ISSN No 2583-3146

Krishi Udyan Darpan

Volume 3 : Issue 3 : December 2023

(Innovative Sustainable Farming)

Society for Advancement in Agriculture, Horticulture & Allied Sectors
SAAHAS

ISSN No. 2583-3146

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(Innovative Sustainable Farming)

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Editorial Board

ISSN No. 2583-3146

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(Innovative Sustainable Farming)

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ISSN No. 2583-3146

ISSN No. 2583-3146

From Coop to Carton: Unleashing Maximum Quail Egg Productivity

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Introduction

Quail farming has gained significant popularity in recent years due to its numerous advantages, including efficient land utilization, low investment costs and high - profit potential. In addition to the economic and practical advantages, the quail layer system contributes to sustainable farming practices. By utilizing vertical space and minimizing land usage, it helps conserve natural resources and protects the environment. Quail farming also produces lower greenhouse gas emissions compared to other livestock industries, making it an environmentally friendly choice for egg production. When it comes to quail farming, the primary focus for many farmers is the production of eggs. Quails are known for their prolific egg-laying abilities and with the right management strategies, you can maximize their egg production. Keeping quail is a favoured choice due to the delicious nature of their eggs.

Female quails have the ability to lay eggs without the presence of a male counterpart (similar to chickens), eliminating the necessity of keeping one unless the intention is to breed quail. On average, quail eggs weigh a mere 12 grams, in contrast to approximately 60 grams for a hen's egg. These eggs are commonly relished when hard-boiled and added to salads, offering a delightful bite-sized portion (Figure1).

Quails generally reach the laying stage at around 8 to 12 weeks old. During their first year or so of laying, they tend to be quite prolific, while their natural life span ranges from two to four years. Despite their small size, quail eggs have a rich yolk - to- white ratio, making them not only a delicious treat but also suitable for pickling and various recipes that call for eggs. In this article, we will explore essential management practices that will help you optimize egg production in your quail farm.

Figure1: Layer Quail and Eggs

A. Selecting the Right Quail Breed

Choosing the appropriate quail breed is crucial for maximizing egg production. Some popular breeds known for their high egg-laying capabilities include the Coturnix (Japanese) quail and the Bobwhite quail. These breeds have been selectively bred over the years to enhance their egg production potential. Ensure you acquire healthy birds from reputable breeders to establish a strong foundation for your flock.

B. Optimal Housing Conditions

Quail, belonging to the pheasant family, have a preference for living in close proximity to the ground, which means they do not utilize elevated houses with high ramps. While they do not require perches or nest boxes within their housing, these timid birds appreciate the presence of branches and objects like small logs to provide cover in their enclosure.

Creating a suitable housing environment is essential for promoting egg production in quails. To promote optimal egg laying, it is beneficial to provide quails with a serene and peaceful environment, free from disruptive noises. Additionally, it is crucial to keep pet cats and dogs at a safe distance from the quails, even if they are physically unable to reach them. The mere presence of potential predators can cause distress to the quails, potentially affecting their laying performance. Consider the following factors for better management and production:

a. Space: Provide enough space to allow for natural movement and minimize stress. Ensure that each quail is provided with a minimum of 1 square foot (0.093 square meters) of floor space. Sufficient floor space is crucial for quails to avoid feeling confined and stressed, as stressed quails are less likely to lay eggs. To enhance the floor space available for each quail, consider expanding the size of their cage or allowing them to freely roam for a portion of the day.

b. Ventilation: Proper ventilation is crucial for maintaining optimal air quality and temperature control. Good ventilation prevents the build-up of harmful gases and reduces the risk of respiratory diseases. Proper ventilation is of utmost importance in quail housing due to their higher production of ammonia compared to other poultry. When temperatures drop, they will require additional protection, but with the provision of artificial lighting, they can continue to lay eggs throughout the winter season.

c. Lighting: The Coturnix quail, also known as the Japanese quail (depicted on the right), is highly favoured and known for its exceptional productivity. In their natural habitat, they typically lay two to three clutches per year, with each clutch containing approximately a dozen eggs. However, in captivity, without any specific breeding selection, they can lay over 230 eggs or even more if provided with sufficient lighting. Some Coturnix quails have been documented laying an impressive 300 eggs within a year, surpassing the egg-laying capabilities of most chickens.

To ensure continuous egg production during the winter season, when daylight hours are reduced, quails will require artificial lighting. They need to be exposed to 14 to 16 hours of light each day to stimulate egg production. Use artificial lighting to supplement natural daylight during winter months when daylight hours are shorter. It is advisable to gradually decrease light levels in the morning instead of abruptly plunging them into darkness when the timer switches off at night. Similar to chickens, artificial lighting for quails applies the same principles needed for egg production.

d. Nesting Boxes: Provide well-designed nesting boxes filled with clean, dry bedding material to create a comfortable and secure space for the quails to lay their eggs. Add hay or straw to the quail cage, allowing them to utilize it for nest-building purposes. Nesting behaviours may vary among individual quails as some quails may lay eggs directly on the ground, others prefer having a nest. Supplying nest-building materials assists those quails that prefer to construct a nest for laying eggs. Although cleaning the cage is typically required every 1-2 weeks, it is essential to ensure that the quails have daily access to fresh food and water (Figure 2 and 3).

C. Balanced Nutrition

To achieve high egg production (the capability to lay up to 300 eggs per year), it is essential to provide them with appropriate quail feed. A balanced diet plays a vital role in egg production. Quails require a high-quality feed that is rich in protein and essential nutrients. Consult a poultry nutritionist to formulate a feed that meets the specific requirements of your quail breed. Proper nutrition will not only enhance egg production but also improve the overall health and vitality of your

quails. Additionally, it is crucial to ensure that quails have constant access to clean and fresh water at all times Ensure a steady supply of fresh, clean water at all times.

Nutrient requirements of domestic quails under tropical conditions

	Age of Quails		
	0-2 Weeks	3-5 Weeks	
Nutrients			
Metabolizable Energy (Kcal/kg)	2750	2700	2650
Protein (%)	24 20	19	
Minerals			
Calcium (%)	0.8	0.6	3.0
Phosphorus %)	0.3	0.3	0.45
Vitamins			
Vitamins A (IU)	8000	8000	8000
Vitamin D3(ICU)	1200	1200	1200
Riboflavin, (mg)	6	6	6
Amino acids			
Lysine (%)	1.20	1.10	0.80
Methionine (%)	0.45	0.40	0.33
Methionine + Cystine %	0.70	0.65	0.60

Quails have a tendency to flick the mix on the floor while searching for their preferred seeds within the blend. Quails are not prone to overeating, so they can be fed ad-lib, similar to other poultry. When feeding them with a quail seed/pellet mix, it is recommended to use a hopper equipped with "anti-spill fingers" to prevent wastage.

D. Disease Prevention and Biosecurity

Maintaining a strict bio security protocol is crucial to prevent the outbreak of diseases that can hamper egg production. Implement the following practices: Consult with a veterinarian to develop a vaccination program suitable for your quails, protecting them from common diseases such as sis coccidio and Newcastle disease. Maintain a clean and hygienic environment by regularly cleaning and disinfecting the housing, feeding and drinking areas. Quarantine new birds before introducing them to the main flock to minimize the risk of disease transmission. Regularly monitor your quails for signs of illness and promptly isolate and treat affected individuals.

E. Record Keeping and Analysis

Maintaining detailed records of egg production, feed consumption, and other relevant data will provide valuable insights into the performance of your quail flock. Analyze these records regularly to identify trends, make informed management decisions, and adjust strategies as necessary to optimize egg production.

Conclusion

In conclusion, the quail layer system offers numerous benefits and opportunities for individuals and businesses involved in poultry farming. Implementing effective management strategies is key to maximizing egg production in your quail farm. By selecting the right breed,

providing optimal housing conditions, ensuring balanced nutrition, enhancing bio-security measures, and maintaining accurate records, you can create an environment that encourages high egg-laying rates in your quail flock.

Fig. 2. Cheap Wooden cage for Layer Quails

Fig. 3. Commercially available 6 Tier Cage for Layer Quails

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ISSN No. 2583-3146

Major Fungal Diseases of Garlic

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Introduction

Garlic can be a very easy-to-grow herb in the garden, however it is also prone to several diseases. Today it is popular throughout the world for its distinctive flavor, health giving properties and its usage in culinary preparations. These include, but are not limited to: Basal Rot (*Fusarium culmorum*), White Rot (*Sclerotium cepivorum*), Downy Mildew (*Peronospora destructor*), Botrytis Rot (*Botrytis porri*) and Penicillium Decay (*Penicillium hirsutum*).

The garlic plant's bulb is the most commonly used part of the plant. The cloves are used for cloning, consumption (raw or cooked) and in the preparation of medicines and have a characteristics pungent, spicy flavor that mellows and sweetens considerably with cooking. The leaves and flowers (bulbils) on the head (spathe) are also edible and being milder in flavor than the bulbs, which are most often consumed.

When garlic was planted at the traditional time, final stands and yields were reduced 56-92% primarily from the attack of *S. cepivorum*. A 100% loss in yield occurred in some crops planted in cool soils in late March. In a late planting (15 May), the final stand was 75% lower with correspondingly lower yield than that obtained with the early plantings. The largest bulbs (21.6 g) were obtained from the planting on 28 February; however, the yields from this planting were reduced by half from the planting 2 weeks earlier because of the 50% reduction in final stand. Early planting of garlic is recommended as an important management strategy to avoid white rot in areas with soils infested with sclerotia of *S. cepivorum*.

Symptoms

Basal Rot

- The fungus infects garlic at any growth stage through the wounds and scars at the base of the bulb.
- Initial symptoms include leaf curling, yellowing, and dieback. Red-brown discoloration and rot forms along the root-basal plate margin.
- When cut open, the bulb tissue will appear brown.
- Symptoms may not be visible in the field, as they tend to develop during storage.

Management

- Plant resistant cultivars.
- Implement crop rotation. Rotate out of onion, garlic, and leeks for 3-4 years.
- Avoid planting in fields with a history of Fusarium basal rot problems.

Fusarium Basal Rot

Size Reduced bulb

Small lesions on clove

Deep cracks

White Rot

- The symptoms of white rot may look almost identical to basal rot, with the exception that the process of disease initiation to plant death is more rapid.

• Early symptoms include white, fluffy fungal growth on the stem that extends around the bulb base.

• Small, dark, over-wintering structures called sclerotia form in the decayed tissue.

Management

• It is advisable to not re-plant in infested fields, but application of some iprodione products at planting may help reduce disease incidence.

• Also avoid planting infested cloves. Pre-treating garlic cloves before planting can help reduce white rot.

• Hot water pre-treatment includes dipping cloves in hot water before planting, though the water should not be above boiling as this will kill destroy the cloves.

Downy Mildew

• The symptoms of downy mildew are quite distinct: a whitish, furry growth will appear on the leaves, along with yellow discoloration.

• It can kill younger plants and stunt the growth of older ones. Diseased leaf tips and other tissues will eventually collapse.

• Bulbs in storage will have a blackened neck, be shriveled, and outer scales will become water-soaked. Some bulbs may sprout prematurely.

Management

• Three spraying with Mancozeb 0.2 % is effective. Spraying should be started 20 days after transplanting and repeated at 10-12 days interval.

Boitrytis Rot

• The symptoms of Botrytis Rot include water-soaked stems and gray fuzzy fungal growth. This disease is also called "neckrot."

• Botrytis is the major disease of onions in cool climate areas. Light infections do not affect yields but heavy infections causing major yield reductions can occur. Hundreds of white specks are seen on the foliage.

• The disease then spreads very rapidly and tops of the entire crop may be killed.

Management

• Bulb treatment with Captan/ Thiram 0.25%. Spraying of Maneb or Mancozeb or Chloroth-alonil. Fungicides may be applied every 5-7 days for disease control.

Blue mold rot: *Penicillium* spp.

• A blue-green color powdery mould is observed on cloves in soil and in storage, thus its common

Blue mould on wounds

Blue green powdery mould

name, "Blue Mold".

- Air-borne spores spread the disease.
- Infection first occurs on wounds sustained when cloves are separated from the parent bulb.

Management

- Bulbs are harvested carefully to avoid wounds and bruising, then promptly dried or cured.

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ISSN No. 2583-3146

Major Fungal Diseases of Tomato

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Introduction

Tomato (*Lycopersicon Esculentum* L.; Family Solanaceae) is one of the most important protective food crops of India. It is grown in 0.458 Million ha area with 7.277 Million metric tonnes production and 15.9 mt/ha productivity. The plants typically grow to 1-3 meters in height and have a weak stem that often sprawls over the ground and vines over other plants. It is a perennial in its native habitat, although often grown outdoors in temperate climates as an annual. Tomato introduced in India from the west. The tomato is more prone to a high disease incidence and during cultivation and post-harvest period, it can be affected by more than 200 diseases caused by different pathogens throughout the world.

Tomatoes are highly nutritious, rich sources of vitamins A, C and minerals. They are also cholesterol-free. Tomatoes are used as raw and processed to make puree, soup etc. It contains lycopene, a carotenoid, which is a powerful anti-oxidant and protects human from cancer and heart diseases. An average sized-tomato fruit contains only 35 calories, but it contains a variety of anti- oxidants like ascorbic acid, vitamin E, carotenoids and phenolics.

This article's main subject is of significant tomato illnesses and how to manage them. Damping off, fusarium wilt, early blight and late blight are a few of the most common fungal diseases that affect rice crops.

Damping Off

Damping off is caused by the fungus *Pythium Aphanidermatum*, this is one of the worst diseases of tomato occurring in the nursery. Damping off of tomato occurs in two stages, i.e., the pre-emergence and the post-emergence phase. In the pre-emergence the phase the seedlings are killed just before they reach the soil surface. The young radical and the plumule are killed and there is complete rotting of the seedlings. The post-emergence phase is characterized by the infection of the young, juvenile tissues of the collar at the ground level. The infected tissues become soft and water soaked. The seedlings topple over or collapse.

Management

Seed treatment with fungal culture *Trichoderma viride* (4 g/kg of seed) or Thiram (3 g/kg of seed) is the only preventive measure to control the pre-emergence damping off. Soil drenching of the affected seedlings with Dithane M45 (3 g/litre of water) helps to reduce the disease incidence.

Fusarium Wilt

It is caused by the fungus *Fusarium oxysporumf*. sp. *Lycopersici*. The first symptom of the disease is clearing of the vein lets and chlorosis of the leaves. The younger leaves may die in succession and the entire may wilt and die in a course of few days. Soon the petiole and the leaves droop and wilt. In young plants, symptom consists of clearing of vein let and dropping of petioles. In field, yellowing of the lower leaves

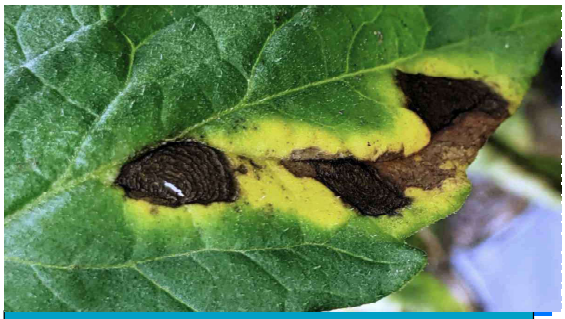
first and affected leaflets wilt and die. The symptoms continue in subsequent leaves. At later stage, browning of vascular system occurs. Plants become stunted and die.

Management

The affected plants should be removed and destroyed. Spot drench with Carbendazim (0.1%). Crop rotation with a non-host crop such as cereals.

Early Blight

It is caused by *Alternaria Solani*, this is a common disease of tomato occurring on the foliage at any stage of the growth. The fungus attacks the foliage causing characteristic leaf spots and blight. Early blight is first observed on the plants as small, black lesions mostly on the older foliage. Spots enlarge and by the time they are one-fourth inch in diameter or larger, concentric rings in a bull's eye pattern can be seen in the center of the diseased area. Tissue surrounding the spots may turn yellow. If high temperature and humidity occur at this time, much of the foliage is killed. Lesions on the stems are similar to those on leaves, sometimes girdling the plant if they occur near the soil line. Transplants showing infection by the late blight fungus often die when set in the field. The fungus also infects the fruit, generally through the calyx or stem attachment. Lesions attain considerable size, usually involving nearly the entire fruit; concentric rings are also present on the fruit.



Management

Removal and destruction of the affected plant parts. Practicing crop rotation helps to minimize the disease incidence. Spraying the crop with Difolatan (0.2%), Dithane M-45 (0.2%) or Bavistin (0.1%) is recommended for effective disease control.

Late Blight

It is caused by *Phytophthora infestans*, late blight occurs when humid conditions coincide with mild temperatures for prolonged periods. Lesions produced on the leaves are at first irregular, rather large, greenish-black and water-soaked. These areas enlarge rapidly, becoming brown and under humid conditions, develop a white moldy growth near the margins of the diseased area on the lower surface of the leaves or on stems. The disease spreads rapidly under humid conditions, destroying quickly large areas of tissue. Fruit lesions occur as large, green to dark brown lesions, mostly on the upper half of the fruit, but they may also occur on other parts. White moldy growth may also appear on fruits under humid conditions. The disease attacks the fruits a well as the leaves of the plant. Symptoms on the fruits usually begin on the shoulders of the fruit because

spores land on fruit from above.

