the plant height and straw yield were remaining significantly higher with combined application of phosphorus @ 90 kg/ha and zinc @ 5 kg/ha. The 1000-grain weight, grain yield and biological yield of wheat were significantly higher with combined application of phosphorus @ 90 kg/ha with zinc @ 10 kg/ha.

Iqbal *et al.* (2017) found that in saline-sodic soil, the control treatment gave significantly higher plant height (47 cm), number of tillers, 1000-grain weight (31.4 g/pot) and shoot dry weight (10.1 g/pot) of wheat, while Zn concentration in straw (55 mg/kg)) and grain (67 mg/kg) was higher in combined application of P @ 75 kg/ha and Zn @ 5 kg/ha.

Conclusion

From ongoing discussion, it is concluded that the application of phosphorous with zinc at optimum level produce synergestic effect but at higher level produce antagonistic effect on yield, yield attributes, content of nutrients in groundnut and wheat under groundnut-wheat cropping system.

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LITTLE MILLET- THE IMMUNITY BOOSTING INDIGENOUS GRAIN

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Millets are one of the oldest foods known to humans and possibly the first cereal grains to be used for domestic purposes. Millets are highly nutritious, no-acid forming and non-glutinous foods. Hence they are easy to digest. Millets have high content of minerals like iron, magnesium, phosphorus and potassium. In India the consumption of hardy millets has dropped exponentially since urbanization in rice and wheat. But millets could be the answer to fighting climate change and poverty, while being packed with nutrients. Little millet *(Panicum millare)*, one of the small millets, is called samai, kutki, sava and gajro. Little millet is suitable for people of all age groups. Little millet is grown throughout India and is a traditional crop. It is a relative of porso millet but the seeds of little millet are much smaller than porso millet. Samaidosa, porridge, paddu and payasam from little millet are a few traditional recipes in different millet growing states in India.

Nutritional facts:

Nutritional information on little millet versus other millets (per 100g of raw millet) expressed on dry weight basis.

Principle	Nutrient value
Energy (K cal)	329
Fat (g)	4.7
Carbohydrate (g)	67
Protein (g)	9.7

Fiber (g)	7.6
Iron (g)	9.3
Calcium (mg)	17
Phosphorus (mg)	220

- Little millet is fibrous millet, next to barnyard millet. According to research, some varieties of kodo millet and little millet have been reported to have 37% to 38% of dietary fiber, which is highest among the cereals.
- Like foxtail millet and barnyard millet, little millet is also high in iron.
- Little millet is high in fat, comprising majorly healthy polyunsaturated fatty acids (PUFA).
- The flavonoids present in the little millet act as antioxidants and play many roles in the body's immune defence system.

Health benefits:

- It is rich in phto-chemicals and it has excellent antioxidant properties
- ❖ Its dietary fiber protects against hyperglycemia
- ❖ It reduce cholesterol and helps in digestion
- ❖ Has nearly 2.5 times minerals, nearly 38 times fiber and 13 times iron than rice.
- ❖ Has nearly 6.3 times fiber and nearly 1.8 times iron than wheat
- ❖ Reduces chances of heart attack
- ❖ Protects from breast cancer
- ❖ Protects childhood asthma

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EPILACHNA BEETLE, *Epilachna vigintioctopunctata*: AN PEST OF BRINJAL

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Brinjal or eggplant (*Solanum melongena* L.) is an important solanaceous crop of sub-tropics and tropics. Brinjal is native of India and is grown throughout the country. It is an important vegetable grown in all the seasons. It is being cultivated in an area of about 733 thousand hectares in India with a production of 13510 thousand MT (Anon., 2019). Pests were found attacking on the crop were jassids (*Amrasca biguttula biguttula*), aphids (*Aphis gossypii*), white fly (*Bemisia tabaci*), leaf roller (*Eublemma olivacae*), shoot and fruit borer (*Leucinodes orbonalis*), epilachna beetle (*Epilachna vigintioctopunctata*), leaf webber (*Psara bipunctalis*) and grass hopper (*Chrotogonus* spp.). Among them, brinjal shoot and fruit borer (*L. orbonalis*) was recorded as major pest. Jassids (*A. biguttula biguttula* Ishida), aphid (*A. gossypii* Glov.) and epilachna beetle (*E. viginitioctopunctata* F.) were found to damage the crop moderately.

Epilachna beetle is genus of beetle in the family coccinellidae. Incidence of this pest was noticed in kharif season in the month of August to mid December. Natekar (1990) recorded that incidence of this pest occure for shorter period in summer brinjal, but severe infestation noticed on kharif crop up to August with the population level of 136 grubs/150 plants.

Distribution: Spotted beetles are distributed from East Asia to South Asia and Australia.

Alternate host: it is a common pest of various cultivated plants, including potato, brinjal, *luffa* sp. and other cucurbitaceous plants.

Marks of identification

- ✓ The adults beetle is spherical shaped, pale brown and mottled with black spots on elytra.
- ✓ There are two species reported: one having 12 spots, epilachna 12-stigma and another having as many as 28 spots, epilachna 28-punctata.
- ✓ Eggs are yellowish and cigar shaped
- ✓ The grubs are yellowish in colour and stout body with short spine like hair on the body.



Life cycle:

- ✓ Eggs: The females lay eggs mostly on the lower surface of leaf. Each female lays about 100-400 eggs. Eggs is spindle-shaped and yellowish in color. Eggs are laid in clusters of 10-40. The egg period was varied from two to five days.
- ✓ They hatch in 3 to 4 days and spiny, yellowish grubs start feeding on epidermis of leave. The larval stage lasts for 11 to 15 days. There are four stages of larva.
- ✓ Full grown grubs pupate on the leaves. The pupa resembles the grub but is mostly darker in colour, although it sometimes is yellowish in colour. The pupa bears spiny hairs on the posterior part of body. The pupa period is one to two weeks.
- ✓ The entire lifecycle is completed in 18 to 25 days during hot season and it may be as long as 50 days in winter.
- ✓ The pest has 7 generations in a year.

Nature of damage

Both the grub and adult of hadda beetle have chewing type mouthpart. They scrape the chlorophyll from the epidermal layer of leaves. This results to typical ladder-like window on leaf surface. The windows will dry and drop off, leaving holes in the leaves.

Management:

- ✓ Hand picking of grubs and collect the beetles by hand nets in the early stages of attack and destroy it.
- ✓ Grub, pupae and adults can easily be found on skeletonised leaves. Pick off these stages by hand and destroy it by manually.
- ✓ Choose resist genotype/cultivars available in the region. Varieties such as Arka shirish, Hissar selection 14 and Shankar vijay have been reported to be tolerant or resistant to epilachna beetle especially *E. Vigintionctopunctata.*
- ✓ Protect the population of parasitoids such as *Pediobius foveolatus* (Crawford). Reduced use of synthetic pesticides may enhance the actives of natural enemies.
- ✓ Release of parasitoids such as *Tetrastichus ovulorum* Ferr. and *Achrysocharis appannai* to the crop to parasitize the eggs of hadda beetle. For grubs *Solindenia vermai*, *Pleurotropis epilachinae*, *Tetrastichus* sps, *Uga menoni*, while pupa is parasitized by *Pleurotropis foveolatus*.
- ✓ Wood ash can be a good alternative for poor farmer or organic growers.
- ✓ Spay of Neem Seed Kernel Extract (NSKE) 5.0 per cent or neem oil 2.0 per cent at fortnightly intervals or make the solution of 1 lit of neem oil with 60 g of soap dissolved in ½ L. of water.
- ✓ In case of wide spread attack, the crop may be sprayed with suitable insecticide such as carbaryl 50WP (0.10%), fipronil 5SC and lamda cyhalothrin 5SC.

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APPLICATION OF TILLING AND ECO- TILLING IN CROP IMPROVEMENT BY INDUCED MUTATION

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What is Tilling ?

- **TILLING** (**Targeting Induced Local Lesions in Genomes**) is a method in molecular biology that allows directed identification of mutations in a specific gene or allele. TILLING was introduced in (McCallum *et al.* 2000) by using the model plant *Arabidopsis thaliana*. TILLING has since been used as a reverse genetics method in other organisms such as zebrafish, corn, wheat, rice, soybean, tomato and lettuce.
- TILLING is a general reverse genetic technique that combines chemical mutagenesis with PCR based screening to identify point mutations in regions of interest. TILLING is a powerful technology that employed heteroduplex analysis to detect which organism in a population carry single nucleotide mutation in specific genes.
- McCallum utilized reverse genetic approaches such as T-DNA lines and antisense RNA, but was unable to successfully apply these approaches to characterize CMT2.The approach that was successful turned out to be what is now known as TILLING.
- TILLING can also be used to detect naturally occurring SNP in genes among the accession, variety or cultivar. To study the gene function, or to detect genetic marker in population.
- TILLING methodology can also be used to uncover natural nucleotide variation linked to important phenotypic characters, a process termed EcoTILLING (Comai *et al*. 2004). The current status of various plant TILLING and EcoTILLING methods are generally applicable across the plant kingdom.

DNA sequence →	**Protein** →	**Phenotypes**

- To create an induced population with the use of physical/chemical mutagens is the first prerequisite for TILLING approach. Most of the plant species are compatible with this technique due to their self-fertilized nature and the seeds produced by these plants can be stored for long periods of time (Borevitz *et al.*, 2003).

Why Tilling ??