Management

Crop rotation should be followed and the seed material should be obtained from a disease free area. Before planting the seeds should be treated with Thiram (2-3 g/kg of seed). The plants must be sprayed with Captafol (2 g/litre of water) or Dithane M 45 (2 g/kg of seed) at 15 days interval, starting from 30 days after transplanting.

Conclusion

Fungal diseases remain a persistent challenge in tomato cultivation, threatening both crop yields and quality. Vigilance, preventative measures, and integrated disease management approaches are vital to combat these fungal infections effectively. Researchers and farmers must continue to work together to develop resilient tomato varieties and sustainable practices to minimize the impact of these diseases on tomato production.

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ISSN No. 2583-3146

Effect of Added Beneficial Micro-organisms on Vermicompost & Waste Management of Rice Straw

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Introduction

Vermi-composting is a mesospheric bio-oxidation and stabilization process of organic materials that involves the combined action of earthworms and micro-organisms. The optimum temperature for earthworms activity in vermin-composting process is considered up to 35°C where as in conventional composting (including thermopile composting), it may reach up to 70°C. Due to its innate biological, biochemical & physicochemical properties, vermi-composting can be used to promote sustainable ruminant manure management.

With the consistent increase in agricultural production, some of the by-products like wheat straw, rice straw etc., are now being generated in huge quantities and proper utilization of these wastes are becoming a major constraint. To overcome the problem of large-scale generation of straws, many farmers are now burning these crop's residues in the fields, resulting in severe environmental degradations. Under this situation, large scale adoption of composting of these biodegradable crop wastes are being suggested by many experts with the major objective of reusing these crop residues to sustain the soil health and productivity.

Vermicompost Unit

In this study, we assessed the possibility of vermin-composting rice straw. Since this waste is a slowly degradable cellulosic material with wide C:N ratio, several workers have suggested to strengthen the decomposition process through fortification of some beneficial micro-organisms. In our study we used N2 fixing *Azotobacter chroococcum,* P. solubilizing *Pseudomonas* and Cellulose degrading *Trichoderma viridaeto* accelerate the vermicom-posting process.

Objectives of vermicomposting

a. The chief objective of the study was to compost organic wastes, not just for decreasing the disposal of solid organic wastes but also to produce superior quality manure to feed our "nutrient/ organic matter hungry" soils.

b. To recycle different organic waste material for productive purpose through vermi-compost.

c. Large volume of organic matter generated from agricultural activities, dairy farms and animal shelters usually dumped in corners emanating foul smell, can be utilized by properly composting it into a value–added end product.

d. To facilitate the decomposition of rice straw, a slowly degradable by product of our agricultural farming, through enhanced microbial action ie., vermicomposting .

Practical Utility

a.Reduction in the quantum of mineral

fertilization.

b. Resource utilization through recycling of organic waste mineral.

c. Reduction of pollution load.

d. More sustainability in agriculture through larger use of organic materials.

e. Possibility of emerging as a profitable enterprise as a circular economy.

f. Maintaining as well as and increasing long term soil productivity.

g. Recycling the slowly decomposable organic waste like rice straw through vermi-composting with external addition of some beneficial micro-organisms.

To convert waste into warm manure (also known as worm castings), a nutrient rich, biologically beneficial soil product.

Vermi composting is the use of worms as a composting method to produce vermicompost.

Vermi culture is worm farming for the production of worms.

Most worm farms raise two main types of earthworm: *Eisenia foetida* and *Lumbricus rubellis*. These worms are commonly used to produce vermi compost, as well as for fish bait.

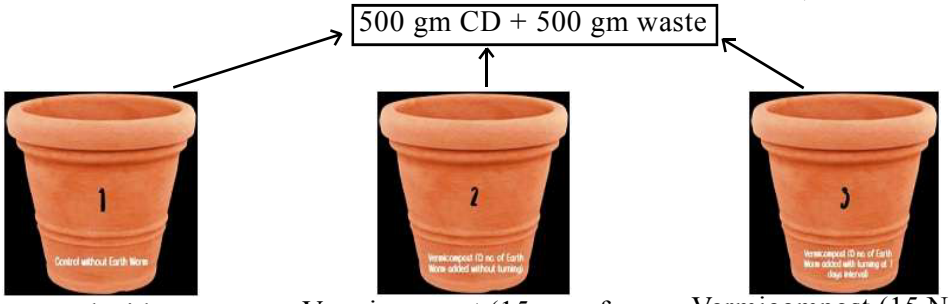
We are going to discuss the actual produ-ction process of vermi-compost and the effect of beneficial micro-organisms in the process of composting. Firstly, we will take a note of the required ingredients then learn the steps, which are to be taken and finally see the procedure through which we obtain the final output.

Fig- E foetida

Fig- L rubell

Ingredients

- Cow Dung
- Organic Waste (Rice Straw)
- Epigeic Earthworm (15 no /kg)
- Beneficial microorganisms: PSB- *Pseudomonas fluorensis*; NFB- A*zotobacter chroococcum*; Cellulose degrading microbe – *Trichoderma viridians*)



control without earthworm

Vermicompost (15 no. of earthworm) added without turning

Vermicompost (15 No. of earthworm) Added with turning at 7 days interval

Chemical & Physical Properties of Vermicompost on Rice Straw

PARAMETER	RICE STRAW	PARAMETER	RICE STRAW
pH	± 7.60 0.08	Zn (mg. kg-1	± 38.40 2.20
TOC (%)	± 39.20 0.95	Cu (mg. kg-1	± 9.30 0.67
C/N ratio	± 61.30 2.61	Fe (mg. kg-1	129.20 ± 1.90
MC (%)	± 11.43		

N (%)	0.77 ± 0.64
P (%)	0.07 ± 0.21
K (%)	0.02 ± 1.12
	0.11

• Then the mixture is divided into 3 tubs at the rate of one kg in each.

• The first tub is left aside to decompose naturally, this was called "Control" tub.

• NFB & PSB were inoculated in the two vermi-composting pots @ 5 gm/kg substrate for each.

• Then the earthworms were added in the rest two tubs. One of these was kept.

The other tub was turned/ stirred regularly once in a week.

• The tubs were kept moist with occasionally adding little water. The temperature of all 3 tubs was cheeked two times in a week.

• As the mixture started decomposing the temperature keep rising, then came down as the process came to an end. Thus the cooling of the temperature indicated the maturity of the mixture.

When the texture changed to a solid fine texture, became friable, showed a dark brown color and stopped emitting foul smell it was considered that the vermi-compost mixture has been matured for harvesting.

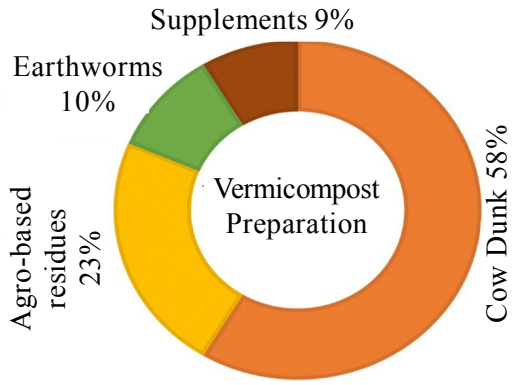
After the vermi-compost mixture had decomposed completely to sieve the mixture to separate the earthworms from the mixture to get the final output.

Observation

Week 1: We mixed the cow dung (1 kg) and straw (1 kg) together very well and kept adding water until the mixture came together. Then it was divided into pots had been left to decompose naturally.

Week 2: The mixture had changed colour and texture showing that some natural decompo-sition had already taken place at this point. We added water to all the three pots.

Week 3: During the middle of this week we added the earthworms (*Eisenia fetida*) in two



pots to help the process of natural decomposition and also to observe the difference between natural decomposition and the nature decomposition aided by earthworms.

Week 4: Some pots were lacking moisture so we added water to all the pots and turned the content of the two pots.

Week 5: The process of decomposition in the earthworm treated pots was much faster this time and the earthworms were also growing rapidly.

At this stage we added the bio fertilizers

a) Phosphate Solubilizing Bacteria (PSB)

b) *Azotobacter sp*

c) *Trichoderma viride*

in the amount of one spoon of bio fertilizer in each pot.

Week 6: We turned and mixed all the ingredients well and added moisture to the mixture. We added earthworms by this time the process of decomposition was going smoothly but we wanted to speed up the process so as to get better results.

Week 7: Our vermi-compost pots are ready and can be applied to the agricultural plots. The texture and quality of the mixture has changed completely. The mixture has decomposed very well.

Week 8: The pot which was turned regularly and had earthworms in it has decomposed uniformly and thus giving us the best possible output. The pot which did have earthworm but was not turned did decompose but the process was not uniform as the first one.

The last pot which was regularly turned but did not contain earthworms has decomposed much slower than the other two but the decomposition

here has been uniform throughout the mixture.

Then we sieved the mixture to separate the earthworms from the manure and kept it a side

Week 9: Packaging and labeling–after we obtained the final output by sieving the mixture, the vermi-compost manure was packed and labeled carefully and stored for selling it in the local market.

Economic Analysis

An attempt has been made in this section to carry out a tentative analysis of expenditure and income of vermi-composting. This analysis has been on the projections of the vermi-composting unit being constructed which will be having a production capacity of about 45 metric ton/year.

A. Fixed cost

i. Vermi-composting unit with 500 CFT chambers: Rs 1,00,000
ii. Cost of earthworms: Rs. 30,000
iii. Equipments (sieve, spade etc): Rs. 5,000
Total: Rs.1, 35,000/-

B. Recurring cost

i. Labor (50 man days/cycle) @Rs.300/day: Rs.15,000/day
ii. For six cycles in a year, total labor cost :Rs. 90,000
iii. Misc. expenditure.10,000
Total annual expenditure: Rs. 1,00,000/-

C. Expected production

i. 7.5 ton. cycle of two months
ii. i.e. 7.5x6 = 15 ton year
iii. Sale price of vermicompost : Rs. 5,000/ton
iv. Total price for 45 ton =Rs. 2,25,000/-
Cost: Benefit ratio on recurring expenditure: 1:2.25.

Conclusion

The Vermi-composting activity is such a worthwhile & exciting venture. We have learned a lot specifically in the methodologies, benefits on significance of the activity. It is a substantial way of converting farm waste into organic fertilizer & maintaining the balance of the ecological environment. It increases crop yield & lessens dependence on chemical fertilizer thus mitigating climate change. However, under organic farming vermi-compost is the best among all sustainable practices. It also improves physical characteristics & increase water retention capacity of the soil. It can be made into a livelihood program & become a source of extra income. It is an eco-friendly approach towards management of rice straw

Vermi-composting of rice straw provides a good quality bio fertilizer. It improves soil quality and promotes plant growth, health and yield. Vermi compost can be prepared easily at low cost. Farmers must be encouraged for organic farming. It is an eco-friendly approach towards management of rice straw.

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ISSN No. 2583-3146

Rootstock Breeding in Vegetable Crops

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Introduction

To "maximize the probability of creating and identifying superior genotypes that will make successful new cultivars" is the goal of plant breeding. In other words, they will have every desired quality required for employment in a manufacturing system (Brown and Caligari, 2011). The following steps must be completed in the breeding process before a new cultivar can be commercially released (a) identifying variable germplasm (b) utilizing hybridization to combine genetic materials from various sources into a single entity (c) choosing superior genotypes with a favorable combination of traits and (d) propagating stable cultivars.

Historically, improved yield, fruit quality and disease resistance were the main objectives of the majority of breeders of graftable vegetable crops. Due to this, commercial elite scion cultivars with high yields, fruit qualities acceptable for postharvest handling, and consumer appeal have been released. These cultivars are typically paired with a variety of important qualitative disease resistance loci. Such cultivars must be crossed and again selected for all favorable features, a time-consuming and expensive procedure that can take up to 10 years, in order to add further rootzone-expressed traits. Additionally, due to regional soil conditions and the related abiotic and biotic pressures, desirable rootzone expressed features frequently depend heavily on the environment and vary accordingly among growth systems.

Trait stacking by means of grafting provides various benefits, including the ability to breed rootstock and scion independently, which divides the breeding scheme's issues into two more manageable ones. Additionally, the rootstock can contain a lot more wild species DNA than the scion without having an effect on domestication qualities like fruit size and quality. The influence of the qualities from each are then combined by grafting and the grower or plant nursery can select the scion and rootstock pairings to fulfill certain market or environmental requirements. A non-grafted system, in contrast, necessitates a greater number of whole-plant cultivars to offer the grower the same level of flexibility and selection and the use of wild-species germplasm is severely constrained due to effects on marketable yield.

The cost of buying grafted transplants is the only drawback of the grafting approach for growers, but it is obvious from the industry's quick uptake of grafting that the economic benefits outweigh the additional expenses. For commercial seed firms, the problem is more complicated because grafted crops frequently have two main stems produced from a single rootstock, which results in reduced seed sale volumes in grafted crops even when providing both rootstock and scion seeds. When breeding rootstocks, compatibility is an extra difficulty to the selection criterion, and selection processes must find effective rootstock × scion × environment pairings (Cohen *et al*., 2007).

Purposes of Grafting Vegetables are

a. To combat soil-borne diseases

Crops of the cucurbitaceous and solanaceous family are vulnerable to soil-borne ailments like Fusarium wilt and root knot nematodes. In addition, under protected agriculture as opposed

to open fields, soil-borne illnesses and root knot nematodes are more dangerous. As a result, the main goal of vegetable grafting is to prevent or lessen damage brought on by soil-borne ailments such fusarium wilt, verticillium wilt, bacterium wilt and root knot nematodes.

b. Abiotic stress tolerance development

Grafting increases the tolerance to abiotic stress, which is a key factor in why grafted plants developed rapidly in protected environments. Vegetables frequently suffer from low temperatures and low light intensity. Under protected cultivation, secondary soil salinization brought on by excessive fertilizer input and facility cover is also a severe problem. The ability of grafted plants to tolerate low temperatures and salinity can be increased by choosing the right rootstock; as a result, grafted vegetable seedlings were frequently used in protected cultivation. For instance, using fig leaf gourd as a rootstock increased cucumbers' tolerance to low tempe-ratures and high salinity.

c. To increase uptake of mineral nutrition and use efficiency

The root systems of selected rootstocks are typically much larger and more vigorous than non-grafted plants.

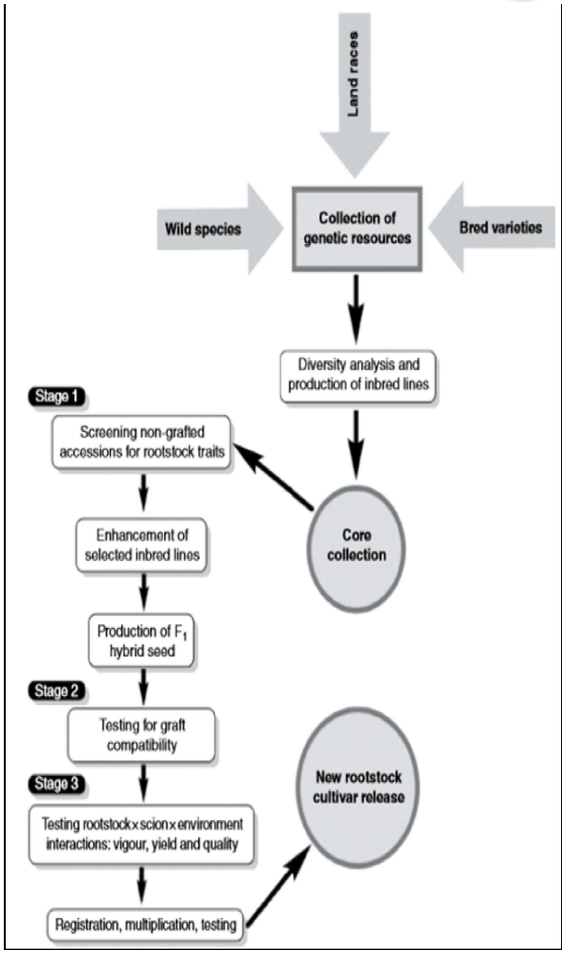
d. To improve yield and quality of produce

Regardless of the presence of specific soil-borne diseases, grafting is associated with appreciable increases in fruit output in many fruit and vegetable plants (Huang *et.al*., 2009). Extended harvest times were frequently linked to higher fruit yields; for instance, grafting can extend the harvest of bitter gourd and eggplant by three months (Tian *et. al*., 2012). Grafting can improve fruit quality when particular rootstock-scion combinations are used. On the fruit surface of the cucumber grafted onto Cucurbita moschata, less wax powder was discovered. Watermelons grafted onto C. *moschata* frequently have higher *lycopene* accumulation than ungrafted varieties. (Huang *et. al*., 2014)

Current Problems in Vegetable Grafting

a. High prize of grafted vegetable seedlings

The high cost of grafted seedlings is a result of



Process of breeding a new rootstock cultivar (Pico *et al*., 2017)

labor-intensive propagation methods, a protracted production cycle and added rootstock costs. Potential customers are frequently put off by the rising costs of grafted seedlings, which are rising as quickly as labor costs in China. Therefore, simple grafting techniques, inexpensive robotics and acclimatization systems will be useful for producing large numbers of grafted seedlings.

b. Safety of grafted seedling

In some seedling nurseries, sanitation and seed testing are frequently overlooked. However, the creation of grafted seedling frequently results in the occurrence of seed-borne diseases which can seriously harm the seedlings.

c. Small scale production

It is typical to create grafted seedlings on a small

scale, which makes it impossible to guarantee the quality of the seedlings. In order for grafted plants to survive, proper acclimation is essential. Many farmers regularly tend to their seedlings after grafting based on their personal experience. In actuality, the environment frequently varies significantly over time and space. As a result, controlling the healing and hardening process is frequently challenging and the small-scale grafted seedling production system frequently fails.

d. Negative effect on fruit quality

Sometimes rootstocks have a negative impact on the quality of the watermelon and melon fruit. For instance, grafting reportedly resulted in a slight decrease in the sugar content of melon, about 1° Brix (Xu *et. al*., 2006). As a result, it is crucial to breed rootstock of the highest caliber, particularly by selecting germplasm from wild type resources, such as watermelon wild type resources for breeding watermelon rootstock.

e. Lack of compatible multi disease resistant rootstock

The disease resistance, abiotic stress tolerance and yield of grafted plants are all improved. The selection of commercial rootstocks is regrettably, constrained. Finding suitable, multi-disease resistant rootstocks with abiotic stress tolerance is thus a fundamental necessity for ongoing success. Future breeding efforts will focus on cucurbit rootstock with small cotyledons and high temperature-tolerant rootstock for long-season farming. (Huang *et al.*, 2014)

Conclusion

Rootstock breeding is a relatively new discipline of vegetable crop improvement and novel functions of rootstocks still are being understood and developed; this increases the requirements of rootstocks without diminishing the testing requirements. Vegetable breeders' ultimate goal is to combine all of the rootstock and scion traits into a single non-grafted cultivar; however, grafting will always offer the fastest method to introduce new traits, such as a new soilborne disease resistance allele in the rootstock or a new fruit quality gene in the scion, without the need to recombine and reselect all traits into a single non-grafted cultivar.

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ISSN No. 2583-3146

Role of Nano Fertilizers in Agriculture

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Introduction

In modern era, Farmers are using high quality agrochemicals in their farm or agriculture land. Industrial fertilizer sreach over 42 million metrictons in India (Statista, 2022). In the hurry, the quantity of artificial fertilizers expected to rise to the level that can feed 9.6 billion people by 2050. Fertilizers, which is synthetic in nature are used to achieve optimum growth and productivity of the plants. But industrial fertilizers used in dense cultivation show low nutrients use efficiency values in most of the cases (Guo *et. al*., 2018). However, widely use of chemical fertilizers will lead to prominent environmental risks in the long term, such as soil fertility, productivity, air pollution, soil depletion, nutrient enrichment and pollution of ground water. For reducing such risks, different types of methods should be adopted like, organic farming, natural farming and sustainable farming. Sustainable farming is the best option for enhancing productivity with soil fertility. Because in this method, organic and chemical fertilizers are used together with optimum quantities. We can replace artificial fertilizers with Nano fertilizers. Because, Nano fertilizer is the nutrient itself or nutrients carrier and it can convert the chemical fertilizers to NFs aiming to increasing their use of efficiency and then supply to crops (Usman *et. al*., 2020). Nano fertilizers are further classified into macro and micro-nutrients (Chhipa, 2017). Nano fertilizers have high values of both surface area and adsorption ability as well as controlled-release process to specific sites. Nano structured fertilizers can increase NUE and exactly release their active contents according to crop requirements (Seleiman *et. al*., 2020 a, b). The purpose of this overview is to discuss the role and uses of nano-fertilizers in crop.

What is Nano fertilizers?

Nano fertilizers are synthesized or altered form of habitual fertilizers, fertilizers extracts from various reproductive parts of the plant by several mechanical, chemical, physical or biological methods with their uses to enhance soil fertility, productivity and quality of agricultural output.

Unique properties of Nano fertilizers

a. Nano fertilizers have smaller particle sizes (less than 100 nm), which increases the specific surface area and the number of particles per unit area and provides more possibilities for the nano fertilizer to come into contact with the plant system. This leads to better penetration and absorption, resulting in significant fertilizer use efficiency with lower fertilizer consumption.

b. It is highly soluble in various solvents.

c. Fertilizer component enclosed in nanoparticle increase phytonutrients availability and thus, their uptake by crops.

d. Nutrient availability for the crop is increased even during the growth phase thanks to zeolite-based nano-fertilizer's ability to discharge nutrients to the crop gradually.

Uses of Nano Fertilizers

Increased nutrient usage efficiency will lead to precision agriculture, which is the major goal of employing these nano fertilizers. In this regard, smart nano fertilizer technology is anticipated to result in a step toward the sustainability of the

agricultural industry. These nano chemicals can be a fantastic alternative to conventional fertilizers that need to be applied in big quantities while also guarding against nutrient pollution of the soil and water. Different nano fertilizers, including as N, P, K, Cu, Fe, Mn, Mo, Zn and carbon nano tubules, have demonstrated superior control release for efficient targeted distribution. Different nano particle morphologies, their oxide nano particles and inputs in the form of nano fertilizer have been created using typical nutrient formulations in nano scale. The conversion results for these nano particles have been good.

Nano fertilizers are created to deliver nutrients that are compatible with the crop's nutritional needs since various crops have varying nutrient requirements. This is possible by using nano-membranes to encapsulate the fertilizer particles, which aid in the gradual and constant release of nutrients. N tests, which were approved using maize as a model system, revealed that N-use productivity from nano fertilizer was 82% and that of conventional compost (urea), which tallied 42% with a net greater nitrogen-use productivity of 40% that is not actually possible in the conven-tional system. This suggests that using nano fertil-izers as a mechanism to manage the rapid arrival of supplements that are similar to crop require-ments may be useful. Plants treated with nano particles showed a significant improvement in NUE. In general, there was a 3-4 times increase in usage efficiency.

A plant must continuously deal with a number of biotic and abiotic stressors during the growth cycle leading up to harvest. Major abiotic stressors, such as dry spells, heat, salt, waterlog-ging and cold, among others, result in significant crop loss to farming around the world by lowering yield and crop quality. With regard to reducing salt pressure in Solanum lycoper-sicum, lithovit, glycinebetaine, acetylsalicylic acid and mono-potassium phosphate fertilizers were evaluated. Lithovit was shown to be the most successful, boosting the yield by 76%. Application of nano silicon is shown to be more efficient and effective than application of normal silicon in reducing salinity stress.

Advantages of Nano Fertilizers

Due to their simplicity of synthesis, nano fertilizers have an additional benefit in that they may be made while taking into account the nutrients required for a particular crop. In addition, the large surface area, size and reactivity of the nano particles contribute to the bio-availability of nutrients. Nano particles allow cultures to elimi-nate a number of problems, such as biotic and abiotic stressors, by delivering the components in a balanced manner. However, there may be significant drawbacks and restrictions associated with the extensive use of nano fertilizers in agric-ulture, which call for particular consideration.

Different advantages of Nano Fertilizers

- Improved nutrient utilisation effectiveness.
- Longer fertilizer release window.
- 50% less chemical fertilizer use is recom-mended.
- 30% more nutrients were mobilized.
- An increase of 15–30% in crop yield.
- Lower toxicity of the soil.
- Minimize the impact of an overdose.
- Improved plant system nutritional security and prevention of nutrient loss.
- Greater tolerance to pathogens and pests.
- Enhance the soil's quality and ability to store water.

Conclusion

The purpose of nanofertilizers, according to science, is to increase agricultural outputs, which are defined by careful seed selection and uniform seed distribution, complete irrigation and appropriate as well as controlled fertilizer usage. This phenomenon is influenced by a number of variables, such as the kind of soil, how other nutrients combine chemically with it, the amount of leaching, and how well plants absorb nutrients. When applied in the right quantities and overcoming the drawbacks of traditional fertilizers, nanofertilizers have a huge potential to increase

agricultural output at the required price.

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ISSN No. 2583-3146

Importance of Integrated Fish Farming In Rural Economic Development

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Introduction

Rural economic development has ample importance in all over sustainable development of a country. So rural livelihood development must be prioritized to uplift the status of rural economy in large scale. Crop production could not be the only option to reach our ultimate goal. Integrated farming system should be adopted by which we may avail required food security along with sustainable socio-economic development. Integrated fish farming is such a beneficial method that may bring a drastic change in the earn ability and nutritional status of rural community. We must go for optimum level of natural resource utilization to get a balanced development with growing population. If fish farming would be combined with animal husbandry and crop cultivation, it may lead to proper natural resource utilization and enhanced livelihood. The diversified approach used in such integrated farming process may take part in reducing economic risks. Though it faces several challenges at the time of ground level implementation, it must be said that it could be used as a magic stick to facilitate the developmental scenario of country nation.

Objectives of the Study

The main objective of the study is to highlight the unbounded prospects of development of the fishery sector of West Bengal. It also aims to show that there is huge potentiality of employment generation for fisher men, farmers and their family members in the aquaculture.

Methodology

Methodology: Data and information's have been collected from different secondary sources and are analyzed.

Project Utility

- Introduces the field fisheries to the reader and throws light on the concept of rural development simultaneously.
- Followed by the Socio Economic impacts of the fisheries' developments.
- Allows investment in order assets or enterprises such as land, livestock or fishing gear which is turn can further vulnerability to poverty.

Advantages of Integrated Fish Farming

a. Productivity: IFS provided an opportunity to increase economic yield per unit time by virtue of intensification of crop & allied enterprises.

b. Profitability: Use waste material of cost. Thus, reducing of cost of production and form the linkage of utilization of waste material.

c. Balanced food: Produce different sources of nutrition.

d. Environmental Safety: In IFFS waste materials are effectively recycled by linking appropriate components. Thus, minimize environment pollutions.

e. Recycling: Effective recycling of waste material in IFPS.

f. Saving Energy: To identify an alternative source to reduce our dependence on fossil energy source within short time.

g. Employment Generation: Combing crop

with live stock enterprises would increase the labour requirement significantly & would help in reducing the problems of under employment to a great extent IFS provide enough scope to employ family labour round the year.

h. Fodder crisis: Plantation of perennial legume fodder trees on field borders & also fixing the atmospheric nitrogen.

i. Agro-industries: When one of produce linked IFS are increased to value adoption leading to development of allied agro-industries.

Disadvantages of Integrated Fish Farming

a. Integrated fish farming is having some benefits but farmers have experienced many difficulties though. We can say that lack of capital and resources may be the major constraint.

b. To execute such projects good; level of skills and knowledge are required but in rural areas poor farmers lack that level of training and education.

c. For making such projects financially successful, we need systematic management and marketing skills. Lack of these endear owes cause the failure of integrated Fish farming.

Challenges of Integrated Fish Farming

There are some challenges of integrated fish farming, as we know that there are more than one systems of integrated fish farming, each system having its own disadvantages too.

a. Major production constraints are labor & animal feed storages throughout the year.

b. Long transition time may be required for implementation of multi enterprise agriculture model.

c. High start-up costs may restraints farmers from switching to multi- enterprise system and enjoy the benefits of resources integration.

d. Disincentive from government subsidies in adopting multi enterprise agriculture system, credits for fertilizers and herbicides are the constraints.

Expected Economic Analysis to grow a Integrated Fish Farming

Source: Central statistical office, Extract for Hand book of fishery statistics, 2020

Fig: 1: GDP Contribution from Fisheries Sector

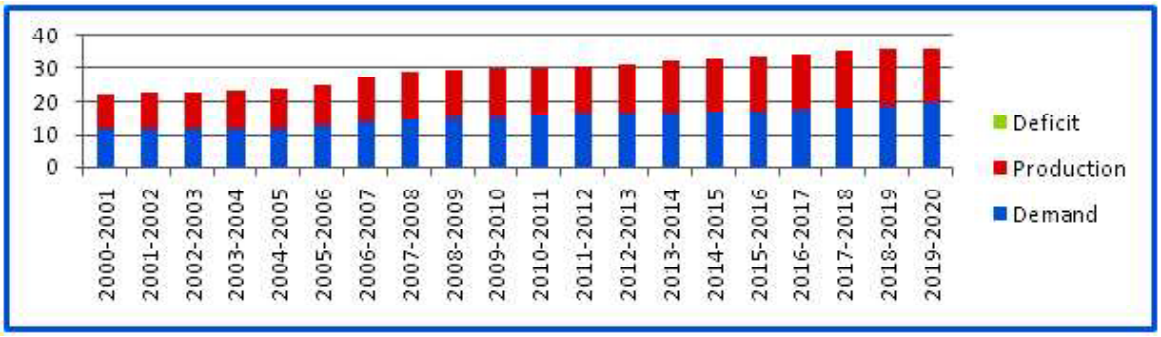

Fig 2: Demand & Production of Fishes in West Bengal

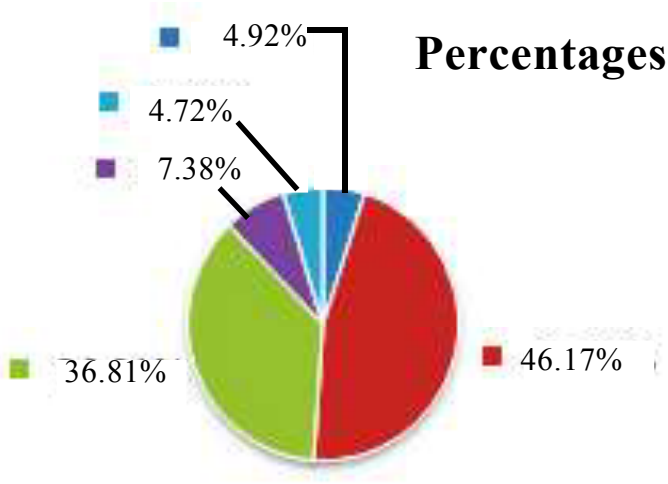

Fig: 3: Inland Fishery Resources of West Bengal

Table: 5: Prospects of Ancillary Business of Fishery Sector

Areas	Prospects
Fish Feed and Disease Management	Immense scope for setting up fish feed plants. Ever growing demand for fish medicine and prophylactics
Fish Processing Units for Export	West Bengal is one of the major export epicenters for sea and processed fish in the world.
Development of Cold Chain	Essential for increasing shelf life of fishes and Fetching remunerative prices for farmers.
Modern Hatcheries	Potential to set up hatcheries for seed production of new species.
Aqua Farming With Bio Floc and Ras Techniques	Immense scope for aqua farming of Indian and Exotic carps.
Ornamental fish farming	Tremendous opportunities to set up Mother Hatcheries and Ornamental Hubs in PPP for Ornamental Fish.
Deep Sea Fishing including	The State offers opportunities for Deep Sea fishing, manufacturing of vessels, gears, etc
Modern Fish Markets	Demand for modern, clean, air conditioned fish markets on the rise. Fish retail chains coming up.
Manufacturing and Packaging Units	Scope to set up manufacturing and packaging units for Packaged Fish, Aquaponics, Bubblers, Solar Fish Driers etc.
Value Addition	Enormous demand for ready to cook, ready to eat fish items waiting to be tapped
Fish Eco-Tourism	Opportunities abound in Aqua Sports, Amusement and Fish Eco -Tourism Lodges

Source: http://www.wbfisheries.in/opportunity-for-investors.php on 19.5.2022 at 9 am

Tips for Fish Farming

Some suggestions could be followed to facilitate the application of integrated fish farming for enhancement of rural economy as follows:

- Fish farming should be combined with agricultural production activities along with poultry and animal rearing in large scale to reduce the seasonal income fluctuations in rural areas.
- Fish waste could be used in promotion of organic farm productivities.
- More market research must be done to analyze the future viability of specific project
- Timely process monitoring and evaluation is highly needed to enhance the quality production
- More skill training and awareness programs should be organized

Conclusion

Integrated Fish Farming is a very effective way of farming as it relies on the concept of fall utilization of waters. Integrated Fish Farming provides various types of food items that implore the nutrition value for farming. Due to which it lusts the efficiency to improve farm productivity. Integrated Fish Farming can generate balanced food ensuring environmental safety and security while saving energy.

If precautions can be implemented for overcoming disease, environmental issues and other challenges, Integrated Fish Farming can be very productive model of farming.

Undoubly, Integrated Fish Farming gives opportunity of income rounds that can improve socio-economic situation of rural areas by generating more employment, lump sum income of villagers and this can contribute in the execution of sound environmental management.

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ISSN No. 2583-3146

Major Fungal Diseases of Mustard and Their Management

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Introduction

Indian mustard (*Brassica juncea* L.) is one of the most important winter oilseed crops and India is the third largest rapeseed-mustard producer in the world after China and Canada with 11.12% of world's total production (DRMR, 2012-13). Rapeseed Mustard is the second most important oilseed crop in India after soybean and accounts for nearly 20-22% of total oilseeds produced in the country. Mustard seed is grown with a different consumption pattern in the country, Indian mustard is mainly used for extraction of mustard oil while black mustard is mainly used as a spice. Improved varieties plays a crucial role in raising the seed yield of the crop. Development of HYV's of mustard has been one of the major concern of the scientists because use of the improved varieties alone accounts for 15-20% increase in productivity among the oilseed brassicas, yellow var.