- Tool for functional genomics that can help decipher the functions of the thousands of newly identified genes.
- To identify SNPs and/or INS/DELS in a gene of interest from population.
- Genetic mutation is a powerful tool that establishes a direct link between the biochemical function of a gene product and its role *in vivo*.
- Non transgenic method for reverse genetics.

History

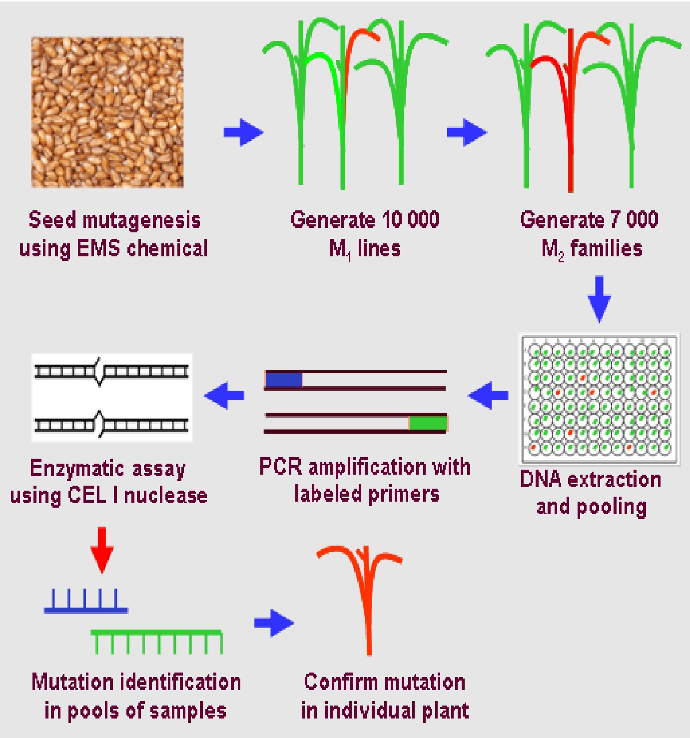
- TILLING first began in the late 1990's by a graduate student, Claire McCallum (and collaborators from Fred Hutchinson Cancer Research Center and Howard Hughes Medical Institute), who worked on characterizing the function of two chromomethylase genes in Arabidopsis (Henicoff *et al*., 2004).Claire McCallum utilized reverse genetic approaches such as T-DNA lines and antisense RNA, but was unable to successfully apply these approaches to characterize CMT2.
- The approach that was successful turned out to be what is now known as TILLING (Targeting Induced Local Lesions in Genomes). This was accomplished by pooling chemically induced mutagenized plants together, amplifying the region of interest, creating heteroduplexes among the pooled DNA, and performing dHPLC (denaturing high performance liquid chromatography) to detect the mutants by chromatographic alterations(McCallum *et al*., 2000).

The Basic Procedure

- TILLING is straightforward; for1) the creation of a large genetically diverse population of plants; 2) the high throughput identification of individual plants whose genotype predicts a phenotype of interest; and 3) the evaluation of these individuals' phenotypes for the accelerated development of novel cultivars that exhibit traits of interest.
- It combines random mutagenesis of seeds with an alkylating agent such as ethyl methanesulfonate (EMS) or other mutagenic agent with the targeted identification of induced alterations in the genes of interest.

Tilling In The Plant

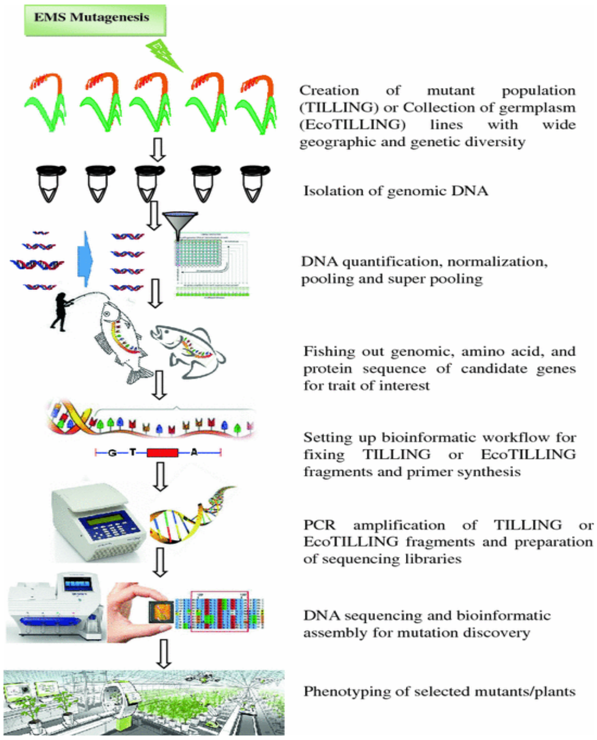
1. *Arabidopsis thaliana*: TILLING was first applied to Arabidopsis thaliana (McCallum *et al*.2000). A mutagenized population was created by treating seed with EMS, using the single seed descent method of plant breeding.



2. *Lotus japonicus* :Perry and colleagues adapted the TILLING method for the model legume *Lotus japonicus* (Perry *et al.* 2003). Seeds were treated with EMS similar to what was done for Arabidopsis.

3. *Zea mays*: As part of a NSF-funded research project to ascertain the suitability of plant populations for TILLING, the STP screened maize populations donated by Clifford Weil and Nathan Springer (Till *et al*. 2004).

4. Wheat : The feasibility of TILLING in a polyploid species was shown for wheat by Slade and colleagues (Slade *et al.* 2005). Starting with seed mutagenized with EMS, they developed TILLING populations in tetraploid and



hexaploid wheat.

5. Other Plant Species : The number of plant species in which TILLING has been successfully applied continues to grow. Caldwell and colleagues used a combination of denaturing HPLC and CEL I to identify mutations in barley (Caldwell *et al*. 2004). In collaboration with Tom Tai, the STP has developed TILLING for rice (Till *et al*. 2007).

Applications of Tilling

Major areas of applications are

- Functional genomics: The identification of numerous mutations in target region of genome. Construction of TILLING library is useful for scientists to search for mutations in gene of interest. TILLING offers a way to search target GOI in any crop of interest without first having knowledge of gene product.
- Genetic engineering: Agricultural interest in producing phenotypic variants without introducing foreign DNA of any type into plants genome. T-DNA/ Transposon insertions are used to obtain specific gene knockouts but practically limited to some crops only. TILLING is in front of transgene, as consists of identification of numerous mutations within a targeted region of whole genome.
- Evaluation of genetic diversity of natural populations: Alternative to wild relatives, TILLING is used to introduce useful genetic variation of elite germplasm. Also applicable in a population which has several pre-existing polymorphism for developing SNPs.

EcoTILLING

- The first publication of the EcoTILLING method in which TILLING was modified to mine for spontaneous polymorphisms was in 2004 from work in *Arabidopsis thaliana.*
- EcoTILLING is similar to TILLING, except that its objective is to identify **natural genetic variation** as opposed to induced mutations
- Many species are not amenable to chemical mutagenesis; therefore, EcoTILLING can aid in the discovery of spontaneous variants and their putative gene function
- This approach allows one to rapidly screen through many samples with a gene of interest to identify naturally occurring SNPs and / or small INs/DELS.

Merit

- Its applicability to virtually any organism.
- Its facility for high-throughput and its independence of genome size, reproductive system or generation time.

- Since it uses Chemical mutagenesis virtually all genes can be targeted by screening few individuals.
- High degree of mutational saturation can be achieve barring excessive collateral DNA damage.
- Eco- TILLING is useful for association mapping study and linkage disequilibrium analysis.
- Ecotilling can be used not only to determine the extent of variation but also to assay the level of heterozygosity within a gene.

Perspective

- TILLING and EcoTILLING have been proven to be highly effective reverse genetic tools for functional genomic studies in plants and animals. Since the inception of these techniques, many researchers have gained indispensable insight on gene function and have identified natural and induced variants.
- These methods are now well established for many model plant and animal systems regardless of their mating system, genome size, or ploidy level. TILLING is one of the few reverse genetic applications that has not been proven to be applicable in a species specific manner unlike other approaches (i.e.-RNAi or homologous recombination), which potentially makes this application available for all species.
- We demonstrate that high throughput TILLING is applicable to maize, an important crop plant with a large genome but with limited reverse genetic resources currently available.
- The main limitation for TILLING is that the species is capable of being mutagenized. So, for ethical reasons TILLING should not be employed for analyzing functional genomics in humans.

Conclusion

TILLING and EcoTILLING are high-throughput and cheap methods for the discovery of artificial mutations and spontaneous polymorphisms. The methods are general and have successfully been applied to many crop spcies. With sequence data and general tools such as TILLING, reverse genetics can be applied to lesser studied species. Now that successes have been found in a variety of important plant species, the next challenge to be use the technology to develop improved crop varieties in plant breeding. The utility of artificial mutations and spontaneous polymorphisms has already been established for plant breeding and hence the task is mostly one of implementation. Cost effective method than Genetic engineering and has no associated bio-safety issues. But the problem lies in the fact that the rate of induction of mutation is low, requires skilful labours and moreover a mutagenized organism must be kept alive long enough to screen mutant population in vegetatively propagated plant species.