Yellow brown var. brown toria var. Indian mustard Karan Rai and oilseed rape are grown for edible oil, where as black mustard is used as condiment and for pickle making, food preserving and spices to improve flavour, also as fodder for live-stocks. The leaves of young plants are used in the human diet as green vegetable. Mustard seed and oil has multiple uses in health care system. It improves the body complexion because of its antifungal property.

It is used as a very good massage oil, which brings vitality and strength to the body and improves the circulatory system and cures body ache. It also kills various microbes and thus, keeps skin infections away. Oral doses of oil help in strengthening the teeth and cure various mouth related diseases. It helps in healing wounds by stopping the pus formation and in curing various skin disorders by removing unwanted fluids from the body (Kumar and Chauhan, 2005). Erucic acid and glucosinolate are the two major deterrents of oil and seed meal in oilseed brassica, respectively (Singh 2013). The oilseed brassicas usually contain 38-57% of erucic acid, 4.7-13% linolenic acid and 27% of oleic and linoleic acid, which are of high nutritive value required for human health.

Alternaria blight

It is caused by *Alternaria brassicae*, this is a common disease of mustard occurring on the foliage at any stage of the growth. The disease plays havoc with the crop by reducing its photosynthetic area, growth and seed yield.

Alternaria blight attacks all the green aerial parts of the plant reducing its photosynthetic area and vigour. The disease, in northern parts of India is usually seen during mid December to early January as chlorotic specks, later turning into minute dark-brown or black spots on lower leaves of young plants. On older leaves, the spots turn into circular, dark-brown, sunken necrotic lesions surrounded by light yellow halo and bear conidiophores and conidia in concentric rings, at the grayish white centre, giving them a target board effect.

Management

Crop rotation helps reduce disease carryover but does not eliminate airborne spores from another field. Clean seed to remove shrunken seed that may be infected with black spot and have low viability. Spray of mancozeb @ 2 g/l, Spraying 1

percent Bordeaux mixture or 2g Copper oxychloride or 2.5 g Zineb per litre of water effectively control.

Sclerotinia stem rot

It is caused by *Sclerotinia sclerotiorum*, this is a common disease of mustard occurring on the foliage at any stage of the growth. As the incidence of this disease was noticed up to 72 percent in Rajasthan and up to 80 percent in Punjab and Haryana also observed up to 49.2 percent disease incidence from Haryana, however, in few areas the disease incidence has approached up to 80 percent. Losses in yield up to 72 percent from Uttar Pradesh and up to 50.9 percent from Rajasthan in mustard due to this disease have been also reported.

The stems develop water-soaked spots which later may be covered with a cottony white growth. As the disease progresses, affected portions of the stem develop a bleached appearance and eventually the tissues shred. Girdling of the stem results in premature ripening and in lodging of plants. Hard black bodies, the sclerotia, are formed inside the stem and occasionally on the stem surface. Basal stalk infections rarely occur.

Management

Use at least a five year rotation for severely infested fields. Avoid planting next to a field that had severe Sclerotinia in the past four or five years. Control broad-leaved weeds. Plant thoroughly cleaned seed. Seed treatment with carbendazim @2g/kg seed, drenching with carbendazim@ 2g/lt. of water is effective and spray of carbendazim @2g/lt. of water in satnding crop is effective.

White rust

It is caused by Albugo candida is one of the major causes in low productivity of rapeseed mustard due to its destructive nature. In India, yield loss due to this disease was 17- 34 per cent in Indian mustard and 34 per cent in toria. The pathogen causes potential yield loss of upto 89.9 per cent due to foliar and floral infection. Seed yield loss up to 36.88 per cent in mustard due to white rust disease was reported.White to creamy yellow pustules develop on the lower leaf surface. The pustules, later coalesce to form patches on the lower leaf surface. Tan-yellow spots develop on the upper leaf surface opposite the pustules. Pustules may also form on the pods.

Management

Select resistant varieties. See current variety recommendations for information on susceptibility. Use at least a three year crop rotation. Control volunteer canola and susceptible mustard-type weeds in the rotation.Use "Apron SD-35" (metalaxyl) at 6 g/kg seed (protect for 60 days) or "mancozeb" at 92.5 g/kg seed to treat the seeds. At intervals of ten days, apply Ridomil MZ-72 (0.1%), mancozeb (0.25%) or Bordeaux mixture to the crop.

Downy Mildew

It is caused by Peronospora parasitica, this is a common disease of mustard occurring on the foliage at any stage of the growth. Leaf spots initially are angular, translucent, light green, later developing into grayish-white irregular necrotic (dead) patches. bThe stems of flower clusters become swollen. Frequently associated with white rust. May develop late in the season on turnip-type (Polish) canola varieties.

Management

Sanitation of the soil and crop rotation help in reducing the occurance of the disease. Weed host plants should be searched and destroyed. Spray fungicides at regular intervals.Broad spectrum protectant fungicides such as chlorothalonil, mancozeb (0.25) and fixed copper are at least somewhat effective in protecting against downy mildew infection.

Conclusion

Fungal diseases remain a persistent challenge in mustard cultivation, threatening both crop yields and quality. Vigilance, preventative measures, and integrated disease management approaches are vital to combat these fungal infections effectively. Researchers and farmers must continue to work together to develop resilient mustard varieties and sustainable practices to minimize the impact of these diseases on mustard production.

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ISSN No. 2583-3146

Rust of Wheat and Their Management

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Introduction

Wheat (*Triticum aestivum L.*) is the most important staple food of the world. In India it is one of the main food crops next to rice. It is produced annually on over 30 million hectares of land, yielding about 103 million tonnes of grain.

Incidences of pests and pathogens are rising as agriculture becomes more intensive. There are now new biotic concerns such as stem rust pathogen Ug 99, stripe rust pathogen virulence for resistance gene Yr9, and wheat blast. Reduced production impact from biotic and abiotic challenges will be essential to maintaining and growing wheat production.

The most well-known aspect of wheat rust diseases is their widespread and deadly character, even though many biotic stressors hinder wheat production. While leaf rust can only cause a 50% loss, stem and stripe rust can both cause a 100% loss. In India, 10 million hectares of Northern India are under risk from stripe rust of wheat (*Puccinia striiformis* f. sp. *tritici Westend*., Authority), while roughly 7 million hectares of Central and Peninsular India are at risk from stem rust (*Puccinia Graminis Pers*. f. sp. *tritici* E riks. & Henn).

This article's main subject is on serious wheat diseases and their management. Three wheat diseases, stem, leaf and stripe (yellow) rust, caused by *Puccinia graminisf*. sp. *tritici*, P. *reconditaf*. sp. *tritici* and P. *striiformisf*. *sptritici*, respectively cause important losses of grain production (McIntosh *et. al.*, 1995).

Black Rust (Stem Rust)

It is caused by *Puccinia Graminis* f. sp. *tritici* which was once a widely severe disease of the wheat crop. It made sense to be afraid of stem rust since, three weeks before to harvest, a crop that seemed healthy could turn into a black tangle of broken stems and shrivelled grain by harvest time.

The initial sign of rust infection is flecking on the leaves, culms, floral structures and leaf sheaths. These are the precursors of uredosori, which appear as rectangular, reddish-brown pustules that eventually burst to reveal a mass of brown uredo spores. These pustules often merge with one another. Even from a distance, the entire leaf blade and other affected areas will appear brownish when a significant number of urediniospore burst and release their spores. Later in the season, teleutopsore are produced. The term "black rust" originates from their noticeable, oblong or linear, dark-brown to black lesions that frequently merge together to form linear patches of black lesions. Sulphur dust of 400 mesh fineness when applied @15kg/ha at weekly interval. Seed dressing with Plantvax protects seedlings for about 7 weeks from rust. Wheat varieties of N.P. 700 and N.P. 800 are resistant to this rust.

Symptoms of stem rust on stem

Leaf Rust (Orange Rust)

It is caused by *Puccinia recondita*, losses due to leaf rust are usually small (less than 10 percent), but can be severe (30 percent or more) under favourable environmental conditions. The symptom of the disease is the appearance of minute round, orange sori, irregularly distributed on the leaves, rarely on the leaf sheath or stem. Uredia are seen as small, circular orange blisters or pustules on the upper surface of leaves. When the sori mature, they turn brown and the orange urediniospores are replaced by black teleuto-spore. Pustules containing these spores are black and shiny since the epidermis does not rupture..When the infection is severe, leaves dry out and die. Since the inoculum is blown into a specific location, higher leaves are frequently the first to exhibit symptoms. The telial stage may occur in the same pustule as the disease progresses. The telia are tiny, black, two-celled, elliptical to linear and epidermis-covered. Additionally, the leaf sheath is where the telia form. Destroy collateral host, early sowing of crop and avoid high nitrogen content fertilizer. Zineb-zinc sulphate combination is effective in controlling brown rust, when sprayed 4-5times @ 1kg/450L of water per acre during crop season

Symptoms of leaf ruston leaf

Foliar symptoms of orange rust

Stripe Rust (Yellow Rust)

It is caused by Puccinia striiformis and is distributed world wide. In India it is common on wheat and barley in the Gangetic plains and rare in the west and peninsula region. Although it occurs every year, it is only occasionally serious, causing considerable damage to crops. Yellow streaks develop first, and are followed by small, bright yellow, elongated uredial pustules on leaves, leaf sheaths, glumes and grains that are arranged in linear rows. Teleutosori appear at the end of the season, also in linear rows. They are more abundant in leaf sheaths than in leaf blades. Teleutospores can often form in uredosori. They are compact, elongated and black and remain sub-epidermal. Sulphur dusting @35-40kg/ha and mancozeb @2g/l of water is found most effective. Application of para toluene sulphonyla-mide to the soil @ 1 gm/sqare metre is effective in reducing stem rust incidence. Two sprays of carboxin @ 1% give good control.

Symptoms of Stripe Rust on leaf

Conclusion

The main staple food after rice farmedona global scale is wheat (Triticum aestivum L.). Wheat rust is still a recurring problem in the global agricultural sector, although it may be efficiently controlled to improve wheat's yield and nutritional content through the implementation of best management practices.

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ISSN No. 2583-3146

Aerial Root Pruning: Root Trainers for Production of Quality Planting Material in Grapes

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Introduction

Grapevine (*Vitis* spp.) is one of the most widely grown fruit crops in the world, due to its increased demand in both domestic and international markets to meet this ever-growing market demand, there has been an area expansion to the tune of 20% every year. The estimated annual planting material in grapes farming sector is approximately 4.8 crores. Conventionally, the self-rooted stem cuttings are used as the planting material, for direct field planting or for in-situ grafting in grapes. However, high mortality of nursery plants raised in polybags (50%) warrants alternative efficient growing containers/media for quality planting production in grapes.

Root trainers are specially designed plastic containers made from polypropylene that has vertical ridges inside to promote fast and healthy growth of roots. They stimulate well established root system by preventing tap root coiling the size and shape of the containers also eases transporting and handling seedlings, Grace and Zaragoza (2019).

Generally, grape rooted cuttings will be maintained in the nursery for a period of four months before transplanting to the field. When raised in polybags for such longer periods, the plants will have the tendency to overgrow, the roots reaching the bottom end of the bag, coil or tear the polybags, allowing roots to penetrate the soil beds in the nursery. This may disrupt the root structure, leading to root damage while transferring plants from nursery to field. These planting activities may cause severe harm to the root system and soil core. Numerous factors, including the type of cuttings, the season of propagation, the rooting medium used and the type of container used, have been identified as influencing the rooting of cuttings in plants. A good rooting medium in combination with an appropriate container is crucial inputs for the rooting and success of grape nursery plants. Aerial root pruning with root trainers is a novel technique for propagating grape rootstocks and it is very useful alternative technique for producing high-quality planting material.

A container's primary function in a nursery is to store the potting medium, nutrients and water required for the plant, as well as to offer the necessary physical and mechanical support to the planting stock during its life in the nursery and while being transported to the planting site. The container should also assist the potting material in storing and releasing nutrients, water, air, light and temperature optimally. It should also have the ability to reduce planting stock with a strong root system. This is critical for ensuring successful plant establishment and consistent growth. Due to these reasons, root system should be free of problems such as root coiling, root strangling and root deformation and it should have a balanced root-shoot ratio and a well-developed lateral root system with strong regeneration capacity. Furthermore, a container for use in large-scale nurseries should allow for easy handling of

planting stock while also contributing to cost-effectiveness, eco-friendliness and ease of nursery and planting processes.

Root trainers will help to grow the plant roots in a specific pattern. Ideally, the roots will grow straight without coiling around, making a plant plug. The grooves inside on the trainers enable the roots grow downwards, preventing the plant from root tangling in the potting medium. The hole at the bottom of the trainer allows air pruning of the roots in addition to proper drainage of excess water in the medium. Root trainers allows roots of plants to come into contact with the air as they grow in the nursery.When the fully grown root tips get exposed to the air, the individual root tip dries out and stops growing as a natural process. As a result, the plant produces even more fibrous lateral roots. It will provide a dense fibrous root system to the healthy plant, ready to take nutrients and water to the plants. Some of the advantages of air-pruning include reduced transplanting shock, faster growth after transplant, reduced-even elimination of coiled roots, even soil moisture and reduced susceptibility to root rot and disease.

Air contact of the root tips, self-pruning and well-aerated planting medium helps the plants to experience little stress and these subsequently leads to the emergence of a significant quantity planting material with well-established shoots, of well-develop lateral roots without deformation as previously reported when the plants are grown in polybags.

Alternatives such as root trainers are being developed to encourage healthy root growth and prevent injury during planting. It is labor-saving environmentally beneficial because these containers are reused and cost-effective, particularly for commercial applications. Plants cultivated in root trainers or plastic containers exhibits superior morphological characteristics, such as height and stem diameter, to those cultivated in polybags (Ginwal *et. al*., 2001).

Root trainers are extensively used in forest nurseries, for woody hardwood perennial plants. It reduces problems like pests and diseases associated with the use of soil and reduced use of soil fumigants are equally possible.

Establishment of cutting is highly dependent on the quality of potting mixture, appropriate growth media act as a reservoir for plant nutrients, retain available moisture for the plants, facilitate gas exchange, and provide adequate anchoring for the plants Galavi *et. al*., (2013). lack of one or more of these, results in a decreased percentage of cuttings rooting or poor root shape. Growing media should have several advantages, including being less in weight and more compact, being more eco-friendly due to the media's container being reusable, improving root growth and reducing labour costs due to more efficient design and simpler in handling. Thus, producers often make healthy potting mixtures using different media combination. Long durability is another advantage of root trainers, making them suitable for use in multiple growing seasons.

Increased root number and thus root volume may have increased the plants' ability to absorb more nutrients and water from the media. Furthermore, when compared to traditional approaches, root trainer has a longer life span and takes less space Sharath and Bhoomika (2018).

In grapes, when compared to conventional polybags, root trainers proved the better containers for raising nursery plants. Plant sprouting was highest in root trainers (95%) compared to polybags (50-60%). Survival rates are significantly greater during outplanting and over time. Plants produced in root trainer systems become ready for transplantation in lesser time while still much smaller than plants cultivated in ordinary polybags. Due to the well-developed healthy root system, root trainer grown stocks have strong root growth potential, the stock establishes itself significantly more quickly and with early subsequent growth in the main field. This improves post-planting survival, as well as subsequent growth and development. Thus root trainers can play crucial role in meeting the huge demand of high quality planting material, with significant contribution in crop yields and quality

indirectly.

Conclusion

Among the two containers tested, the root trainers performed well when it was compared to polybags. This could be owing to the favorable conditions established in the root trainers for good root growth and development as a result of mechanism known as air pruning. It helps in natural pruning or ceasing of root growth at the point of air exposure at the bottom, fostering the development of more fibrous roots. Increased root number and thus root volume may have increased the plants and ability to absorb more nutrients and water from the media. Furthermore, when compared to traditional approaches, root trainer has a longer life span and takes less space.

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ISSN No. 2583-3146

Use of Plant Growth Regulators in Solanaceous Crops

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Introduction

Plant growth Regulators are the organic chemical compounds which modify or regulate physiological processes in an appreciable measure in the plants when used in small concentrations. They are readily absorbed and they move rapidly through the tissues when applied to different parts of the plant. "Plant hormones" are also regulators but are produced by the plants in very low concentration and these hormones move from the site of production to the site of action. Therefore, the difference between the plant regulator and plant hormone is that the former one is synthetic while latter is natural from the plant source.

Plant growth regulators considered as a new generation of agrichemicals when added in small amounts, modify the growth of plants usually by stimulating or modifying one part of the natural growth regulatory system, thereby the yield is enhanced. Higher production through breeding is a continuous endeavour of mankind. But, these methods are however, not only time consuming but also costly. The growth regulators have therefore, been known to be one of the quick means of increasing production.

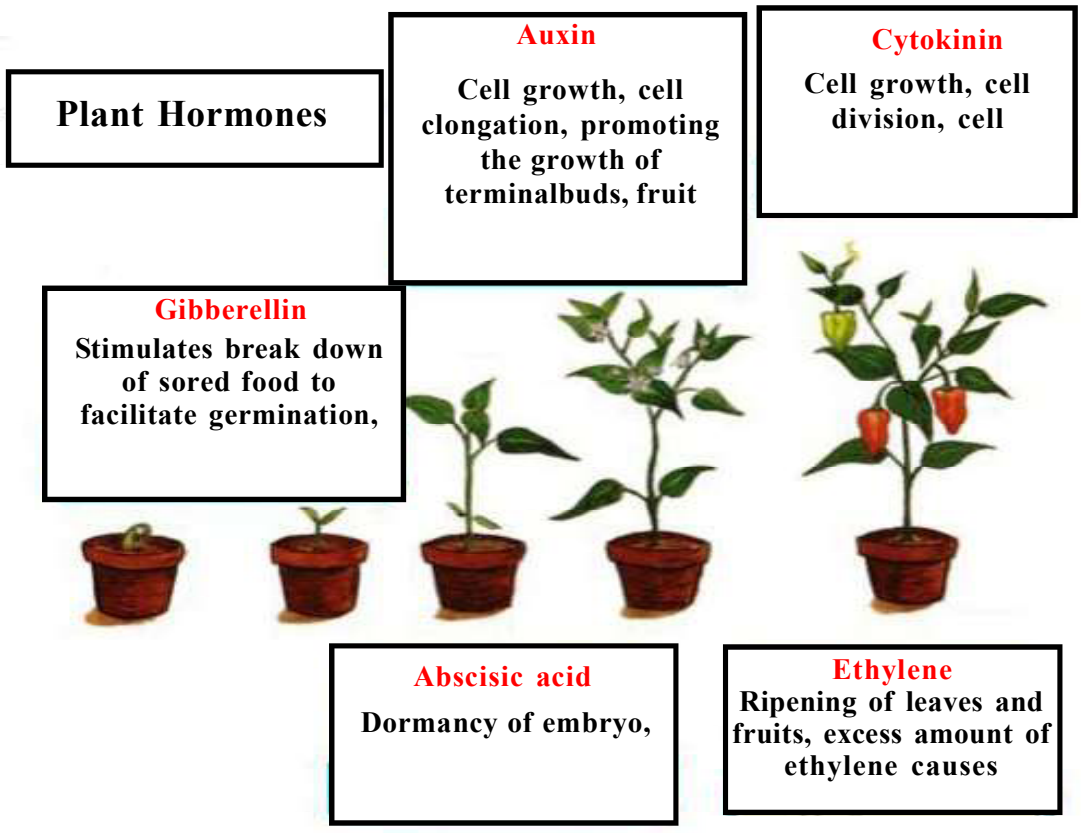
Plant Hormones	Plant Growth Regulators
Chemicals produced naturally by the plants.	Chemicals either produced naturally by the plants or synthesized artificially by humans.
Synthesized as result of plant metabolic processes.	Formulated by humans.
These are Endogenous.	These are Exogenous.
These are long lived chemicals. Hence, the effect is long lasting.	These are short lived chemicals. Hence, the effects are temporary and reapplication is required.
Ex. Auxin, Gibberellins, Cytokinins, Ethylene and Abscisic Acid.	Ex.NAA, IBA, Ethephon, etc.

Solanaceous crops

The family Solanaceae, or nightshades, is an economically important family of flowering plants. The family ranges from annual and perennial herbs to vines, or either shrubs, or trees, including a number of important vegetable crops like tomato, pepper, eggplant, white and red potato, and tomatillo. This family also contains several plants that are considered toxic to humans being such as the weeds jimsonweed, nightshade and mandrake. Many members of the family contain potent alkaloids that are having immense value by considering its nutritional value.

Major plant growth regulators used in Solanaceous crops

Class	Examples	Associated functions
Auxins fruit	IAA, NAA, IBA, 2-4D, 4-CPA	Apical dominance, Root induction, Control drop, Regulation of flowering, Parthenocarpy.
Gibberellins	GA3	Stimulate germination of seeds, Stimulates flowering in response to long days, Increase flower and fruit size.
Cytokinins	Kinetin, Zeatin	Stimulate bud initiation and root growth, Translocation of nutrients, Prolong storage life of vegetables.
Ethylene	Ethereal	Induce uniform ripening in vegetables, Senescence of leaf.
Abscisic acid	Dormin, Phaseic Acid	Dormancy induction of buds and seeds, Induces seeds to synthesize storage proteins, Stomata closing.



Major Plant Growth Regulators

a. Auxins: Charles Darwin was the first who proposed the existence of Auxin in 1880. The word Auxin is from Greek word i.e., Auxein (to grow). Auxins comes from the work on oat (*Avena sativa*) coleoptiles. Auxins are those compounds that give positive effect on formation of bud, enlargement of cell and root initiation and they are also helpful for the formation of other growth hormones.

Precursor: Tryptophan (Amino Acid)

Synthesis: Meristematic tissues.

Transport: Phloem

b. Gibberellins: Kurosawa was the Japanese scientist who discovered gibberellins in 1926. It is the second growth regulator. It was first extracted from the fungus *Gibberella fujikuroi* (*Fusarium moniliforme*), the causal organism of "foolish seedling of rice" or commonly called Bakanae disease of rice. Gibberellic acid when applied to intact growing plants induced abnormally great extension of stems and leaves.

Precursor: Mevalonic acid

Synthesis: Young leaves, shoot tip, root tip and immature seeds.

Transport: Xylem & Phloem

c. Cytokinins: Cytokinins were discovered by F. Skoog, C. Miller and co-workers during the 1950's as factors that promote cell division (Cytokinesis). Letham (1963) extracted, purified and crystallized Cytokinin from immature kernel of maize and named it as Zeatin.

Precursor: Adenosine Monophosphate.

Synthesis: Root tips, developing seeds and cambial tissues

Transport: Roots to shoots (xylem)

d. Ethylene: Neljubow (Russian plant physiologist) was the first to show the importance of ethylene present in the illuminating gas as a growth regulator of plants in 1901. He observed that dark grown pea seedlings growing in the laboratory exhibited symptoms that were later termed as triple response reduced stem elongation, increased lateral growth and abnormal horizontal growth. Gane established that ethylene is actually a natural product of ripening fruits in 1934.

Precursor: Methionine

Synthesis: Tissues (senescence or ripening)

Transport: Diffusion

e. Abscisic Acid: This growth inhibitor was isolated in buds of *Acer pseudoplatanus* by Philip Wareing in 1963 and named Dormin. It is also called plant stress hormone. It acts as inhibitory chemical compound that gives direct effect on growth of bud, seed and dormancy of bud.

Precursor: Mevalonic acid

Synthesis: Roots, mature leaves, seeds

Transport: Roots (xylem) & leaves (phloem)

Other Plant Growth Regulators used in Solanaceous Crops

a. Jasmonates (Jasmonic Acid): In 1990, airborne Jasmonic Acid Methyl Ester (JAME) was shown to induce Proteinase inhibitors in tomato, there by attributing to an 'immunization' against herbivore attack.

b. Growth Inhibitors: These are substances which suppress the growth of plants. Ex. Maleic hydrazide, TIBA, etc.

c. Growth Retardants: These are diverse groups of chemical having common physiological effect of reducing stem growth by inhibiting cell division of the sub- apical meristem. Ex.CCC, Phosphon-D, etc.

Commercial Utility of PGRs in Solanaceous crops

a. Growth Parameters

- Application of GA_3 at 80 ppm and NAA at 100 ppm increased plant height of Tomato.
- GA_3 @ 20 and 60 ppm gave maximum plant height in Chilli.
- In Capsicum, NAA @ 60 ppm gave maximum plant height.
- GA_3@ 150 ppm gave highest plant height in Brinjal.
- Foliar application of ethrel at 250 ppm increased plant height in Potato.

b. Inhibition of sprouting: Soaking potato tuber in IAA @ 250 to 1000 ppm solution prolongs dormancy.

c. Flowering: Application of GA_3 at 50 mg/l to young leaves of non- flowering varieties of potato, when floral buds had just formed, resulted in flower induction in all varieties.

d.Seed Germination: In tomato, higher germination with GA_3 at 0.5 mg/l, and 2, 4-D at 0.5 mg/l is reported.

e. Parthenocarpy: PCPA 50-100 ppm induced parthenocarpy in tomato and brinjal

f. Gametocides: GA_3 at 100 mg/l can also be used for inducing male sterility in pepper.

g. Stimulation of fruit set: Poor fruit set is a major problem in solanum crops. In tomato apply 4-CPA or PCPA 50-100ppm enhance the fruit set and earliness.

h. Fruit ripening: Ethephon, an ethylene releasing compound, has been reported to induce ripening in tomato and pepper. Application of Ethephon at 1000 mg/l at turning stage of earliest fruits induced early ripening of fruits thus increasing the early fruit yield by 30-35%. Postharvest dip treatment with Ethephon at 500-2000 mg/l has also been reported to induce ripening in mature green tomatoes.

i. Fruit yield enhancer: Soaking of seed in NOA at 25-50 mg/l, GA_3 at 5-20 mg/l and CIPA at 10-20 mg/l has been reported to improve fruit yield in tomato. In brinjal soaking of seedlings roots in NAA at 0.2 mg/l and ascorbic acid at 250 mg/l has been reported to produce higher fruit yield. Application of 2, 4-D @ 2 ppm, Triacontanol @ 5 ppm, NAA 40 ppm and GA_3@ 10 ppm produced maximum fruit yield in Chilli.

j. No. of Seeds per Fruit: Maximum numbers of seeds per fruit were recorded in 2, 4- D @ 7.5 ppm treated plants in Chilli.

Conclusion

Plant Growth Regulators are extensively used in Solanaceous crops especially for better growth, better fruit yield and better seed yield parameters. GA_3 is majorly used for seed germination in Solanaceous crops. PGR is of great use of farmers which want their crops to get more yield and thus more profit but PGR should be applied at particular dosage.

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ISSN No. 2583-3146

Management of Wilt Disease In Pigeonpea

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Introduction

Fusarium wilt (*Fusarium udum* Butler) is an important soil borne disease of pigeonpea [*Cajanuscajan* (L.) Millsp.], which causes significant yield losses in susceptible cultivars throughout the pigeonpea growing areas. In India, the annual loss due to this disease is estimated at US $71 million (Reddy *et. al.,*1993). Fusarium wilt causes economic loss in pigeonpea of about 470, 000 t of grain in India and 30,000 t of grain in Africa (Joshi *et. al.,*2001). Kannaiyan *et. al.,*(1984) reported wilt incidence (and range) in Kenya, Malawi and Tanzania of 15.9% (0-90%), 36.6 (0-90) and 20.4% (0-60%) respectively with annual loss estimated at US $ 5 million in each of the countries. In Tanzania, an incidence of Fusarium wilts as high as 96% has been observed (Mbwaga 1995). Losses due to wilt in Kenya vary from negligible amount to 100% depending on the stage of the crop and environmental factors (Kannaiyan and Nene 1981; Sheldrake *et. al.,*1984).Although numerous control measures have been suggested to alleviate the problem of wilt and increase productivity of pigeonpea, their success still remains low due to prohibitive cost of practices and labour-constrained smallholder producers.

These practices are both resource and knowledge intensive and small farmers often find it difficult to control the disease especially when the rate of field infestation is high. Research on disease management strategies for *F. udum* may be relevant to areas where the disease is important. This paper reviews the literature on the distribution, symptomalogy, pathogenecity, factors affecting its spread and control strategies of the disease. The paper also suggests priority areas for future research.

Symptomatology: Being a soil-borne pathogen, *Fusarium udum* and the fungus enters the host vascular system at root tips through wounds leading to progressive chlorosis of leaves, branches, wilting and collapse of the root system (Jain and Reddy 1995). Although the infection occurs in the early seedling stage, symptoms are not visible until later in crop developmental stages (Reddy *et. al*., 1990; Hillocks *et. al*., 2000). The initial visible symptoms are loss of turgidity in leaves and interveinal clearing. The leaves shows slight chlorosis and sometimes becomes bright yellow before wilting (Reddy *et. al*., 1990). Partial wilting of the plant as if there is water shortage even though the soil may have adequate moisture distinguishes this disease from termite damage drought and phytophthora blight that all kill the whole plant. Leaves are also retained on wilted plants. Partial wilting is associated with lateral root infection, while total wilt is due to taproot infection (Nene, 1980; Reddy *et al*., 1993). The most initial characteristic internal symptom is a purple band extending upwards from the base of the main stem. The xylem develops black streaks and this results in brown band or dark purple bands on the stem surface of partially wilted plants extending upwards from the base visible when the main stem or primary branches are split open (Reddy *et. al*., 1990; Reddy *et. al*., 1993). This band is more easily seen in pigeon peas with green stems than in those with colored stems. The intensity of browning or blackening decreases from the base to the tip of the plant. Sometimes,

branches (especially lower ones) dry, even if there is no band on the main stem. These branches have die-back symptoms with a purple band extending from tip downwards and intensive internal xylem blackening (Reddy *et. al*., 1993). When young plants (1-2 months old) die from wilt, they may not show the purple band symptom, but have obvious internal browning and blackening.

Pathogenic races: The existence of variants/ races of *F. udum* has been reported and has been cited as a major drawback in the development of pigeonpea varieties resistant to Fusarium wilt (Okiror and Kimani, 1997). *F. udum* isolates from the same site or diverse geographical origins have been shown to exhibit high variability in cultural characteristics (Reddy and Chaudhary, 1985; Gaur and Sharma, 1989) and virulence or pathogenicity on pigeonpea genotypes (Parmita *et. al*,. 2005). Baldev and Amin (1974) tested 10 isolates of *F. udum* from various sources on 10 pigeonpea lines. Only three genotypes showed resistance to all the isolates. They also characterized these isolates as the races of this fungus. In Malawi when 60 isolates were inoculated onto the highly susceptible pigeonpea line ICP 2376, all but seven isolates were pathogenic (Soko *et. al*., 1995).

In a study to verify diversity in *F. udum* on pigeonpea in Kenya using several isolates of the fungus, Okiror and Kimani, (1997) reported strong differences in growth habit, morphology and high variability in terms of their attack on various test cultivars used; and concluded that the isolates are true variants of the pathogen. Similar observations were made by Gaur and Sharma (1989) using 18 pigeonpea varieties against seven isolates of *F. udum* from India and Okiror and Kimani (1997) using six pigeonpea genotypes against 12 isolates of *F. udum* from Kenya. Kiprop *et. al*., (2002) observed differential reactions of seven pigeonpea varieties to seventeen different isolates of *F. udum* and concluded that five virulent groups exist among Kenyan isolates. This variability was confirmed by Songa *et. al*., (1995) through field trials. Songa *et. al.,* (1995) found that pigeonpea line ICP 9145, which was wilt resistant at Katumani (Kenya), ICRISAT Asia Centre (India) and Malawi was highly susceptible (71% wilt) at Kiboko (Kenya). Variability of fusarium wilt reactions between countries and even sites within the same country is due to existence of different virulent isolate and environmental influence (Songa *et al*., 1995; Hillock *et al*., 2000). The high variation in cultural and morphology characteristics of this pathogen could be due to environmental conditions, age of the isolates, subculturing, method of storage and culturing conditions Kiprop *et. al*., (2002) However, according to Okiror and Kimani (1997) and Kiprop *et. al*., (2002) the wide variations in virulence (pathogenecity) to different genotypes of pigeonpea among *F. udum* isolates could be due to environmental conditions and inoculation techniques used. More work need to be done to confirm these reports. There has been conflicting reports on the diversity of the pathogen using molecular markers. Conflicting reports on the relationship between cultural characteristics and the virulence of the isolate are also available. While studies of genetic diversity using isozyme markers revealed low variation in *F. udum* isolates Kiprop *et.al*., (2002) using AFLP reported high variability.

Disease control methods

Cultural method

Several cultural control practices are recommended for restricting the severity of the Fusarium wilt of pigeonpea. Crop rotation with sorghum [*Sorghum bicolour* (L.) Moench], tobacco (*Nicotianatabacum* L.) or castor (*Ricinuscommunis* L.) every three years has been found to free pathogen completely from the field (Verma and Rai, 2008). Pigeonpea intercropped with sorghum had only incidence of 24% wilt against 85% in sole crop treatment. One-year break with either sorghum or fallow reduced wilt to below 20% (Verma and Rai, 2008). Application of nitrogen in form of farmyard manure and green manuring with *Crotalaria juncea* also reduce the incidence of wilt disease

considerably. Upadhyay and Rai (1981) reported a significant reduction in pigeonpea wilt incidence under mixed cropping with *Crotalaria medicaginea*. Solarisation of the field during summer period reduces the Fusarium inoculum (Reddy *et. al*., 1993). However, limited studies have been conducted to understand the effect of cultural practices such as intercropping and rotation on the disease, with the aim of developing integrated disease management practices.