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MAIZE :- AN IMPORTANT SOURCE OF HUMAN NUTRITION AND HEALTH

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Introduction

Maize (*Zea mays* L.) is an important cereal crop belonging to the grass family, Poaceae and is a native to South America. It is the third most important cereal crop in the world after wheat and rice with the production of 1211.64 mt and productivity of 5573 kg/ ha. from an area of 191.89 m ha. In India, it is cultivated in an area of 9.50 million ha with a production of 31.96 mt and the productivity of 3050 kg/ha. In Rajasthan, it is cultivated over an area 8,57,172 ha.in all 3 seasons with the production of 1.95 million tonn grains and productivity of 2285 kg per hectare (USDA, July, 2019).. Maize production has increased annually by 6% in Asia as compared to Latin America and 2.3% in Sub Saharan Africa. Maize grain is extensively used for feed purpose, 23% as food, and 7% for other purpose. It contains about 10 per cent protein, 4 per cent oil, 70 percent carbohydrate, 2.3 percent crude fiber, 10.4 percent albuminoides and 1.4 per cent ash (Shiferaw *et al.* 2011). However, now a day's corn grain is also a key raw material for making starch, glucose and oil (Singh *et al*., 2009). Corn starch is used to make sweeteners, as well as items such as disposable forks and spoons. Corn starch is widely used in industrial purposes such as coating for paper and paper products and wallboards for buildings. The pharmaceutical industry also uses corn starch to make pills and other similar products. Sustainable maize cultivation is continuously challenged by diseases that cause quantitative and qualitative losses in yield. Many fungal, viral and bacterial pathogens have been reported on maize apart from abiotic stresses. Some of very important and major maize diseases prevalent in Rajasthan are Post Flowering Stalk Rot (PFSR), Rajasthan Downy mildew, Turcicum leaf blight, Maydis leaf blight, Banded leaf and sheath blight, Curvularia leaf spot and Brown stripe Downy mildew. Some diseases also caused due to Bacteria, Nematodes and Viral pathogens.

Nutritional value of maize:-

Maize kernel is an edible and nutritive part of the plant. It contains vitamin C, vitamin E, vitamin K, vitamin B1 (thiamine), vitamin B2 (niacin), vitamin B3 (riboflavin), vitamin B5 (pantothenic acid), vitamin B6 (pyridoxine), folic acid, selenium, N-p-coumaryl tryptamine, and N-ferrulyl tryptamine. Potassium is a major nutrient present which has a good significance because an average human diet is deficient in it. Roasted maize kernels are also used as coffee substitute. Maize germ contains about 45–50% of oil that is used in cooking, salads and is obtained from wet milling process. The oil contains 14% saturated fatty acids, 30% monounsaturated fatty acids, and 56% polyunsaturated fatty acids. The refined maize oil contains linoleic acid 54–60%, oleic acid 25–31%, palmitic acid 11–13%, stearic acid 2–3% and linolenic acid 1% (Kumar & Jhariya, 2013). The two main forms of vitamin E present in our diet are alpha (α) and gamma (γ) tocopherols. Maize oil is amongst the rich sources of these tocopherols, especially γ-tocopherol and their reported concentration was 21.3 and 94.1 mg/100 g, respectively. Maize silk contains various constituents essential for our diet such as maizenic acid, fixed oils, resin, sugar, mucilage, salt, and fibers.

Health benefits of maize:-

Maize has various health benefits. The B-complex vitamins in maize are good for skin, hair, heart, brain, and proper digestion. They also prevent the symptoms of rheumatism because they are believed to improve the joint motility. The presence of vitamins A, C, and K together with beta-carotene and selenium helps to improve the functioning of thyroid gland and immune system. Potassium is a major nutrient present in maize which has diuretic properties. Maize silk has many benefits associated with it. In many countries of the world such as India, China, Spain, France and Greece it is used to treat kidney stones, urinary tract infections, jaundice, and fluid retention. It also has a potential to improve blood pressure, support liver functioning, and produce bile. It acts as a good emollient for wounds, swelling, and ulcers. Decoction of silk, roots, and leaves are used for bladder problems, nausea, and vomiting, while decoction of cob is used for stomach complaints. The presence of essential fatty acids, especially linoleic acid in maize oil plays an important role in the diet by maintaining blood pressure, regulating blood cholesterol level, and preventing cardiovascular maladies. Moreover a tablespoon of maize oil satisfies the requirements for essential fatty acids for a healthy child or adult. Vitamin E in maize oil which is known as a key chain breaking antioxidant prevents the promulgation of oxidative stresses in biological membranes and prevents the development of atherosclerosis through intervention of maize oil in the diet.

Composition per 100 g of edible portion of maize (Source: Shah, (2016)

Carbohydrate	71.88 g
Protein	8.84 g
Fat	4.57 g
Fiber	2.15 g
Ash	2.33 g
Moisture	10.23 g
Phosphorus	348 mg
Sodium	15.9 mg
Sulfurr	114 mg
Riboflavin	0.10 mg
Amino acids	1.78 mg
Minerals	1.5 g

Calcium	10 mg
Iron	2.3 mg
Potassium	286 mg
Thiamine	0.42 mg
Vitamin C	0.12 mg
Magnesium	139 mg
Copper	0.14 mg

However the damage caused due to diseases and insects can be reduced through the conscientious use of an integrated disease program. Use the following practices to reduce harvest losses:

(1) Plant well adapted disease-resistant hybrids

(2) Follow a balanced soil fertility program

(3) Control insects

(4) Plant at the proper rate

(5) Avoid stress through proper irrigation, soil management, and foliar disease and weed control.

(6) Practice regular field scouting.

(1) Disease-Resistant Hybrids Corn growers should select high yield potential hybrids that also have stalk rot resistance, leaf disease resistance, and good standability. Full-season hybrids are generally more resistant than those that mature early in a given area. Resistance to the fungi that cause stalk rots helps prevent losses from premature plant death and lodging. Many resistant hybrids are available. Most hybrids, however, are only resistant to the organisms causing Diplodia, Gibberella and Fusarium stalk rots. Hybrids that are resistant to these fungi may be highly susceptible to anthracnose stalk rot. Hybrids resistant to anthracnose may be somewhat susceptible to other stalk rot fungi. Thus, it is important to know which organisms are causing major stalk rot damage in an area and to which stalk rot fungi a hybrid is resistant. In addition to stalk rot resistance, growers should select hybrids resistant to foliar diseases important in their area. Resistance to leaf diseases is important since loss of leaf area can predispose the corn to stalk rot problems. Hybrid standability is another factor that should be considered. Hybrids with thick rind or other characteristics that increase standability often remain standing even though the interior of the stalk is thoroughly decayed. Corn producers should check out such characteristics before selecting a particular hybrid. It is often worthwhile to tour local hybrid strip plots to check on the susceptibility of various hybrids to stalk rot. Up-to-date information on the yield performance and lodging of many hybrids is also available in the latest issue of the U.K. publication "Kentucky Hybrid Corn Performance Test." Balanced Soil Fertility Balanced soil fertility, particularly with respect to potassium, is important.

(2) Fertilizer should be applied based on the results of soil tests. Recent research has shown the importance of an adequate supply of nitrogen throughout the season in reducing the severity of

stalk rot. In areas where leaching or denitrification is expected, the use of a nitrification inhibitor may help reduce stalk rot.

(3) Insect Control Control of insects such as the European corn borer and the northern and western corn rootworms is important in reducing stalk rot losses. Corn growers should follow the "Insect Management Recommendations for Field Crops and Livestock" published annually by University of Kentucky Extension entomologists. The use of scouting procedures will greatly help identify if and when insecticides should be applied for maximum benefit.

(4) Proper Rate of Planting Corn growers should plant at populations suggested for the particular hybrid, soil type, fertility level, available soil moisture and productivity potential in a given field.

(5) Planting at "excessive" rates can result in spindly stalks with reduced standability. Growers should consult seed-corn handbooks for suggestions on planting rates for hybrids. Stress Reduction Timely irrigation (where possible), weed and nematode control, and other stress reducing practices are important in controlling stalk rot damage.

(6) Field Scouting Monitoring fields on a weekly basis are the best way to determine pest levels in a field. Corn producers should begin to scout fields for stalk rots (lodging potential) when the corn kernels contain 30 to 40 percent moisture. An effective scouting procedure is to walk a zigzag pattern through the field while pinching the stalks (of at least 100 plants) between two lower nodes to check for firmness. An alternate procedure is to push a similar number of random plants 8 inches from the vertical and estimate the ease of lodging. If more than 10 to 15 percent of the plants have spongy stalks or appear to lodge easily, it would be beneficial to harvest the field early to prevent potential harvest losses. The same procedure can also be used to assess hybrids in strip plots. Growers should also check the extent of premature plant kill when inspecting strip plots **(Vincelli, Paul and Hershman, 1985).**

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ADVANCES MICRO-IRRIGATION IN HORTICULTURE CROPS

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Abstract: In arid and semi-arid regions, irrigation improves economic returns and can boost production by up to 400%. On the other hand, the major problems on conventional (surface irrigation) irrigation for arid and semi arid region are soil salinity, soil alkalinity, soil dispersion, soil infertility, rise of water table and pollution of the surface and underground resources due to over-irrigation practices and over-application of chemical agri-inputs. Thus, Turkey has been made considerable an effort to convert from conventional irrigation systems to modern irrigation systems for the last decade. The rate of pressurized irrigation systems in Turkey increased to 5% from 20% by the support of the government, recently. Ministry of Agriculture, Food and Livestock have compensated 50 % of the all investment cost for the pressurized irrigation systems since 2007. Considering the positively effects of micro irrigation on water saving, liters of consuming water per kilo of crop by surface irrigation for cotton, alfalfa, corn, winter wheat, and water melon in semi arid region of Turkey were 2801, 1200, 943, 846 and 83, respectively. Whereas, liters of consuming water per kilo of crop by drip irrigation for cotton, corn and water melon are 1515, 474 and 68, respectively. Thus, the amount of irrigation water of 5 000-6 000 m^3 per ha are used in the modern irrigation systems (micro irrigation) while water more than 10 000 m^3 per ha are used for conventional irrigation. This paper presents impacts of micro-irrigation technologies in terms of crop water consumptive use, crop yield, environment, effective fertilizer use, sustainability and incomes for modern agriculture in Turkey and around the World.

Keywords: Environment, micro irrigation, sustainability, water saving

1. Introduction

Use of water in agriculture is very important for agricultural production and to decrease risk of drought. Global water use in agriculture is approximately 70% in not only Turkey but also in the world. The irrigation sector is under pressure to increase its efficiency since it is the major user of fresh water globally. This is exacerbated as water resources become scarcer due to climate change, increasing population and inappropriate-

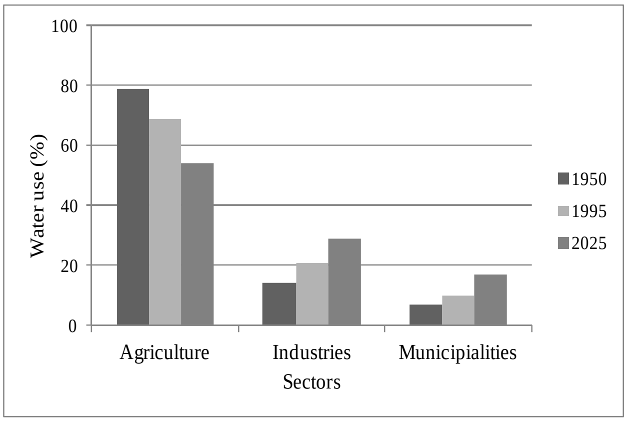

Figure 1.Estimated global water withdrawals (Mohtadollah and Bhatiya., 1994.)

-irrigation applications, and as the competition for water from other economic and environmental uses. In the future, improved efficiency in the use of water for food production will become even more important. The amounts water used for industries and municipalities will increase while it for the agriculture decreases in future (Fig. 1).

In order to increase the contribution of irrigation on food production, FAO says, what is needed is improved efficiency in the use of irrigation water (FAO, 2003). A major advantage of water-saving technologies, particularly drip irrigation, is that as well as saving water they can increase yields and reduce the rate of salinization. Furthermore, since neither system brings water into contact with foliage, they can be used with brackish water for crops that are not too sensitive too salinity (Cetin, 2004.).

Several government and non-government organizations are actively promoting micro-irrigation in developing countries (Varma et al., 2006). Since the agriculture is an important sector of Turkey's economy, the Government pays much attention to irrigation infrastructure investment and irrigation management within the framework of integrated water management concept (Gündoğdu, 2013). Thus, use of pressurized irrigation systems has recently increased in Turkey. Ministry of Food, Agriculture and Livestock have compensated 50 % of the all investment cost for the pressurized irrigation systems since 2007 (Cetin *et al*., 2010). Micro-irrigation, is an irrigation method which saves water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters**.**

Why micro-irrigation is necessary

- To improve the productivity of irrigated land
- To improve use-efficiencies of water, energy, nutrient and human efforts in agriculture
- To conserve scare resources such as water and electricity
- To extend the benefits of irrigated agriculture to more people with the available water
- To facilitate better crop management through fertigation and chemigation.

Principles of micro-irrigation

- Water is applied directly to the root zone of the plants.
- Water is applied at frequent intervals at precise quantities
- Water is applied through a low-pressure pipe network comprising Mains, Submains, Laterals and Emitting Devices

Advantages of Micro Irrigation

• Crop Yield Enhancement	• Reduced Labour Costs Suitable for Marginal lands
• Improves Soil Health	• Suitable for inferior quality water
• Reduced Weed Growth	

Types of micro irrigation

1.Sprinkler irrigation system 2. Micro sprinkler/ spray irrigation 3. Drip irrigation

1. Sprinkler irrigation

Refers to the application of water to crops in the form of spray from above the crop like rain.

- Conveys water from the source through pipes under pressure to the field and distributes over the field in the form of spray of “rain like” droplets

Adaptability of sprinkler system

• Sandy soils with high infiltration rate.	• Shallow soils that do not allow proper land leveling.
• Areas with steep slopes having erosion hazards.	• When light and frequent irrigations are to be given.
Merits of sprinkler	
• Highly suitable for sandy, shallow and steep soils.	• 5 per cent land saving.
• 25-50 per cent saving in irrigation water.	• Prevent the frost damage
• More uniform water application than surface irrigation.	

2. micro spray irrigation

- Small sprinkler like devices called micro sprinkler, sprays water over soil surface in the root zone.
- Micro sprinklers can be located like emitters.
- Discharge rates are usually 12-200 l ha-1.
- Micro sprinkler normally require 35-300 Kpa of pressure for proper operation.
- Wetted diameter from 2-9 meters..

3. Drip irrigation

- Drip irrigation is defined as the precise, slow application of water in the form of discrete or continuous or tiny streams of miniature sprays through mechanical devices called emitters or applicators located at selected points along water delivery lines.
- Efficient method of providing irrigation water directly into the soil at root zone of plants.
- Permits the utilization of fertilizers, pesticides and other water soluble chemicals .

Table 1. Drip and surface irrigation- water saving and increase in yield (Shah, 2011)

Crop	Yield (kg ha^{-1})			Irrigation		
	Surface	Drip	Increase (%)	Surface	Drip	Saving (%)
Bet root	570	880	54	86	18	79
Bitter gourd	3 200	4 300	34	76	33	57
Broccoli	14 000	19 500	39	70	60	14
Chili	17 100	27 400	60	27	18	33
Cucumber	4 230	6 090	44	109	42	62
Okra	15 500	22 500	45	54	24	56
Onion	28 400	34 200	20	52	26	50
Potato	17 200	29 100	69	60	28	54

Merits of drip system

• 30-70 per cent water saving	• 44-47 percent saving in energy
• 30-100 percent increase in yield	• Saves labour cost
• 40-60 per cent savings in fertilizer and chemicals	• Improved water penetration
• Better quality of crop	• Poor quality water can be used safely
• Eco-friendly technology	

Stepping Stone

The Government of India has launched Centrally Sponsored Scheme on Micro-irrigation during the IV year (Jan., 2006) of the X Plan making provision for 40 per cent assistance from Central Government, 10 per cent assistance from State Government and the rest of 50 per cent to be borne by the farmer either through his own resources or soft loan from financial institutions.

Future thrust

- Enhancing water-use-efficiency and reaching water to the un-reached areas must be the guiding principle of the promotion of micro-irrigation.
- It must be viewed as an integral part of comprehensive water management strategy.
- The approach must be to produce more and more from less and less water.
- The investment and funding arrangement should consider micro-irrigation as an important infra-structural development.
- Micro-irrigation should be made compulsory in the command areas of new irrigation project.

- There is need to introduce a policy of “no lift without drip” to ensure benefits to large number of farmers with the same amount of water.

Conclusion

- More than 95 per cent of irrigated area in our country is under surface irrigation but the overall irrigation efficiency for surface irrigation is too low
- Considerable progress has been made in the past towards understanding the problems associated with management of irrigation command
- Shift to micro-irrigation requires additional funds, change in infrastructure such as construction of water storage facilities under canal commands and regular dependable supply of electric power
- The success or failure of micro-irrigation system depends to a large extent on careful selection, thorough planning, accurate design and effective management
- Surface irrigation will still dominate as the primary irrigation method, but with the current trends, the area under micro-irrigation will continue to expand

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ROLE OF RADIOISOTOPES IN AGRICULTURE

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Abstract

Radioisotopes emit some extraordinary types of energy in form of rays (alpha, beta and gamma), which are very helpful to human beings in minute quantity. These rays are invisible spontaneous and penetrating. Their presence can be easily detected with the help of the latest devices such as Geiger Muller and Scintillation Counters. These instruments are used for the detection of even, the very tiny or minute quantity of radioactive element present. Thus, new tiny tool radioactivity is proving very helpful in several fields of daily uses such as medicine, agriculture and industry. Presently, the radioisotopes are being widely used in the field of agriculture than in any other field of science and their application is leading us to the solution of many agriculture problems in a shorter time and more precisely. Thus, radioisotopes have become a very important aid to scientists dealing with the solution of agricultural problems. In addition to this, radioactive tracers and radiation sources have become indispensable to all the intricate agricultural research problems. Radioisotopes and radiations give us the chance to clear the events that once were mysterious in the nutrition and growth of plants and evolution of new crop varieties. They help us to clear the casual factors, which produce ill-effects to the plants in different ways.