Biological control

In view of the adverse effect of fungicides to the environment and increasing interest in sustainable agriculture, biological control has been reported as an attractive possibility for management of soil borne plant pathogens. Reports have shown that supplementing the soils with fungal or bacterial antagonists reduces incidences of Fusarium wilt. Numerous rhizobacteria have been used as biocontrol agents. Soil amendment with *Trichoderma harzianum* at all pathogen levels has been reported to give a disease control of 22% -61.5% (Prasad *et. al*., 2002). Studies on antagonism, found that *Aspergillus niger, Aspergillus flavus, Micromonosporaglobos, a* and *Aspergillus terreus* highly suppressed the population of *F. udum*. In a different study on tomatoes *Micromonospora globosoes* (*Lycopersicon esculentum*), Khan and Khan (2002) observed that root-dip application of *Bacillus subtilis*, *Pseudomonas fluorescens, Aspergillus awamori, Aspergillus niger* and *Penicillium digitatum* resulted in significant decline of *Fusarium oxysporum* f. sp *lycopersici* population in the rhizosphere. In a bio-control experiment, Anjaiah *et. al*., (2003) reported that inoculation of pigeonpea and chick pea seeds with Pseudomonads aeruginosa (PNA1) significantly reduced the incidence of fusarium wilt in naturally infested soil. Soil antagonists are also known to suppress the development of wilt through induction of resistance. For large scale management, Mahesh *et. al*., (2010) recommended integrated management (Systemic fungicide, biocontrol agent and FYM) as the most effective treatment of *Fusarium udum*.

Host plant resistance

The deployment of cultivars with resistance to Fusarium wilt remains the most effective means of control. The search for sources of resistance to wilt in pigeonpea began as early as 1905 in India. Subsequently screening has been conducted in many locations in India.

Malawi and eastern African. Through evaluation of local landraces, extensive world collections, introductions and segregating populations of pigeonpea, resistant/tolerant pigeonpea lines have been identified. The release of many resistant lines indicates the abundance of available resistance to Fusarium wilt within the genus *Cajanus*. The most successfully adopted wilt-resistant cultivar in Africa was ICP 9145 which in the mid 1990's accounted for around 20% of pigeonpea production in Malawi. According to Hillocks *et. al*., (2000), the resurgence of pigeonpea wilt as a problem in Malawi, has been due to a combination of the lack of a sustainable seed production system to make ICP 9145 widely available to farmers, introgression between local susceptible types and ICP 9145, nematode-induced susceptibility and consumer preference for the cooking qualities of local, wilt susceptible cultivars. In Kenya where ICP 9145 has also been tested, it has not shown the high level of wilt resistance expected. This may be due to a loss of resistance as a result of segregation in ICP 9145 or some other environmental factor in Kenya.

Effects of chemical control on Fusarium Wilt in pigeonpea

Several chemicals have been recommended for the management of Fusarium wilt (Singh, 1998). Seed treatment with a mixture of benomyl and thiram at equivalent rates completely eradicate the fungus (ICRISAT, 1987; Reddy *et. al.*, 1993). Ingole *et. al*., (2005) also observed that a combination of carbendazim + thiophanate (0.15 + 0.10%) was effective in reducing the Fusarium wilt. Seed treatment with 4g *Trichoderma viride*

formulation + 3 g thiram kg-1 seed and application of 2 kg *T. viride* formulation with 125 kg farm yard manure ha-1 has also been reported to control the disease (Verma and Rai, 2008). Addition of boron (Bo), manganese (Mn) or Zinc (Zn) and methyl bromide (CH3Br) to the soil effectively controls Fusarium wilt (Perchepied and Pitrat, 2004). This report was supported by Mandhare and Suryawanshi (2005) who recommended the application of Trichoderma as a seed treatment and soil application for managing Fusarium wilt of pigeonpea. Sinha (1975) observed a significant control of the disease by Bavistic applied as a soil drench at 2gkg-1 of soil days before inoculation of pigeonpea with *Fusarium udum.*

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ISSN No. 2583-3146

Mulch magic in Vegetables for Crop Improvement

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Introduction

Mulching is a process in which organic or synthetic materials are spread around the plants on the soil to create the best conditions for the growth and development of plants. Waggoner (1960) coined the term mulch and it was derived from the German word "molsch" which means 'soft to decay' (Bakshi *et al*., 2015). It protects the soil from harmful organisms and the plant roots from adverse climatic conditions. Different types of mulching are used in vegetable crops i.e., manure, synthetic plastics, seaweed, wood chips, leaves, grasses, straw, sands, stones etc. Both organic and synthetic mulches help in weed control, protect from direct raindrops, prevent soil erosion, control soil temperature and conserve the soil moisture, which improves vegetable production. Vegetable production is very costly and needs essential inputs i.e., fertilizers, irrigation water, insecticides/pesticides and cultural operations like weeding, etc. Tomato and cucumber both are high-value crops and paper or plastic sheets are used to save water, protect the soil and prevent weed growth is found very cost-effective (Singh and Rangare, 2021).

Properties of ideal mulch

- There is no water saturation in an ideal mulch
- Freely drains the water
- maintains better aeration
- Remains contamination free of weed seeds and biotic pathogens
- It is easy to make and we can get it at a reasonable price also.
- Can be applied very easily

Types of mulch

a. Plastic mulch: Plastic mulch is a thin layer of polyethylene that is used to cover soil. It is used in various flower, vegetable and fruit crops. Apart from this, commercial farmers also use it in greenhouses.

b. Organic mulch: Organic mulch is made of organic material that is used to cover the soil. It improves the soil texture and structure of the soil and increases its fertility. Many types of organic mulches are available such as grass, dry leaves, paddy straw, green manure, sugarcane molasses, bags, peanut shells, coconut leaves, etc.

c. Mineral ornamental mulch: This type of mulch is not biodegradable and has a long service life. It includes clay pellets, crushed stones, slate, colored stones, wood chips, gravel, peat moss, sand, etc. All of these decorate the soil and help keep it warm.

Uses of mulching in Squash at Vegetable Research Center, GBPUAT, Pantnagar

Usage of mulch

The main reasons for mulching use are soil moisture conservation, improvement of soil fertility and soil health, prevention of weed growth and improvement of the area of soil appearance. They are spread out on the ground, around trees, on paths, flower beds etc. At the start of the growing season mulching warms the soil and retention of lost heat during the night. This allows early sowing of certain vegetables and increases their faster growth. In addition, mulching has another following usage:

Mulching as water saver

In arid regions, mulching work as water savier and is used to conserve soil moisture from evaporation losses and regulate the temperature. (Yang *et. al*., 2015). In rainfed conditions, surface mulching is used to conservation of soil moisture. (Chakraborty *et. al*., 2008). Plastic sheet is more effective in the conservation of soil water than straw mulch.

Mulching as a weed management

Black polyethylene sheet is always used for the prevention of weed growth. It is used either before seedbed preparation or before planting vegetable crops and then making the hole in sheet for vegetables sowing or transplanting. Water and liquid fertilizers are provided to the plant through pipes of drip irrigation at appropriate distances depending upon the types of vegetables.

Mulching as a nutrient supplier

All organic mulches enhance the amount of beneficial soil microbes that break down these mulches in carbonic material and improve the health of soil. compost mulches balanced to the C:N ratio and help in increasing the soil nutrients. This type of mulch contains adequate amounts of nitrogen and other nutrients that enhance plant growth.

Mulching as a regulation of soil temperature

We have already discussed above that it maintains the soil temperature for the overall growth of vegetables. Many research studies have proven that the use of mulch on the soil surface cools the soil in hot climatic zones and whereas, in cold climate areas the temperature remains normal (Kader *et al*., 2019).

Time of mulch application

The time of application depends upon the types of crops, types of soil, or climatic conditions and what you want to achieve. For example, if you are using mulch during warm weather in a vegetable patch, apply it only when the soil is warm. Because the cool and wet soil delays the seed germination and the seeds and their seedlings rot.

Important Parameters of Mulch

a. Thickness: Thickness of mulches film recommended with duration of vegetables (Table 1). If we talk about mulching thickness, different vegetables require different thicknesses and give more than normal yield (Table 2).

b. Width: The width of the mulches depends on the inter row spacings of different vegetable crops.

c. Perforations: Depend upon situation

d. Selection of mulch film: The selection of mulch sheets depends upon the situations of ecology and different aspects of mulching.

Table 1. Recommended Thickness of mulch film according to duration of crops

Thickness (μ)	Recommended crops
25	Short duration crops (Annual)
50	Medium duration crops (Biennial)
100	Long Duration crops (Perennial)

(Singh *et al*., 2011)

Table 2. Plastic mulching markedly influences the yield of some of the vegetable crops as given below

Vegetable crops	Plastic sheet thickness (μ)	Yield increased (%)
Tomato	25	65-70
Brinjal	25	10-27
Chilli	25	60
Okra	25	48-55
Cucumber	25	44-52
Carrot	50	10-50
Cabbage/ Cauliflower	50	10-71
Snap bean	25	33-73.3
Potato	50	49-50

Benefits of Mulching

- Mulching saves water and maintains soil moisture
- It helps in collecting surface water which is lost through evaporation.
- It helps in maintain the soil temperature
- It helps in prevention of noxious weed growth
- It protects soil from adverse climatic conditions, erosion, highly intense sunlight and heavy winds.
- Increases the yield of vegetable crops
- Organic mulch decomposes after use and improves soil health

Conclusion

Mulching help in weed control, protect from direct raindrops, prevent soil erosion, control soil temperature and conserve the soil moisture, which improves production of vegetable crops. Different types of mulching are used in vegetable farm that cause significant effect on growth and developments of vegetable crops. Thickness and width of mulching depends upon the nature of vegetable crops and the weather conditions of that area. The main function of mulching is to improve the moisture condition of the soil and maintain the soil temperature. For various vegetable crops like squash, melon, cucumber, chilli, tomato, okra, cole crops, sweet corn, etc., use of mulching increases their yield and quality.

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ISSN No. 2583-3146

Cultivation of Lettuce under Soilless Condition

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Introduction

Lettuce (*Lactuca sativa* L.) 2n=2X=18 belongs to Asteraceae family andit is the most popular leafy vegetable which has largest production and area in comparison to other salad crops in the world.Firstly, lettuce originated in the Mediterranean region and cultivated as weeds. Firstly, documentation of cultivations starts in Ancient Egypt over 6,000 years ago, but it may have been cultivated in the Middle East prior to this. After sometimes Lettuce spreads throughout the world. Asia accounts 69.3% of total production of lettuce in the world in 2018, followed by Americas (17.4%) and Europe (10.9%). Now China is the largest producer of lettuce in the world followed by United states and India.In India area under lettuce crop increased significantly because of the change in fruit habit of the society and its medicinal and nutritional properties.

Four principal types of lettuce cultivated in the world i.e., Crisp head, Butterhead, Romaine and Leaf type among these Crisp head is the leading type in the world and stem lettuce is the major lettuce type produced in China. Lettuce is cool season crops so it is generally cultivated in cool areas of India like Jammu & Kashmir, Himanchal Pradesh, Nilgiris Hills and around the Bengaluru-Mysore but it was also cultivation in other part of India like Uttar Pradesh, Bihar, West Bengal during winter season.

It is shallow rooted and highly self-pollinated crop. Inflorescence of lettuce is Capitulum and its fruits known as Achene. Lettuce seeds have thermos-dormancy and required temperature to breaking dormancy 4-6^{0}C for 3-5 days and also recommended optimum temperature for seed germination 24-25^{0}C. It grows well in a variety of soil types but it sensitive to highly acidic soils and required climatic conditions, which considered well temperature between 23^{0}C during the day and 7^{0}C at night and is grows well in within an altitude of 1800 to 2100 m.s.l. Suitable optimum temperatures for outdoor cultivated lettuce approximately 20 to 25^{0}C

Lettuce plays important roles in human nutrition and observed health benefits due to presence of Vitamin C, phenolic compounds, fibre content and it is also good source of vitamin A and minerals like Ca, iron, magnesium, potassium and sodium. It is also known for its medicinal properties and impressive health benefits like inflammation reducing body weight and the risk of cardiovascular diseases and promoting brain health. In India area under lettuce crop increased significantly because of the change in fruit habit of the society and its medicinal and nutritional properties.India imports lettuce to cutter the need in metropolitan cities like Mumbai & Delhi.

Recently, greenhouses have started to expand their cultivation techniques to include soilless cultivation technology such as Aeroponic, system. In this system, the roots are suspended in the air and fed up with a best mist of nutrient rich water under controlled environment. Lettuce crops gives more yield in soilless condition like Aeroponic system. In Aeroponic system it is cultivated using nutrient rich water by misting the root under controlled environment. Now a days, soilless condition is most popular to save water, to produce quality rich produce and to get high production and productivity as compared to

other growing method.

Growing Condition

Generally, selection of varieties depends upon area, climatic conditions and time duration. Seeds are sown under shady condition in portray by using the mixture of cocopit, vermiculite & perlite with correspondence ratio 3:1:1 respectively. For early getting yields seeds are sown during October-November in subtropical conditions. Varieties like Tango, Bingo, Grand Rapid, Summer Star, Black Rose etc. are selected for sowing nursery. Seeds sown one by one in 1.5-2cm depth in each block respectively. After one week's germination starts properly then irrigate the seedlings by rose cane with sufficient and nutrient rich water. It goes to ready for transplanting after 25-30 days. Transplant it under controlled environmental or soilless conditions.

Transplanting

The seedlings are ready for transplanting after 25-30 days of sowing seeds. The seedling attaining the 5-7 cm height with 3-4 true leaves can best for transplanting. Generally,uproot the portray from nursery and transplant it in proper spacing 20cmx20cm. After transplanting the roots of plant misted by nutrient rich water at proper time interval.

Increased air exposure in Aeroponic system

Air is the most important factor for the plant to grow healthy. In this system provides the environment for the proper supply of clean air and nutrient solution. Proper supply of nutrient and oxygen promotes the vegetative growth of plant. More aeration around the rootzone helps to control pathogen formation and promote disease free healthy plant. Plants also require some quantities of carbon dioxide which is also available in this system for photosynthesis.

Water and Nutrient supply in Aeroponic system

This is the best method to supply of nutrients rich water to plant rootzone is commonly done by misters, forgers and other equipment's that may release a fine mist. Mist or forger's types equipment's generate excessive root hairs system for proper development of plants.

Disease less Environment

Generally,greenhouse designed well maintained, so the infection of diseases, insects and viruses are very less or null. This method performs best to the transmission of disease from plant to plant can be lessened and also separate easily infected particular plants could be isolated and destroyed without infecting other plants.

Water consumption

Few quantities or null water wastage by this system because every drop of water recycled within the tank.Generally, analysis of water consumption rate 2% consumed by plant for its proper growth & development but nearly about 98% can save water compare to other growing system like soil condition.

Fertilization

Minimum & liquid fertilizers recommended in few quantities which is essential for proper growth of plants. Fertilizers have been savings 50-60% by these methods. The fertilizers depend upon size of plants, requirements of plants and are contained in water distribution system. Plant roots absorb the required nutrients by misting hence the growth and get quality produce with minimum use of fertilizers.

Labour

This method concluded under labour extensive becauseminimum persons are need to care & maintenance of crops and system. 2-3 skilled and 8-10 unskilled persons are sufficient to manage

the whole crop interval of 1ha. crops.

Harvest

Harvesting of lettuce starts after attaining the acceptable size and firmness and it should be done before the leaves become bitter or flowering stage. The maturity of lettuce depends upon varieties and purpose of growing. Generally, lettuce is harvested after 45-55 days after transplanting at tender stage of leaves. Fresh and tender leaves are more demandable in market then farmers achieve more return per unit area of crops.

Yield

Yield of lettuce depends upon proper maintenance of crops, varieties of crops. The yield of the crops / cropping interval under this growing system gives more yield compared to other growing system. Yield of crop quality and quantity is more superior to other farming system.The yield of the lettuce observed under this system 230-250q/ha. Farmers can achieve more returns after cultivating this crop under soilless condition.

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ISSN No. 2583-3146

Drone Technology in Indian Agriculture

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Introduction

According to official statistics, the service sector makes up the largest portion of India's GDP. The world's top producer of pulses, milk, rice, wheat, sugarcane, spices, etc. is our country. With their involvement in the agricultural industry, these contribute significantly to the economy as well. 18% of India's GDP, or gross domestic product, comes from the agriculture sector. It is regarded as the main source of income for about 58% of the population, primarily in rural areas.

Despite the fact that Indian agriculture contributes to the GDP, our nation still needs to increase productivity and efficiency in the industry to the fullest extent possible. There are a number of aspects and issues that need to be recognized, supported, and addressed with solutions. Currently, inappropriate techniques are used for a variety of essential farming tasks, including crop monitoring, water irrigation, pesticide application, and many others. The Return on Investment (ROI) frequently declines because resources are insufficient, are not allocated based on weather conditions, or have not been fully utilized.

Multiple opportunities for technological advancement have been made possible by these obstacles. Since its inception, technology has always had a positive impact on the agricultural industry. The need to tackle some challenges became more pressing as governments and businesses nationwide realized the importance of food security and the effects of environmental deterioration, pollution, and water scarcity.

Who Should Use Agricultural Drones?

Due to its diversity and status as the technology of the future for the agricultural community, drones have received the majority of industry attention. They were initially employed by the military. Unmanned aerial vehicles (UAVs) were, however, swiftly accepted by other industries as they discovered how many uses they had.

What role do drones play in Indian agriculture?

Drones encourage farmers to overcome other obstacles and profit greatly from precision agriculture in addition to improving overall performance. The market for agricultural drones has grown to a staggering $1.3 billion, and UAVs (unmanned aerial vehicles) fill the gaps left by traditional farming systems' human error and inefficiency. Drone technology is being used to eliminate all ambiguity and guesswork and instead concentrate on precise and trustworthy information.

In farming, external variables like the weather, the state of the soil, and the temperature are crucial. The farmer is given the ability to adapt to particular circumstances and make wise decisions as a result thanks to agriculture drone. The information gathered is used to control crop health, crop treatment, crop scouting, irrigation, field soil analysis, and crop damage assessments. Drone surveying increases crop yields while cutting costs and time.

By 2050, researchers project that there will be 9 billion people on the planet. Additionally, it is claimed that agricultural consumption will rise concurrently by around 70%. Because of its benefits, drone technology that includes AI, ML, and remote sensing capabilities is becoming more and more popular. With its online "Digital Sky Platform," the central government has

acknowledged the significance of unmanned aerial vehicles (UAVs), machine learning, and artificial intelligence. Indian drone businesses have taken advantage of this chance to advance their technological capabilities.

Drone Technology: How Does It Work?

Technology of Drones

One can only learn everything there is to know about agriculture drones if they have fully understood the properties of drones. A navigation system, GPS, numerous sensors, high-quality cameras, programmable controllers and tools for autonomous drones are typically included with drones. One such well-known drone used by the sector is the DJI. Currently, the majority of farmers use satellite imaging as a basic management tool for their farms. With sophisticated equipment, unmanned aerial vehicles (UAVs) can obtain more exact data for precision agriculture than satellites. They then use agricultural technology tools to process the data collected and provide useful knowledge.

Capturing data from agriculture drone takes place as in the following stages

Analyzing the area: This designates the area being explored. As a result, setting up a border, analyzing the area, and ultimately transferring the technical GPS data into the drone's navigation system constitute the first phase.

Using Autonomous Drones: Because unmanned aerial vehicles (UAVs) are autonomous, they enter flight patterns into their pre-existing system to gather necessary data.

Uploading the data: After all the necessary data has been collected using sensors like multispectral and RGB sensors, it is processed using a variety of tools for additional analysis and interpretation..

Results: After gathering the data, they format it such that farmers may easily interpret it, advancing them toward precision farming. Using photogrammetry or 3D mapping, you may present a lot of acquired data.

The following traditional agriculture methods are being used via drone technology to quickly re-establish them.

Monitoring of Irrigation

Drones can identify regions that are too dry or require farmer improvement using hyper spectral, thermal, or multispectral sensors. Drone survey provides irrigation monitoring yields calculations of the vegetation index to help realize the health of crops and emitted heat/energy, helping to increase water efficiency and reveal potential pooling/leaks in irrigation.

Crop Health Surveillance and Monitoring

Monitoring the condition of the plants and identifying bacterial/fungal problems early on are critical. Drones used in agriculture can identify which plants reflect various quantities of NIRS and green light. To track crop health, multispectral images are created with the aid of this data. Crops can be saved by quick monitoring and flaw detection. In the event of crop failure, the farmer can also provide accurate damage documentation for insurance claims.

Crop damage evaluation: Agricultural drones equipped with multispectral and RGB sensors can also spot pests, diseases and weeds in field regions. This information makes it possible to determine the precis•e quantities of chemicals required to combat these infestations, which lowers the costs incurred by the farmer.

Field Soil Examination: Farmers can learn more about the soil characteristics of their land thanks to the drone survey. In-depth field soil analysis, irrigation, nitrogen-level management, and seed planting patterns can all benefit from data captured by multispectral sensors. Farmers are able to conduct a detailed analysis of their soil conditions thanks to precise photogrammetric/ 3D mapping.

Planting: India-based drone firms have created systems that let drones spray seeds, pods, and other essential nutrients into the ground. This

method improves uniformity and efficiency while also cutting expenses by over 85%.

Agricultural spraying

Human interaction with such dangerous substances is minimized through drone agricultural spraying. This task can be completed by agri-drones much more quickly than by cars or aircraft. Drones equipped with multispectral and RGB sensors can precisely locate and address problem areas. Professionals claim that using drones for aerial spraying makes the process five times faster than using conventional techniques..

Livestock tracking

The farmers can track not just their crops but also the movements of their cattle thanks to the drone survey. Animals can be located and illnesses or injuries can be found using thermal sensor technology. This task can be successfully performed by drones, which significantly boosts the growth of vegetation.

Drone Technology Benefits

The commercial applications of new technology grow every day as innovators introduce them. The government has been loosening drone usage regulations and encouraging businesses to develop innovative concepts. Drone surveys are becoming more widespread and more affordable. They are quite advantageous in agriculture. Here are a few of them.

a. **Enhanced Production:** The farmer can expand his or her capacity for production through thorough irrigation planning, sufficient crop health monitoring, greater understanding of soil health, and response to environmental changes.

b. Effective and Adaptive Techniques: The use of drones gives farmers regular updates on their crops and aids in the development of more effective agricultural practices. They can allocate resources efficiently and adjust to changing weather conditions.

c. Greater safety of farmers: Using drones to spray pesticides in difficult-to-reach terrain, contaminated areas, taller crops, and power lines is safer and more practical for farmers. Additionally, it aids farmers in avoiding crop spraying, which reduces soil contamination and chemical toxicity.

d. 10x faster data for quick decision-making: Drone surveys support farmers with reliable data processing that allows them to make swift and deliberate decisions without second-guessing, saving farmers the time invested in crop scouting. The drone's various sensors enable the collection and analysis of data from the entire field. The information can concentrate on issue areas like diseased or unhealthy crops, crops of varied colors, moisture levels, etc. A crop management system that is more precise and comprehensive is possible by fitting the drone with a number of sensors for additional crops.

e. Less resource waste: Agri-drones allow for the best possible use of all resources, including fertilizer, water, seeds and pesticides.

f. 99% Accuracy rate: The drone survey aids farmers in mapping the soil, calculating the exact area of the land, and dividing up the various crops.

g. Helpful for insurance claims: Farmers utilize the information obtained by drones to file crop insurance claims in the event of damage. Even if they are insured, they nevertheless analyze the risks and losses related to the land.

h. Supporting data for insurance firms: Agricultural insurance industries employ agri-drones to collect reliable and efficient data. For an accurate calculation of the financial compensation to be given to the farmers, they record the damages that have happened.

Conclusion

The future of the Indian agrarian community is unquestionably agricultural drone technology, as was previously said. It can alter conventional farming practices in countless ways. Even while this technique is more difficult to understand at

first, once mastered, it produces results quickly. Farmers need to comprehend the full procedure. Setting objectives, achieving balance between the software and drones used, and understanding the basic principles of employing such technology will be difficult. For the purpose of gathering trustworthy data, the farmers will definitely require in-depth training or collaborations with outside professionals in the drone business. In practically every business, drones have altered how data is collected. In the years to come, they will only continue to improve.

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ISSN No. 2583-3146

Use of Mulching Technology for Increase the Yield of Strawberry

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Introduction

Strawberry (*Fragaria* x *ananassa*) belongs to Rosaceae family with chromosome number X=7, 2n=8X=56 and it is most popular fruit crops which has largest area and production in the world.France is an origin of Strawberry and the 1st cultivated variety dates back during 19th century. Generally Strawberry cultivated country i.e. China, U.S.A, India, Mexico, Turkey, Spain, Egypt etc in the world. Now China is the largest producer of Strawberry in the world Followed by U.S.A., Mexico. In India the cultivated area and production increased significantly under Strawberry production because of the demand of market change in fruit habit of the society and its medicinal and nutritional values. In India main Strawberry growerstates Jammu and Kashmir, Mahabaleshwar (Maharashtra), Ooty (Tamil Nadu), Idukki (Kerala), Punjab, Haryana, Himachal Pradesh. Now it is being popular in other parts of country i.e., Bihar, Uttar Pradesh, West Bengal, Madhya Pradesh and Rajasthan.

Strawberry is a rich source of Antioxidants, vitamin 'C', ascorbic acid, ellagic acid,vitamin 'A', fibre, Phytonutrients, minerals like potassium, manganese, copper, iron and iodine, and low in calories (32cal/100g).The fruits of strawberry health benefits and effective against cancer, good for heart issues, skin issues, treating diabetes, reduces hypertension, help prevent allergies asthma, improve eyesight, strengthens the immune system and beneficial for fat loss.

The main uses of strawberry in various items like cakes, juices, bread rolls, wines and the leaves have also been used to flavour food and make people look better. It is a very light flavouring, but it is good surprise, especially in foods like baked chicken or adopt a light summer pasta dish. Main responsible for flavour of strawberry fruits are Ethyl esters i.e., Ethyl butanoate and ethyl hexanoate. Strawberry is also a fruit in which the seed is located in the outer membrane of the fruit. It is monoecious, short day, shallow rooted, perennial type and quick growing plant. It is known as "Accessory" fruit crop and generally cultivated as kitchen garden to get family requirement. Flowers are borne in small cluster and white in colour generally during month of December. Inflorescence type of strawberry is Dichotomic raceme and fruit type is Etaerio of achens. Fruit of strawberry is complete fruit with 98% of edible portions and edible portion known as Succulent thalamus.

Generally, the name "straw"berry comes from practice of the farmers making mulching over the plants of strawberries by using straw. Mulching technology is the best method to grow more crops, conserve moisture and get more returns per unit spacing.

Why growing strawberry

Cultivation of strawberry is one of the best sources of income for farmers to gets more returns per unit area. The demands of this fruit in market significantly increases day by day because of its nutritional values and medicinal properties. Generally, its fruits and leaves also used in pharmaceutical industries, Cosmetic industries and foodies to make strawberry flavour

so the demands of different industries significantly increased in market so farmers are also increasing area of cultivation, increase income source and live happily.

Suitable climate and soil for strawberry cultivation

Strawberry is a cool season crops so generally grown in temperate areas but now it is also grown in subtropical reasons during winter season. It is a short-day plant so it requires less than 8-10 hours sunshine every day is best for its proper growth, development, flowering &fruiting. strawberry required temperature for proper development between 16-22 degree Celsius. Strawberry goes dormant after falling the temperature below 6 degrees Celsius so it is the precious period for care of plant and protect it by the use of mulching and also protect pest like slug. The plants perform best after temperature returns in normal conditions as per requirement.

Soil is the best important factors for get proper development and quality yield of strawberry. The nutrient rich well fertile soil like sandy loam or loam soil is also responsible for proper growth, development and quality yield. The main properties of this soil is to maintain soil aeration and water holding capacity, which is responsible for more produce. And also grows best in slightly acidic soil pH around 5.0-6.5.

Land preparation

It is the most important factors to cultivate the quality strawberry. Generally ploughing the selected field deeply harrow and remove out inert and unwanted things like weeds and previous crops residues. Add organic matter like manure well rotten F.Y.M and neem cake to control different soil born harm - full insects/pests. Divide the field accordingly area in blocks, sub-block and make proper irrigation channel, sub-channel.

Planting method

Generally, there are four methods to plant strawberries

• **Runners:** It is the cheapest source of planting material to develop new plant, and it is a small piece of roots with a few leaves and generally this method is adopted by farmers. It is the commercial propagation method of strawberry. And the ideal time for planting during September, October and November accordingly depends on climatic conditions of cultivating areas.

• **Cold:** Stored runners: Runners are stored in cold storage for used as planting material after winter.

• **Potted plants:** Generally potted plants are purchase from garden centres, it is the easiest method to grow strawberries like if you are a container gardener.

Why black plastic need for strawberry cultivation

In order to prevent moisture and dryness in the dry affected area. the plant plate should be covered up to 20 cm using Organic and Inorganic (Black plastic) substances such as dry paddy Straw, grass straw, maize stalk and other materials in the square plate around the stem after irrigation or at the end of the rain.Moisture remains in the land as well as increases the amount of nutrients, earthworms and micro-organisms. The fertility of the land remains and other characteristics of the land such as improvement in PH, EC and soil health's are also controlled soil temperature and weeds. The growth of plants is good and keeping the pulp for a long time, the production also increases by 10-20%. This method is the best for quality and more produce of strawberries.Generally, it is transplanted at proper distance like 30cm x 30cm, 45cm x 45cm.

Watering and Manuring / Fertilizing

Strawberry is a shallow: rotted plant so the needs of water as per requirement of plant at a proper 5-7 days interval. Best irrigation method adopted like drip irrigation system and sprinkler system to save water and the control the wastage water and fulfilment of water requirement in proper amount with a proper irrigation channel.

Manuring is the most important to main soil health and promotes plants growth so application of well rotten F.Y.M(25-30 tonnes), vermi-compost,

green manuring also adopted for its proper cultivation. And also, use of fertilizers like N:P: K (75-110 kg/ha. N, 40-110 kg/ha. P_2O_5 and 40-80 kg/ ha. K_2O_5) in proper ratio as per requirement of crops and it depend upon soil fertility. Fertilizers also can use in liquid forms during irrigation.

Pests and Diseases of Strawberry

Red Spider, mites and cutworms are the important pests of strawberry so it must be control for getting more quality yield. The mites can be control by organic method use of neem oil, and cutworms can be also control by the use of organic pesticides like Agni Astra.

Diseases like grey mould or fruit rot, black root rotaffects the yield of strawberry so it must be control. Black root rot can be control by

a. Prevent environmental stress like protect crops from injury and prepare good drainage system

b. Rotate out of strawberries

c. Use resistant tolerant tolerant varieties and start with healthy planting. The fruit rot can be control by use of proper mulching/ reduce soil splashing keeping fruit fruits with the direct contact with soil surface.

Harvest and yield

Strawberries are generally harvested at proper maturity stage ½ to ¾ of skin develops colour. Picking of strawberries generally done in the morning hours and it depends up on the weather conditions and demands of market. The fruits are generally starts to ripen from February generally depends on variety of crops.It is non- climacteric fruits so it can be harvested at proper maturity stage of fruits as per demands of market. The yield of strawberry farming fully depends upon the locality and climacteric conditions. Generally, yields of strawberries 8-10 tonnes/acre. It can be also increase as proper farm maintenance and selection of quality planting material. Farmers can get more returns after cultivating this crop under black plastic mulching conditions.

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ISSN No. 2583-3146

Techniques of Flower Drying

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Introduction

Flowers are synonyms of delight and blissfulness due to their power to make people happy and cheerful. Dried ornamental plant parts are generally less expensive and are sought for their everlasting and attractive appearance (Smith, 2000). Their freshness and beauty of flowers is lost due to various bio chemical changes and microbial activities, thus, can be retained only for few days even by using the best techniques of post-harvest management (Datta *et.al.,* 1999). The shelf life of flowers could be prolonged only to an extent of 40% even when the best flower preservatives or chemicals were used (Ranjan and Mishra 2002). So, dried flowers come as a smart alternative to fresh flowers and are looked upon as an economically significant industry.

Dried and preserved ornamental products offer a wide range of qualities like novelty, longevity, aesthetic properties, flexibility and year round availability (Joyce, 1998). Dried flower products on the other hand are long lasting and retain their aesthetic value irrespective of the season (Malcolm, 1994). The art of flower drying is a very age old practice. Earlier dried flowers were in practice in the form of herbarium made by botanists for the purpose of identification of various species (Prasad *et.al*., 1997). Dried ornamental plant parts are generally less expensive and are sought for their everlasting and attractive appearance (Smith, 2000).

Numerous workers have described various methods to dehydrate or dry flowers and other ornamental plant parts (Dubois and Joyce, 1989; Westland, 1995). Drying of flowers and foliage by various methods like air drying, sun drying, oven and microwave oven drying, freeze drying and embedded drying can be used for making decorative floral crafts items like cards, floral segments, wall hangings landscapes, calendars, potpourris etc., for various purposes (Bhalla and Sharma, 2002) with potpourris is being the major segment of drying flower industry valuing at Rs. 55crore in India alone (Murugan *et.al*., 2007). The demand for dry flowers is increasing at an impressive rate of 8-10 percent annually thus offering a lot of opportunities for the Indian entrepreneurs to enter in the global floricultural trade (Singh, 2009). Dehydrated plant parts may be arranged aesthetically and covered with plastic or transparent glass to protect them from atmospheric humidity, wind and dust (Datta, 1997; Bhattacharjee and De, 2003). Saleable articles like paper weights, pendants and table pieces can be made by embedding the dry flowers in transparent blocks or sheets (Kher and Bhutani, 1979).

Techniques of flower drying

The quality and appearance of dried flowers and other ornamental plant parts is greatly influenced by the method of drying or the drying technique being followed. Various techniques involved for the production of dried ornamental plant material includes air drying, press drying, embedded drying, oven drying and freeze drying etc. The National Botanical Research Institute, Lucknow is a pioneer institute in India which works on the dehydration of flowers, foliage and floral crafts. Various dehydration techniques have been developed by which flowers, twigs, branches, foliage etc., retain their fresh look for several months or years (Mishra *et. al*., 2003).

Air drying

The air drying is a very common method of drying where plant materials are attached to rope/

wire and are kept in hanging position either in dark or in the sun for quick drying. Air drying requires a warm clean dark and well-ventilated area with low humidity (Raghupathy *et. al*., 2000). Flowers may also be spread over blotting sheets / newspapers and kept in dark or in the sun (Datta, 1997). Bryan (1992) reported air drying as the earliest method to dry rose, larkspur, statics and straw flower. Flowers hung in a dark area took 8-10 days for drying when there is sufficient ventilation (Champoux,1999).