Introduction

Stable isotopes do not undergo radioactive decay and unstable (radioactive) isotopes can easily undergo changes, transforming them into other isotopes of the same or different elements. Unstable isotopes undergo radioactive decay and stability depends on composition of nucleus. Radioisotopes are used as a research tool to develop new strains of agricultural crops that are drought and disease resistant, higher quality, have shorter growing time and produce a higher yield. Radioactive elements emit a variety of radiations and energy particles during decay which are used in health care, agriculture and physical sciences for basic research and in wide range of applications (Sahoo and Sahoo, 2006). Applications of Radioisotopes and radiations are helpin gus to find the solution of problems in much shorter time (Singh *et al.*, 2013). Radioactive exposure improves quality and productivity of agricultural products alongwith insect, pest and disease management. They are helpful in study of optimum utilization of fertilizers, insecticides and pesticides in cultivated crops without harmful effects to plants and other living organisms. Radioisotopes have played an important role in improving productivity in agriculture in a sustainable manner. Ionizing radiation is very useful for preservation of agricultural and food products. Many products used in our daily life have in some way benefited from radiation during their production. Radioisotopes and controlled radiation are now used in a variety of studies like crop improvement, food preservation, determine groundwater resources, sterilize medical supplies, analyze hormones, X-ray pipelines, and control industrial processes and to study environmental pollution. It is being in the fields of irrigation and crop production, soil fertility, insect and pest control, livestock production, health and food preservation. Improvement of agriculture is one of the most significant contributions that atomic energy can make to meet the challenge of food security for present and future generation, to conserve natural resources and to protect the environment.

To obtain an increased yield from the soils by applying fertilizers, one has got to determine the fertility status of the soil, which appears to be unproductive. Radioactive phosphorus is used in most of the investigations that are carried out to determine the P-status of the soils. Several problems can be solved by this study such as comparison of various fertilizers, influence of particle size, placement, and time of application, doses, absorption by plants and the reaction of the applied fertilizer in the soil. By using radioactive phosphorus research workers have succeeded to distinguish between soil phosphorus and the fertilizer phosphorus, taken by the plants. Radioisotopes like Fe, Mn, K, Ca, N, Rb, C, Cs, Si and Sr etc. and other macro and micro-elements have also been used by workers in order to find out their movement in different types of soils and also their position in different clay fractions of the soils. The radioisotope method is very reliable and helpful in determining fertility level of soil. Thus, the application of radioactive elements in agriculture has received tremendous importance in interpreting certain aspects of soil fertility and other intricate problems. Radioisotopes have also helped the investigation of the effect of such factors as cultivation, irrigation methods and time on the root system of plants.

Recent studies with radioisotopes have also shown that with many crops, supply of plant nutrients through the leaves is more quick and effective than the application in soil. For example, it has been found that a nutrient, which is hardly absorbed upto 10% by root, can be absorbed upto 90% when applied on leaves. Experimentally, it has been found that the absorption of nutrients by leaves takes place not only during the day time but also at night time. Through isotope technique it is possible not only to determine the amount of nutrient that are taken by plants, but it also gives the opportunity to know about their movement and their places of accumulation. In the plants, mostly radio phosphorus has been used for this kind of research works and the results have shown that absorption speed of this nutrient was more than the expected. Stable Isotope studies allow researchers to understand nitrogen fixation in the atmosphere, in plants and other organisms, and in industrial processes. Radioisotopes and radiation is used in mutation induction. Mutation is a sudden heritable change on the chromosomes of the organisms. The employment of radiation to induce hereditary variants is a useful tool of potential value in agriculture and it creates variability in the plants which are useful in plant improvement. Radioisotopes and ionizing radiations are of inestimable value for obtaining an insight into ecological habits of insects. With the aid of radioisotopes we can find out population density, the maturity rate during different stages of the life cycle, modes of dispersal, movement and migration, flight range hibernating places, egg living sites relation to predators, parasites, feeding, mating habits and disease transmission etc.

What is Isotope

Isotopes are two or more forms of the same elements that contain the same number of protons but different number of neutrons. This makes them different in relative atomic mass but not chemical properties.

Importance of radioisotopes in agriculture

In agriculture, radioisotopes are used in the nutritional studies of major and minor elements, milk production, mechanism of photosynthesis studies, plant protection, plant pathology, action of insecticides, uptake of fertilizers, ions mobility in soil, and plants and food preservation. In order to determine the correct nutrition for a plant we need to know the exact soil plant relationship and the factors involved therein.

1. **Plant nutrition studies**

Fertilizers are very expensive and their efficient use is of great importance to reduce the production cost of agricultural crops. It is essential that a maximum amount of fertilizer used during cultivation finds its way into the plant and that the minimum is lost. Radioisotopes are very useful in estimating the amount of phosphorus and nitrogen available in the soil. This estimation helps in determining the amount of phosphate and nitrogen fertilizers that should be applied to soil. Crop requires nutrient elements for growth and development and these requirements can be substituted with radioisotopes of the same elements. The usages of the fertilizer can be tracked through plant's structure and gives better understanding to the farmers, how much fertilizer is required by a plant and how much is lost to the environment. Fertilizers labeled with radioactive isotopes such as phosphorus-32 and nitrogen-15 have been used to study the uptake, retention and utilization of fertilizers.

Phosphorus-32 is used in plant sciences to track the intake of fertilizer from the roots to the leaves. When Phosphorus-32 labeled fertilizer is given to plants through water in the soil, the usage of the phosphorus can be mapped through the emitted beta radiation. With the help of the information gathered from mapping the fertilizer intake, it is easier to understand how a plant takes up and uses the phosphorus from the fertilizer. However, Phosphorus-32 is quite harmful so many precautions must be taken with its use.

Nitrogen-15 is a rare stable isotope of nitrogen. In agriculture, botanists use N-15 to track the movement and absorption of fertilizer by plants. When the isotope is mixed into the fertilizer and monitored, we are able to understand how effective the fertilizer is with the growth of the plant. With the ability to track the usage of nitrogen in plants in order to be given the proper levels of fertilizer, the risk of pollution being added to ground water from excess nitrogen is decreased.

2. **High Production**

Since the use of isotopes gives the ability to track the amount of fertilizers plants use, this also allows farmers to provide the plants with the right amount of nutrients and promoting maximum production. This increases the production and quality of the produces.

3. **Genetic diversity**

Exposure of radiation on seed, bud and tissue are used to improve the genetic constitution of plants. When new kinds/variants of crops are created, they become more resistant to pests and more adaptable to harsh climatic conditions. Radiation creates mutations in plant breeding produces new genetic lines.

4. **Crop improvement**

Genetic variation of useful traits is very important for improvement of any crops. Different types of radiation can be used to induce mutations (Sood *et al.*, 2010) to develop desired mutants line that are resistant to disease, are of higher quality, allow earlier ripening, and produce a higher yield**.** X-rays, gamma and neutron radiation were employed as ionizing radiations. This technique of utilizing radiation offers the possibility of inducing desired characters that either cannot be found in nature. A proper selection of mutant varieties can lead to improved quality and productivity.

5. **Insect pest management**

Insect pests are responsible for significant reduction in production of agricultural crops throughout the world (Alphey, 2007). They not only reduce crop yields but also transmit disease to cultivated crops. Radiolabel pesticides are used to monitor the persistence of their residues in food items, soil, ground water and environment. These studies have helped to trace and minimize the side effects of pesticides and insecticides. The continuous uses of pesticides have negative impacts on the environment and it also results into development of resistance against pesticides in many insect species. Moreover, pesticides not only kill target species but also many other beneficial insects species responsible for maintaining natural ecological balance in the crop fields.

Ionizing radiation can be used in Sterile Insect Technique (SIT). Ionizing radiation can be employed as a means to effectively sterilize male insects without affecting their ability to function in the field and successfully mate with wild female insects. This technique involves release of large numbers of sterile male insects of the target species in the field crop. Sterile male insects compete with the regular male population during sexual reproduction and the eggs produced from their mating are infertile so they produce no offspring. It has been successfully used to eradicate several insect pests of agricultural significance throughout the world.

6. **Food processing and preservation**

About 25-30% of the world's food produce are lost due to spoilage by microbes and pest and these losses are more in developing countries. This loss of food can be avoided by employing radiation. It can be used to destroy microbes in food and control insect and parasite infestation in harvested food to prevent various kinds of wastage and spoilage. Extension of shelf life of certain foods for few days can be achieved by irradiation. It can alleviate the world's food shortage by reducing post-harvest losses. Food irradiation can drastically reduce the use of food additives and fumigants but these are hazardous for consumers as well as workers in food processing industries. Irradiation does not heat the food material so food keeps its freshness in its physical state. The agents which cause spoilage (microbes, insects, etc.) are eliminated by irradiation from packaged food and packaging materials are impermeable to bacteria and insects so recontamination does not take place. Irradiation of food kills insects and parasites, inactivate bacterial spores and moulds, prevent reproduction of microbes and insects, and inhibit the sprouting of root crops, delays ripening of fruits. An average dose of 10 kGy causes no toxicological hazard in the products.

Application of radioisotopes in agriculture has following advantages:

- ✓ With the help of radioisotopes we can easily locate the presence of a single atom and molecule and their movement. Hence, they give research workers the opportunity to follow up step by step all kinds of processes that are related to the nutrition of plant from germination to maturity.
- ✓ Very small quantities of labelled nutrients can be accurately measured in presence of large quantities of other nutrients.
- ✓ The location of materials can be identified by radio-autography.
- ✓ Tracer technique enables one in tracing those elements taken by the plants accurately and precisely.
- ✓ It also helps to study accurately the effect of one element upon the absorption of another and their interaction by plants and now it has become very easy to study properly the phenomenon of interaction among the mineral nutrients.