Susan (1990) reported that flower with crisp texture such as straw flower, statics etc., suit to this technique of drying. This method is simple and cheap. But drying period is more and such flowers naturally retain straight stems upon drying. Air drying was found to be the easiest method to dry rose, statics straw flowers etc., reported by Bryan (1992). Rose flowers were air dried in seven days as observed by Black lock (1993). Stewart (1997) furnished petal shrinkage to be the only disadvantage of this method. Martha (1997) reported that air drying is very successful in herbs, everlastings and ornamental grasses. This method works well with roses.

Water drying

Some flowers dry well if placed in water. The stems of flowers are initially placed in a couple of inches of water, then the water is allowed to evaporate and be taken up the cut flowers. The container and flowers should be in a dry, warm and dark location. Hydrangeas, yarrow, bells of Ireland and celosia dry well with this method. Anonymous (2001) suggested that Hydrangea, Gypsophila and alchemilla mollis should be picked and placed up right in position in vase with an inch of water in the bottom, by the time the flowers have used all the water they have dried successfully. Singh and Kumar (2008) reported that yarrow, hydrangeas, bells of Ireland, ageratums, alliums, acacia, celosia and gypsophila do well with water drying.

Desiccant drying

Susan (1990) reported that this technique was advantageous to produce exquisite life to flowers in both form and colour. Delicate flowers can be dried using desiccants but it is a costly method and desiccated flowers are more fragile and vulnerable to atmospheric moisture. Borax showed slight fading of colour and rough petal texture has been reported by Westland (1992). Silica gel was suggested to be a superior medium than sand or borax for quick drying of flowers (Anonymous, 1997). Evelyn (1997) suggested the use of fine grain builders like sand as a drying medium. Fresh kitty litter can also be used (Barnett, 1996). Silica gel method of flower drying was reported excellent for retaining the colour of flowers (Champoux, 1999).

Sun drying

In India open sun drying is followed for drying many flowers. Flowers like small Zinnias, marigolds, pansies and pompon chrysanthemum embedded in sand in an upside down fashion and kept in the sun would dry in a day or two. Sun drying is the most common method practiced in India (Anonymous, 1997, Bhutani (1990 and 1995) gave a detailed account on sun drying of embedded flowers. Basappa *et. al.,* (1991) reported that sun drying was the most suitable drying technique for straw flowers (*helichrysum bracteatum*). Solar drier can also be used for the same. This method of rapid dehydration is cheap but is dependent on climatic condition (Rangaswamy,1998). Dubious (2005) reported that the greatest advantage of solar drying is that it is cheap. All that is needed is a black painted tin shed or a black plastic tunnel. An efficient solar dryer can reduce drying time to less than three weeks. Deepthi *et. al.,* (2008) stated that marigold, poppy, zinnia, chrysanthemum, acroclinium and globe amaranths can be sun dried.

Sand drying

Anonymous (2001) reported that roses and cup shaped flowers are dried by facing up, daisy type flowers dry with face down and snap dragons and other elongated flowers are placed horizontally on to sand. Anonymous (2004) reported that sand can be used to dry a wide variety of flowers such as roses, tulips, dahlias, marigolds and snapdragons.

Martha (1997) has reported that sand drying can be used to dry a wide variety of flowers, such as roses, tulips, dahlias, marigolds and snapdragons. Flowers which last only one day, like day lilies do not dry well.

Freeze drying

Bhattacharjee and De (2003) reported that several cultivars of carnation flowers were cryodried and remained naturalistic in appearance after being placed in freeze drier (-20°C) for seven days. Liang *et. al*., (2005) studied the application of freeze drying and microwave drying to China rose flowers. The flowers dried freeze drying and pretreated with tartaric acid solution before microwave drying had a good colour and appearance. Wilkins and Des borough (1986) compared the effect of different pretreatments (glycerine, clove oil, ethylene glycol, glycerine + dimethyl sulfoxide, ethylene glycol + dimethy sulfoxide) on carnation flowers at a cryo drying temperature of -80°C for 12 hours duration. After that the flowers were kept in freeze dried for 7 days. It was found that untreated flowers remained naturalistic in appearance while the pretreated ones had lower aesthetic value. Sohn *et. al.,* (2003) studied the effect of freeze drying for 14 days on the shape and colour of Rosa hybrid (C vs. Tineke, Golden Gate, Sapphire and Rote Rose).

Oven drying

This is one of the best method to get superior products. The embedded plant material is kept in hot air oven or microwave oven at a controlled temperature at appropriate time. Kher and Bhutani (1979) reported the temperature and time required to dry various flowers by this method. A temperature range of 45-49°C for 48 hrs was found ideal to dry gerbera, chrysanthemum, gomphrena, helichrysum, China aster, rose buds and zinnia were dried at 40-44°C in 48 hrs, dahlia and narcissus were dried for 72 hrs at 35-39°C.

Papparozzi and Mcallister (1988) reported that microwave dried flowers are susceptible to breakage. Datta (1999) furnished a technique with a temperature of 40-45°C for 48 hrs in a hot air oven to dry pompon type chrysanthemum cultivar 'Jubilee' and 'Birbal Sahani'. The flowers were embedded in sand or silica gel and oven dried. Smith *et. al.,* (1998) stated that microwave drying holds good for brightly coloured flowers like carnation needs 2.5-3 minutes as heating time, rose (1.5min) and zinnia (2-2.5 min). Christy (1999) suggested that a drying temperature of around 75°C seems to give the best results with good air circulation and dry weather. Most herbs will be sufficiently dried within 7-8 days.

Press drying

Flowers and foliage are placed in between two folds of newspaper sheets or blotting paper and these sheets are kept one cover other and corrugated boards of the same size are placed in between the folded sheets so as to allow the water vapour to escape. The whole bundle is then placed in the plant press, it screws tightened. After 24 hours the bundle is removed to an electric hot air oven for 24 hours at 40-45°C. Placing the foliage between two piece of waxed paper and pressing medium hot iron easily preserves the flexibility and the fall colours of foliage. New piece of waxed paper must be used for each pressing.

The drying time can be reduced if the sheets are kept in oven at an appropriate temperature (Datta,1997). Prasad *et. al*., (1997) reported that the shapes of material cannot be maintained as it becomes flattened because the fresh material after pressing within the iron or wooden frame tends to stick to the paper used. Gill *et. al*., (2002) reported that time required for press drying of different flowers and they concluded that roses, carnation and helichrysum required 120, 132 and 72 hours. In that case it need to be cut in half and opened out before pressing. Thick flowers like chrysanthemum needs to have the calyx reduced in thickness, single petals can also be dried and reassembled when making craft. Dana *et. al*., (2002) reported that pressing of plant materials takes about 3 weeks and it is popular method for small flowers, ferns and autumn leaves. Sharon Supriya (2004) has reported that flowers suitable for press drying are pansy, coral-bells, lily, hardy geranium and bell flower.

a) Glycerinisation: Glycerine preserves foliage by replacing them natural moisture present in the leaf with as substance maintains the leaf form, texture and sometimes the colour. Fresh and fairly matured foliage is ideal for glycerining. About 50 percent of most plant fresh weight is water, but brittleness is usually only a problem if the water content falls below 10 percent. Glycerine drying has been used by several workers especially to preserve foliage. It was comparatively less expensive and has a high water attracting capa-city (Joyce,1998). Many types of foliage have been successfully preserved by either immersing leaves or placing crushed stems in a 33 percent glycerol solution. The resultant leaves are soft and flexible (Dana, 1983). Sell (1993) used that mature leaves responded well to this treatments as they translocated the solution readily to stems and reported that glycerin should be mixed with equal parts of water and used to treat foliages like Magnolia, Beech and other tree foliages. Verey (1994) recommended the use of 1:2 glycerol in warm water dipping to preserve eucalyptus, hollyhock, hydrangea etc. In the same concentration of solution, addition of few drops of vegetable oil intensified the colour of immersed stems as observed by Miller (1997). Smith *et. al.,* (1998) stated that plant materials suitable for glycerin infusion include woody sp. such as magnolia, oak and eucalyptus.

b) Bleaching: Bleaching is the process of removing all or most of the discolouration occurring during the dehydrated phase of preservation. A bleaching agent is a material that lightens or whitens a substrate through chemical action. Much of the preserved ornamental plant materials are bleached at some stage during preserving process. Bleached plant materials may be recoloured with dyes. Petal shades require virtually total removal of colour from of the plant material, otherwise uneven dyeing will occur. Profitability is dependent upon the attainment of high white quality and the efficient utilization of expensive bleaching chemicals. Bleached ornamental plant material provides a striking contrast when arranged with dried or dyed flowers. Bleaching also allows the use of dyes for colouring. Oxidative (Hypochlorite, chlorite and peroxide) and reductive bleaching chemicals (sulphite and borohydrite) are used for bleaching ornamental flowers and foliage.

Rogmoulik (1972) ascertained the prolonged exposure of cellulose to peroxide as the cause for cellulose chain shortening or peeling due to the loss of polysaccharide terminals and sugars by adding sodium sulphite to the bleach liquor, this reaction could be inhibited. Masschelein (1979) affirmed sodium chlorite to be the most commonly used bleach for plant foliage owing to its selective mode of action. This bleach was reported to remove the entire colour from cellulose based material with minimal damage to the cellulose even during prolonged contact. Sikdar *et. al.,* (1987) reported that conventional hot hydrogen per oxide bleaching of cotton and jute causes oxidative degradation of the fiber. A chloroorganic compound tends to persist in nature because of the inherent recalcitrance, they are often toxic to aquatic life; many are genotoxic and have the potential to migrate widely throughout the ecosystem, ultimately accumulating in the fatty tissues of organisms (Suntio *et. al.,* 1988). During bleaching treatments chromophoric, highly oxidized, polymeric lignin or chlorolignin derivatives are formed that give rise to a dark colourisation in the effluent (Livernoche, 1983; Bergbauer *et. al*., 1991).

c) Dyeing: Dyes are organic compounds which absorb light of 205-900 nm ultra frequencies, thus only reflecting a portion of the visible spectrum with the result that the eye sees colour. Each pure dye compound, therefore, has a unique colour. The vast number of different colours is available in the result of blending pure dye stuffs. Natural dyes were used exclusively until the discovery of Mauve or Mauveine by Perkin in 1856, the discovery marked the beginning of the dye manufacturing industry.

Sambandamurthi and Appavu (1980) reported that ammonium perpurate gives rhodonite red colour to the flowers and eosin gives scarlet

colour. Phyllis (1982) reported that dyes must be applied in an alkaline medium because dye baths that are strongly acidic may be harmful to cellulose fibers. To dye the dried plant parts, Tampion and Reynolds (1971) suggested the use of culinary dyes which are often used to colour icing sugar, owing to their wide range of available colours and non-toxicity to plants. William and Seagal (1972) gave a detailed account of various categories of dyes. They also furnished that there has been significant development in organic colour chemistry. The first even dye was discovered in 1856, the dye was named as perkins violet and following this, many colour were found out such as indigo sol, fire red, hansa yellow colour, sulfur black etc., and also reported that the basic dyes were the first of the synthetic type to made out of coal tar derivatives. Although basic dyes produce brilliant colours. They have poor fastness to light smudge off easily.

Conclusion

Dry flowers are and plants are gain popularity as ever lasting and eco-friendly products for indoor decoration as well as for a variety of other aesthetic and commercial uses. Dry flowers are beautiful and long lasting. The industry has the tremendous potential to employ thousands of people. It is estimated that about 80% of flower species can be dried and preserved successfully. It could start as a home or cottage scale unit and can quickly grow into a big enterprise. A great variation of wild plant material available widely also strengthen the establishment of the dry flower industry. Different techniques have been developed by which dried products retain their fresh look, appearance and quality. Thus, the dry flower industry as a whole can contribute immensely to area development which in turn leads to be overall development of the nation. The dry floral craft helps to upgrade the creative facility of human mind and converts the cheapest plant raw material into wealth, customer awareness by way of exhibitions, workshops, seminars, trainings etc. Dry flower industry has the potential to provide employment to thousands of people especially to housewives and rural women's as limitless aesthetic and decorative products can be created using dry flower technology.

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ISSN No. 2583-3146

GIS in Agriculture

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Introduction

GIS in agriculture has been boosted by the general advancement of technology in the past few decades. The use of GIS in agriculture is all about analyzing the land, visualizing field data on a map, and putting those data to work. Powered by GIS, precision farming enables informed decisions and actions through which farmers get the most out of each acre without damaging the environment.

Speaking of tools, geospatial technology in agriculture relies on satellites, aircraft, drones, and sensors. These tools are used to make images and connect them with maps and non-visualized data. As a result, you get a map featuring crop position and health status, topography, soil type, fertilization and similar information.

Crop yield prediction

Accurate yield prediction can help governments ensure food security and businesses forecast profits and plan budgets. The recent development of technology connecting satellites, sensing, big data, and AI can enable those predictions.

One of the most profound techniques in this field is Convolution Neural Networks (ConvNets or CNNs). A ConvNet is a deep learning algorithm that is taught to identify the productivity of a crop. Developers train this algorithm by feeding it images of crops whose yield is already known to find productivity patterns. CNN has an accuracy of about 82%.

Crop health monitoring

Checking crop health across multiple acres manually is the least efficient option. This is where remote sensing combined with GIS in farming comes to the rescue.

Satellite images and input information can be paired to assess environmental conditions across the field, such as humidity, air temperature, surface conditions, and others. Based on GIS, precision farming can upgrade such an assessment and help you decide which crops require more attention.

A more sophisticated approach uses imaging sensors on satellites and air vehicles to check the temperature of crops. When the temperature is above normal, this might indicate a disease, infestation or insufficient irrigation.

Neural networks like CNN, Radial Basis Function Network (RBFN), Perceptron and others can be helpful in assessing crop health too. The algorithms can analyze images for unhealthy patterns.

Livestock monitoring

The simplest application of farm GIS software in animal husbandry is the tracking of movement of specific animals. This helps farmers find them on a farm and monitor their health, fertility, and nutrition. GIS services that allow you to do that comprise trackers installed on animals and a mobile device that receives and visualizes information from those trackers.

Here's one example. You want to monitor the weight of your beef cattle. Each animal has a tracker on its ear or neck. Every time it steps on the digital scales, the scales read the ID of that animal and assign a new value to that ID in the system.

You don't need to manually enter that data. Meanwhile, if there's an alarming change in the animal's weight, you can quickly find that animal and check its health.

There are also more interesting use cases of farm GIS software, such as preventing wolf-cattle encounters. There are ambiguous spatial specifics

that affect the distribution of wildlife in an area, including wolves. We could reduce undesirable encounters by understanding those subtle specifics, which could be done by the combined use of AI and GIS in agriculture.

Insect and pest control

The invasion of harmful insects and pests, or infestation, does heavy damage to agriculture. A look from above can enable accurate, timely alarms to prevent that.

Yet even high-resolution images might not provide visible early signs of infestation.

The alternative would be using AI. You develop a neural network and train it using deep learning algorithms. Through this training, you feed the neural network images of infested land, and the network learns to find samples that indicate infestation. After that, you feed it satellite images of the land you want analyzed.

As mentioned above, you can also use remote sensing along with geospatial technology in agriculture to check the temperature of the crops. Plants respond to infestation by heating up as they stop getting enough water or nutrition.

Irrigation control

Keeping an eye on vast fields to make sure that each crop gets enough water is a challenging task, but one easily tackled by geo-informatics in agriculture. Aircraft and satellites equipped with high-resolution cameras take images that allow AI algorithms to calculate the water stress in each crop and spot visual patterns behind water shortages. Pair those images with water delivery system maps, and you will find out how well your current irrigation scheme is performing.

Flooding, erosion and drought control

Marrying GIS and agriculture can help prevent, assess, and mitigate the negative impact of destructive natural phenomena. To identify flood-susceptible areas, you can use flood inventory mapping techniques. You need to collect data such as past floods, field surveys, and satellite images. Use those data to create a dataset to train a neural network to spot and map flood risks, and you will create an ultimate disaster management tool.

If you need to check land for susceptibility for soil erosion, you could pair Universal Soil Loss Equation (USLE) with GIS and remote sensing. Run satellite images through spectral analysis to check USLE factors and verify those images with field observations. As a result, you can create a map featuring the level of deterioration of the soil across the field. Similar GIS solutions for agriculture can be used to control drought.

Farming automation

Seeding machines, intelligent irrigation systems, driverless harvesters, and weed remover robots are the inevitable future. You could equip each of your machines with sophisticated sensors, but why do that if you can connect them to an integral GIS system?

GIS in farming can provide precise maps, including all necessary information about the crops in the field. Maps like those are called task maps or application maps. Smart machines use them to tend to the field.

Here's an example of how GIS solutions for agriculture might work. Once a GIS system has detected weed infestation, it assigns a "Weeding needed" label to that area. The weed remover robot reads the label and places this area on its list of tasks.

Apart from providing signals for machines, task maps can help unskilled workers do their job more efficiently.

Conclusion

If you browse the Internet for use cases of GIS in agriculture, you will find articles and studies dating back to the early nineties. The objectives of agriculture haven't changed much since then nor have the problems that GIS is expected to solve.

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