Conclusion

The heavy application of hazardous chemical in agriculture right from seed sowing to till consumption cause soil and water pollution, unbalance in micro flora, many diseases in human and animal. In such condition, we have to look alternate way of solution like use of radioisotopes. Radioisotopes can be utilized in wide range of agricultural applications. Radioisotopes can be used for producing high yielding crop seeds, for determining the function of fertilizers in different plants, for killing insects, for longer shelf life of cereals, fruits, vegetables and canned food. It helps to find the solution of problems in much shorter time. Today, higher production of radioisotopes by nuclear reactors and other atomic installations have increased the use of radioisotopes in the field of agriculture as India is a leading producer of radioisotopes in the world.

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APOMIXIS –GENETICS AND ITS APPLICATION

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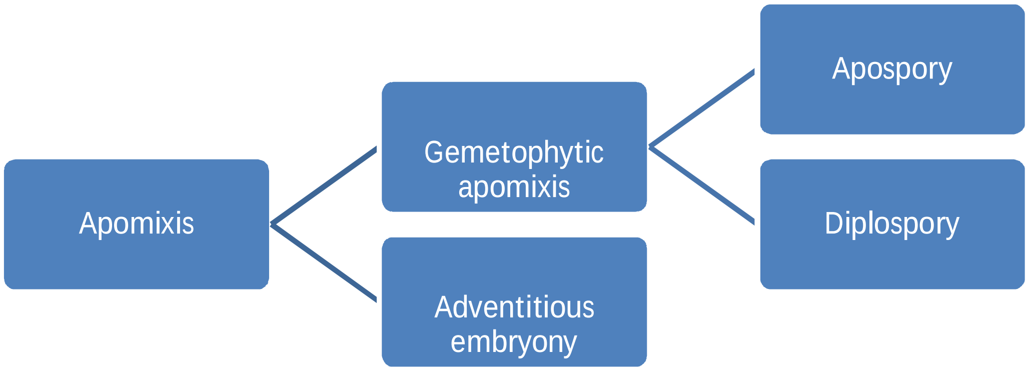
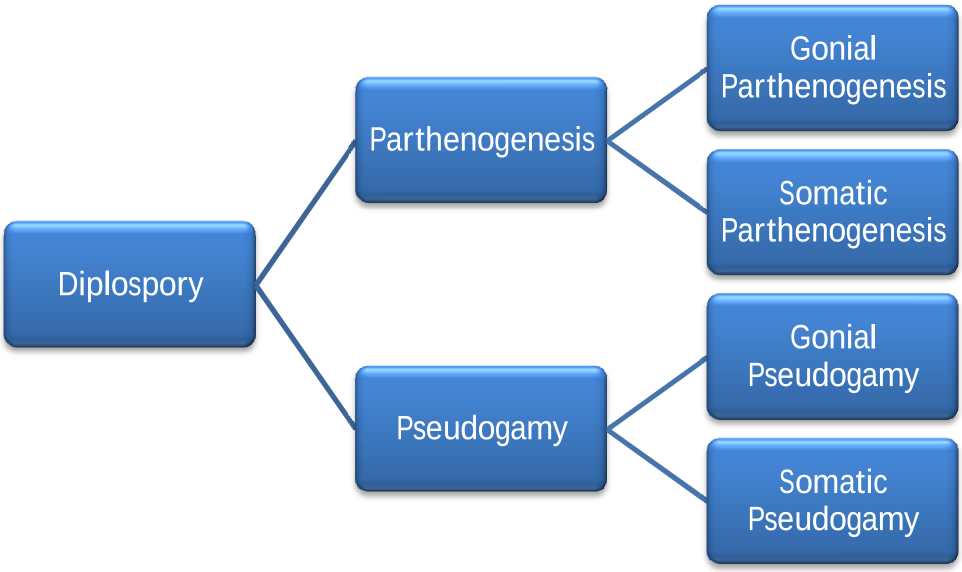
Apomixis is the mechanism of development of embryo and seed,bypassing meiosis and fertilization. It is of two types- facultative apomixis and obligate apomixis. Facultative apomixis is found in Kentucky bluegrass (*Poapratensis*) and guinea grass (*Panicum maximum*) while obligate apomixis is found in Bahia grass (*Pennisetumnotatum*) and Buffel grass(*Cenchurusciliaris*). On the basis of embryo development, it is classified into recurrent apomixis and non-recurrent apomixis. If the embryo arises from diploid cell it is called as recurrent apomixis while if it arises from a haploid cell it is called as non-recurrent apomixis.The progenies of apomictic species are identical in genotype to the mother plant and usually associated with interspecific hybridization and polyploidy.They are usually perennial in nature and derived from strongly outcrossing ancestors. In general, facultative apomixis is more common than obligate apomixis.Apomictic species occur more frequently in Compositae, Rosaceae and Graminae families and are preferably male fertile and self-incompatible and reproduce via pseudogamy.

Genetics of Apomixis

Apomixis is generally governed by one or two genes which may be dominant or recessive in nature. In *Pannicum* and *Citrus*, it is governed by single dominant gene while in *Partheniumargentatum*it is governed by four genes that are recessive in nature. Apart from, intragenic interactions, these genes also show epistatic effect e.g. obligate apomixis showinhibitory gene interaction. In general, apomixis should be dominant to sexual reproduction. The progenies obtained from plants of cross pollinated apomictic species are identical to maternal genotype with limited or no genetic variation observed in F_2 individuals. In these progenies aneuploid chromosome number or structural heterozygosity remain constant from parents to offspring. Alike, sexual reproduction, apomixis is a result of mechanism which is comprised of three developmental components, the first one being apomeiosis i.e. bypass of meiosis during embryo sac formation, the second being parthenogenesis i.e. development of an embryo independent of fertilization, andthird being, formation of viable endosperm either via fertilization-independent means or following fertilization with a sperm cell. In several species, loci genetically linked to apomixis have been identified and sequenced which revealed a number of genes with the potential to have critical roles in apomixis. Several genes have been transferred from wild to cultivated species eg. from*Tripsacum*to maize, *Beta trigyna* to *Beta vulgaris* and from *Elymus*species to bread wheat. It may be induced artificially or isolated as a segregant in interspecific hybridization.





Applications of apomixis

The genetics of apomixis has significant importance from perspectives of crop improvement and it promises to be a better tool because of its potential role if it can be utilized purposefully in plant breeding programmes. Apomixis could be utilized effectively in crop improvement programmes in following ways-

- Fixation of heterosis via apospory and diplospory
  - For fixation of heterosis a sexually reproducing line is used as female while an apomictic line is used as male for hybridisation and thus apomictic hybrids are obtained, which are maintained and multiplied through apomictic seeds.
- Production of Homozygous lines
- Production of hybrids

- In Production of vybrids a facultative apomictic line is used as female and hybridized with another facultative apomictic line that is used as male and hybrids thus obtained are vybrids.

- Maintenance of superior genotypes
  - By means of apomixis the progenies bred true for maternal traits, thus the superior genotypes could be maintained for longer durations without any significant change in their genetic constitution.

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FRUIT AND SHOOT BORER (FSB) *Leucinodes orbonalis* Guenee: A MAJOR PEST OF BRINJAL

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Vegetables are important source of income for the rural population. Brinjal, *Solanum melongena* L, is one such typical vegetable and its commercial cultivation not only helps to improve human nutrition, but also increase income generation for the grower. Brinjal is an important vegetable crop of nutritional and ayurvedic medicinal value. The major insect pests of brinjal are fruit and shoot borer, *Leucinodes orbonali*, Jassids, *Amrasca biguttula biguttula*, Epilachna beetle, *Epilachna vigintioctopunctata* Fab., Whitefly, *Bemisia tabaci* Genn., Aphids, *Myzus persicae* Sulz. Chemical control is widely used for managing insect pests in brinjal. Repeated use of synthetic chemicals creates environmental contamination, bioaccumulation and biomagnification of residues and disturbance in tropic level of ecosystem. Further it has been reported that due to indiscriminate use of insecticides, shoot and fruit borer has developed resistance to the many insecticides. In addition, the residues of chemical pesticides on the economic parts are more than tolerable level. Hence, there is an urgent need to look for alternate and safer method to manage this pest.

Brinjal fruit and shoot borer (BFSB)

Brinjal shoot and fruit borer (Lepidoptera: Pyralidae) is the most damaging insect pest. This pest is active throughout the year at places having moderate climate but it is adversely affected by severe cold. It is found throughout the tropics in Asia and Africa, where it can reduce yield by as much as 70%. Hence, the farmers in the region rely exclusively on the application of chemical insecticides to combat shoot and fruit boere, which has resulted in a tremendous misuse of pesticides in an attempt to produce damage-free marketable fruits. Despite intensive insecticide applications, the pest cannot be controlled due to its resistance to commonly used pesticides.

Biology This pest complete its life cycle with four different stages *viz.*, egg, grub, pupa and adult.

Eggs:

Adult laid eggs singly or in batches. Single female could lay 5 to 242 eggs during entire lifespan Females lay eggs on the lower leaf surface, flowers and calyx. Eggs are oval or elongated in shape and creamy white in colour. The egg period is 3 to 5 days.

Larva:

The larva is creamy white to pinkish in color. The fully grown-up larva are pinkish in colour with sparse hairs on the warts on the body and blackish head. The larva usually has five instars, sometimes six. The larval period is about 12-14 days.

Pupa:

The larva pupation takes place on plant debris on the soil surface. The pupation occurs in silken cocoon. The pupal period varies from 7 to 10 days.

Adult:

The moth is white or dirty white with pale brown spots on the dorsum of thorax and abdomen. Wings are white with brown and red spots on the forewings. The female moth tends to curl its abdomen upwards. The adult life span is 5-7 days.

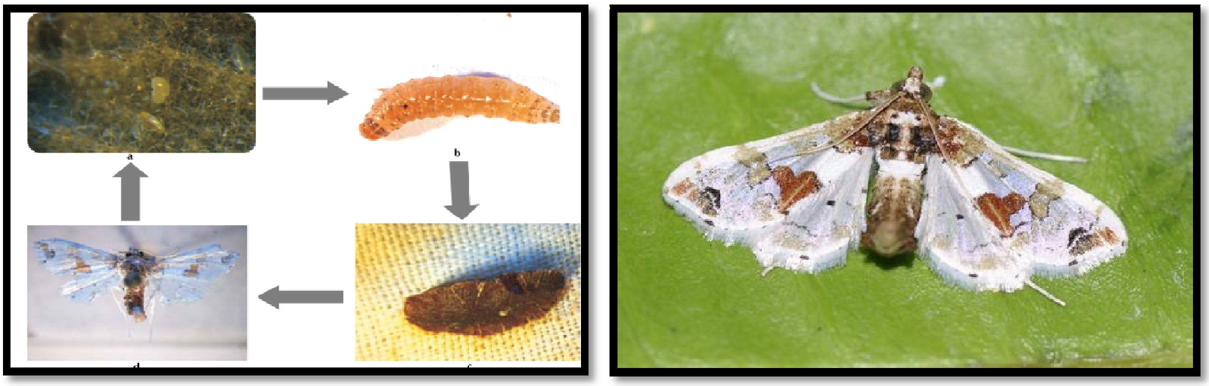

Fig. Different stages of brinjal fruit and shoot borer

Damage symptoms

Just after hatching larva starts to make bore near the growing point of tender flower buds or fruits. During the early vegetative phase larva feeds on the tender shoots. Larva seals the entry hole with excreta after boring. The larva makes tunnel, feeds on the inner contents and fills the tunnels with excreta. This results wilting of young shoots, drying and drop off, which makes slows plant growth. One larva damages four to six fruits during larval period. Larval stage causes the damage varies from 30 to 90 per cent.

Fig: Damage on hooand fruit by brinjal fruit and shoot

Population dynamics

Pest abundance and distribution changes with abiotic factors viz. temperature, RH%, rainfall. Weather parameters play a vital role in the biology of any pest. The incidence of Shoot and Fruit Borer, *L. orbonalis* occure during Nov- Dec with peak shoot infestation during Feb. the infestation of borer was occure during Dec. with peak infestation in the month of Feb. The percent shoot damage was positively correlated with both max. and min. temperatures, total rainfall and wind speed while negatively correlated with mean R.H. While percent fruit infestation revealed a non significant positive correlation with max. and min. temperature, rainfall and wind speed and negative significant correlation with mean relative humidity. (Mathur *et al.* 2012).

Integrated pest management

- ✓ Avoid repetition of solaneuos crops
- ✓ Removal and destroy the infested shoots and fruit at regular intervals until.
- ✓ Select resistant or moderately cultivars viz., Pusa Purple Long, Aushey, Arka Kesav, Pusa Purple Cluster, Punjab Barsati, Pusa Purple Round, Punjab Chamkila and Doli-5 are tolerant or resistant cultivar.
- ✓ Installation of sex pheromone traps at the rate of 100 traps/ha during crop period.
- ✓ Application of neem cake (250 kg/ha) decreased the incidence of borer to 8 per cent and increased the yield of crop to nearly 68 per cent. (Sreenivasa Murthy *et al*. 2001)
- ✓ Application of Dipel 8L @ 0.2 per cent at 10 days interval reduce the shoot and fruit infestation. (Puranik *et al.* 2002)
- ✓ Application of cartap hydrochloride at 0.1% are most effective for reducing this pest.
- ✓ Basal application of neem cake @ 20q/ha + foliar spray of quinalphos 0.05 per cent reduces the fruit borer incidence.

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ROLE OF WIDE HYBRIDIZATION IN CROP IMPROVEMENT

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Wide Hybridization refers to mating between individuals of different species (Interspecific) or genera (Intergeneric). It provides a base for assembling desirable genes from diverse sources into a single individual and most commonly used to transfer genes that are resistant to biotic and abiotic stress from wild relatives to cultivated ones. It is also used to transfer sterile cytoplasm from wild species to cultivated species and plays a significant role in creation of a new crop. However, the success of wide hybridization depends on overcoming barriers of distant hybridization, popularly known as pre-fertilizationbarriers like geographical isolation, apomixis, and pollen-pistil incompatibilities and post-fertilization barriers like ploidy differences, chromosome elimination, seed dormancy and hybrid breakdown. Different techniques are used to overcome these barriersand effectively exploit the potential of wide hybridization for improvement of a crop in terms of yield, quality, adaptation, mode of reproduction, resistance to biotic and abiotic stress, etc.

Wild species or wild genetic resources are the potential sources of desirable genes for improvement of various characters of crop plants. Wide crossing is an effective method of exploiting desirable characters from wild species for the improvement of cultivated crop plants. Wild relatives are also important sources of variability and they can be used effectively to broaden the spectrum of genetic base of the crops.Wide-hybridization is an important tool in the hands of the plant breeder and it is the first step to transfer genes from the wild species into the cultivated ones. The history of distant hybridization was started with production of a hybrid between Carnation (*Dianthus caryophyllus*) and Sweet William (*Dianthus barbatus*) by Thomas Fairchild in 1717. It breaks the species barrier for gene transfer and makes it possible to transfer the genome of one species to other, which results in alteration of genotypes and phenotypes of the progeny. Successful interspecific hybridization can be achieved through wide hybridization with the help of embryo rescue technique, manipulation of cytological events in meiotic division and identifying genes controlling homologous pairing between wild and cultivated species. Hence there is no major problem in producing of fertile interspecific hybrids with desirable traits useful for mankind.

Two dried specimens of Fairchild's Mule at Oxford University (Google images)

Distant hybridization has served as a novel breeding method for transferring valuable genes for important traits such as disease and insect resistance, improved quality and adaptation, tolerance to frost, drought and salinity from wild species to the cultivated species through interspecific and Intergeneric hybridization. For example, in wheat resistance to leaf, stem and yellow rust has been transferred from *Aegilopes* and *Lophopyrum* species. Similarly, resistance to Hessian fly and nematodes has been transferred from *Triticum tauschii.* In potato resistance to late blight is obtained from *Solanum demissum* while in tomato resistance to fungal diseases has been transferred from *Lycopersicon pimpinllifolium* and *Lycopersicon peruvianum.* Apart from disease resistance wide hybridisation has also played critical role in enhancing adaptability in many crops, e.g. in wheat, increased winter hardiness has been transferred from *Agropyron* species. In tomato *Lycopersicon cheesmani* is used as donor for transfer of genes providing adaptability to adverse environment. In grape, *Vitis amurensis* provides genes for hardier vines. Improvement in yield has also been achieved through the use of wild species in some crops like *Avenal, Cicer, Vigna, Zea, Arachis* etc. In cotton wide hybridisation is used for quality improvement. Genes for high fibre strength has been transferred from *Gossypium thurberi* to *Gossypium hirsutum.* In tobacco genes for improved leaf quality has been transferred from *Nicotiana debneyi* to*Nicotianatabaccum.* Similarly, oil quality in oil palm and protein content in wheat, rice and oat has been improved by wide hybridisation programmes. The most notable contribution of wide hybridisation reflects in its ability to transfer genes that could modify the mode of reproduction in specific crops, e.g. Genes for apomixes have beentransferred to maize from *Tripsacum.* Wide hybridisation has been also used for developing improved cultivar as well as entirely new crop. In cotton, commercial interspecific hybrids have been developed both at tetraploid and diploid levels. Varalaxmi is a popular interspecific hybrid between *Gossypium hirsutum* and*Gossypium barbadense*. In pearl millet, Pearl-millet × Napier hybrid has been developed with high fodder yield potential and superior fodder quality. In some instances, wide hybridization followed by polyploidisation lead to creation of entirely new crop species, e.g. *Nicotiana digluta* has been developed from a cross between *N. tabacum* and *N. glutinosa*. Triticale was developed by Rimpau in 1890 from an intergeneric cross between *Triticum aestivum* and *Secale cereale*. Raphanobrassica (*Raphanus sativus* ×*Brassica*oleraceae)is another example of intergeneric cross developed by Karpechenko in 1927.

Recent improvements reported in different crops

In 2008, the first ever hybrid of Indian mustard NRC Sankar Sarson (NRCHB 506) was developed using *Moricandia* CGMS system (MJA5 X MJR1).Singh *et al*.(2013) performed interspecific crosses between ricebean (*Vigna umbellata*) and black gram (*Vigna mungo*) and successfully introgressed genes for resistance to *Mungbean yellow mosaic virus*, *Cercospora leaf spot* and *Bacterial leaf spot* diseases along with increased productivity. Similarly, in case of rice, genes for brown plant hopper resistance such as *Bph10* and *Bph18* have been transferred from *Oryza australiensis* while *bph11*, *Bph13*, *Bph14* and *Bph15* from *Oryzaofficinalis* to the cultivated species, Jena (2010).Recently, Sarao *et al.* (2016) have found seven *Oryzanivara* accessions that are resistant against a new biotype of BPH prevalent in the North Western India (BPH biotype 4) Ivanova *et al*., (2016) performed intergeneric crosses in sunflower (*H. annuus* x *T. rotundifolia* and *H. annuus* x *V. encelioides)* to identify drought resistant lines. This study revealed that that the union of two distinct genomes within a new hybrid individual can provide a source of phenotypic novelty associated with drought resistance.

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ALOEVERA FARMING- PACKAGE OF PRACTICES AND ITS IMPORTANCE

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Introduction:

Aloe Vera is a hardy perennial, drought-resisting, succulent plant belonging to the *Asphodelaceae* family. The name, aloe, is derived from the Arabic " *alloeh* " or Hebrew "*halal*" meaning bitter shiny substance. This plant became very popular in the world due to its medicinal value. This plant also called as "miracle plant" or "nature's tonic". The Aloe Vera plant is a member of lily plant known as Aloe barbadensis, which is full of juice and closes like a cactus. Due to its cactus like feel, Aloe is often mistakenly called a "Desert Cacti". Aloe Barbadensis miller or Aloe Vera, a semi tropical plant is one of the 250 species of Aloe. Most commonly used for its medicinal properties, Aloe Vera or the Sanskrit name "Ghee kunwar" is a member of Lilly family. The plant has lance-shaped, sharp pointed, and jagged and edged leaves.

Aloe is native to North Africa and Spain, now the plant is also grown in the hot dry regions of Asia, Europe and America. Aloe Vera is found as the wild herb along the coast of south India. It is under cultivation in large areas in many parts of India viz; Rajasthan Tamil Nadu, Gujarat, Maharashtra etc. Aloes are often thought to only grow in hot and dry climates, but they actually grow in a variety of climates including desert, grassland, and coastal or even alpine locations.This plant is being used extensively in cosmetic industry and consumer product segment. Aloevera is a plant of great potential and value in the field of therapeutics, pharmaceuticals and cosmetic industries. The colour and odour of each variety is its characteristic and the taste bitter and nauseous. Aloevera used in indigenous (Ayurvedic) and Unani systems of medicine and in cosmetics, shampoos and creams.The major market of Aloe vera and its extracts are in India, Australia, USA, Japan and Europe. The demand for Aloe vera is increasing and with scientific studies supporting the medicinal benefits of Aloe Vera. It is profitable to cultivate the Aloevera & has the potential to become the future of agro-industrial crop. For centuries, it has been medicinally used for an array of ailments such as mild fever, wounds and burns, gastrointestinal disorders, diabetes, sexual vitality and fertility problems to cancer, immune modulation, AIDS and various skin diseases. In the pharmaceutical industry, it has been used for the manufacture of topical products such as ointments and gel preparations, as well as in the production of tablets and capsules. So, there is an urgent need to educate about the miraculous uses of Aloe Vera along with its cultivation methods for human race and popularize it for greater interest (Shahrier 2017).

Contents in Aloevera:

- Vitamins A, B1, B2, B6, B12, Folic Acid, Niacine
- Vitamins: A, B1, B2 B3, B6, B12
- Contributes to well – being & health & supplies body with energy
- Strengthens the immune system
- Minerals: Calcium, Iron, Potassium
- Indispensable for the human metabolism
- Building of blood, needed for growth of bones and teeth
- Amino Acids: Lysine, Threonin, Valine etc.
- Repair tissues / carry oxygen throughout the body
- They form antibodies to combat invading bacteria & viruses
- Enzymes: Oxidase, Catalase etc.
- Regulate intestinal activity.
- Assist in the breaking up of food elements

Uses and Health Benefit of Aloevera:

Aloe Vera is referred for Ayurvedic treatments where it is useful in the treatment of burns, blood disorders, chronic constipation, skin diseases, and as eye drops for relief in sore eyes and redness as well as bleeding and healing of wounds, etc. It plays an important role in gerontology and rejuvenation. Aloe Vera is full of medicinal properties & it is effective in treating various body ailments. Other uses are medical and cosmetic benefits, used in number of lotions, creams, gels and shampoos, as diet supplement or directly, as diet supplement or directly, control the stomach acids and maintain balance in the stomach, improve immune system, stimulate tissues, helpful for diabetes, absorb nutrients and neutralizing toxic and bad elements (Gupta *et al.* 2018). Below are the some of the health benefits and medicinal values of Aloe Vera.

- Aloe Vera is an anti-biotic, anti-microbial, anti-bacterial, disinfectant, anti-biotic, anti-septic, germicidal, anti-fungal and anti-viral.
- Aloe Vera is excellent for the skin treatments/cosmetic use.
- Aloe Vera is extensively used in treatment of urine related problems, ulcers and pimples.
- Aloe Vera is good source of vitamins and minerals.
- Aloe Vera is high in amino acids and fatty acids.
- Aloe Vera helps with digestion.
- Aloe Vera helps in detoxification process.
- Aloe Vera is heart healthy.

• Aloe Vera helps in boosting the Immune system.

Climate Required For Aloe Vera Farming

Basically Aloe Vera is a warm tropical crop. Aloe Vera can grow in various climatic conditions. This can be successfully grown in low rainfall regions and dry areas with warm humid conditions. This plant is very sensitive to extreme cold conditions. This plant thrives best on dry sandy soils in the regions where lower rainfall is expected. This plant cannot tolerate frost and cool climatic conditions. Therefore, dry and hot climatic conditions are best suited for its cultivation. This crop can even grow in areas where the annual rainfall is below average of the region.

- Climatic Requirements - Tropical, Sub- tropical
- Planting Period - June - July (monsoon / rainy season)
- Harvesting Period - After 12months

Soil Requirement for Aloe Vera Farming

Aloe Vera can be grown in most of the medium fertile soils ranging from marginal to sub-marginal. However, black cotton soils (heavy soils) are best for high yield of Aloe Vera. Commercial farming of Aloe Vera is suitable in well-drained loamy or sandy loam soils with pH value up to 8.0. However, Aloe Vera crop can tolerate high pH soils as well. One should go for soil test, if the crop is grown on large scale and any nutrient deficiencies gaps should be filled based on soil test results.

- Soil requirements – Loamy

Propagation and Planting Method in Aloe Vera Farming

In Aloe Vera farming, propagation is done through root suckers / rhizome cuttings. In case of root sucking propagation, the process should be done by selecting medium size root suckers and carefully digging without damaging mother plant at the base. This can be directly planted in the main land. In case of rhizome cutting propagation, after harvesting the crop, digging out the underground rhizome and making about 6 cm length cuttings with two to three nodes on them is advised. After that it has to be placed on prepared sand beds. Once sprouts are popping up, it has to be transplanted into main field. Usually about 15000 suckers are required for 1 acre of nursery.

Propagation Method - Pups (root suckers)

Land Preparation in Aloe Vera Farming

As Aloe Vera is a shallow rooted crop; it is not required deep plough during land preparation. One or two plugging should be given followed by harrowing based on soil type and climate. Make sure to level the land after plugging. Make beds or suitable plot sizes considering good slop for water drainage and irrigation. Any organic matter like well rotten farm yard manure (FMY) of 10 to 15 tonnes per hectare can be supplemented for better crop growth and yield. This FMY also results in better moisture holding capacity and improves soil texture.

Planting Density & Spacing in Aloe Vera Farming

Planting can be done through the year if there is irrigation facility. However, planting right during rainy season (from July to August in India) would be considered best. Plant density of 10,000 to 10,500 suckers is required to cover 1 acre land or 25,000 suckers per 1 hectare land. Dig the pits of 14 to 15 cm deep and plant the suckers at 60 cm x 60 cm apart (Robledo *et al.* 2017). Soil around root zone should be pressed firmly so that there won't be any water stagnation.

Irrigation in Aloe Vera Farming

Aloe Vera crop can be grown both under rainfed and irrigated conditions. Irrigation should be carried out immediately after planting the suckers. Couple of irrigations in hot summer weather will result in good yield. In rainy season, avoiding water logging in the field is advised as this crop is sensitive to water stagnation (Manvitha and Bidya, 2014).

Weed Control/Inter Cultural Operations in Aloe Vera Farming

It is one of the best crop management practices to keep the filed weed free. This also helps in saving manures, fertilizers and irrigation. 2 to 3 hand weedings should be carried followed by light hoeing in a year. Carry out the first weeding and hoeing should be carried within a 4 weeks after planting the suckers. Subsequent years require 1 or 2 weedings with light hoeing to keep the weed growth in control. Destroy any diseased plants. Dried stakes should be removed regularly.

Manures and Fertilizers in Aloe Vera Farming

As part of the land preparation, applying 15 to 20 tonnes/ha of well rotten farm yard manure (FYM) is advised. Thereafter the same dose of farm yard manure should be applied every year. As basal dose (forming or belonging to a bottom layer or base), fertilizers like NPK in the ratio of 50:50:50 kg per hectare should be applied(Liontakis and Tzouramani, 2016).

Pests and Diseases in Aloe Vera Farming

The good thing about Aloe Vera crop is there are no major pests and diseases reported. However, the following are the common pests and diseases found in Aloe Vera farming;

Aloe rust, Basal stem rot, and Bacterial soft rot.

Harvesting Tasks in Aloe Vera Farming

Aloe Vera crop will become ready for harvesting from second year after planting. Fresh leaves of 3 or 4 can be picked. Picking up leaves should be done during morning or evening times. Three harvests can be carried in one year time. This crop is a labor intensive crop. After harvesting leaves, again they re-generate up to 5 years after planting. Not only leaves, side suckers can be harvested for using in planting material.

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