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APPLICATION OF PHASE CHANGE MATERIALS FOR TEXTILES

Sharmila Patil, Kirti Jalgaonkar, P. Jagajanantha, Jyoti Dhakane-Lad, Archana Mahapatra and Manoj Kumar Mahawar

ICAR-Central Institute for Research on Cotton Technology, Matunga, Mumbai (Maharashtra)-400019

**Corresponding author* email: *sharmila.patil@icar.gov.in*

ABSTRACT

Textile industry is focusing more to provide protection to human being from extreme climatic conditions. PCM based textiles can be refereed as smart textiles due to their capability of sensing surrounding temperature fluctuations by absorbing as well as releasing latent heat during melting and cooling process, respectively and thus produce a thermo-regulating effect. The use of PCMs for development of thermoregulatory textile was witnessed since 1980s. In recent years, research has gained momentum in improving cutting edges to manufacture PCMs and applying them in textiles using various processing technologies. The use of PCMs in textile provides good opportunity to industry to fabricate smart and innovative textile products.

INTRODUCTION

Now-a-days, textile industry is focusing more to provide protection to human being from extreme climatic conditions. The normal human body temperature is changes from 37°C to 40°C depending upon the physical activity performed by the individual (Havenith et al., 2008). Usually clothing protects us from water, open fire, extreme heat and cold, toxic chemicals, high voltage, propelled bullets, nuclear radiations etc. Phase Change Materials (PCMs) are smart materials which absorbs, stores as well as releases heat with fluctuation in temperature and hence used in manufacturing of smart textiles products. During process, while transforming into solid state PCMs release the heat whereas they absorb heat when come back to liquid state. This property of PCMs is capable for increasing the comfortness for consumers of sports equipment, bedding, military gear, building materials, clothing and many other consumer products.

WORKING MECHANISM OF PCMs

The phase change process is called a dynamic process, as continuously changing of materials from solid to a liquid or liquid to a solid takes place based on level of physical activity of the body as well as outside change in temperature. The functioning of PCMs is depended on the latent heat of fusion. The increase in the temperature melts the PCMs and absorbs heat from surrounding and gives the cooling effect (Fig. 1). Whereas, decline in temperatures solidifies the PCMs and releases heat to the surrounding and offer the warmer effect (Fig. 2). This cyclic process keeps temperature comfortable within the microclimate between the fabric and the human skin by absorbing, storing as well as releasing latent heat.

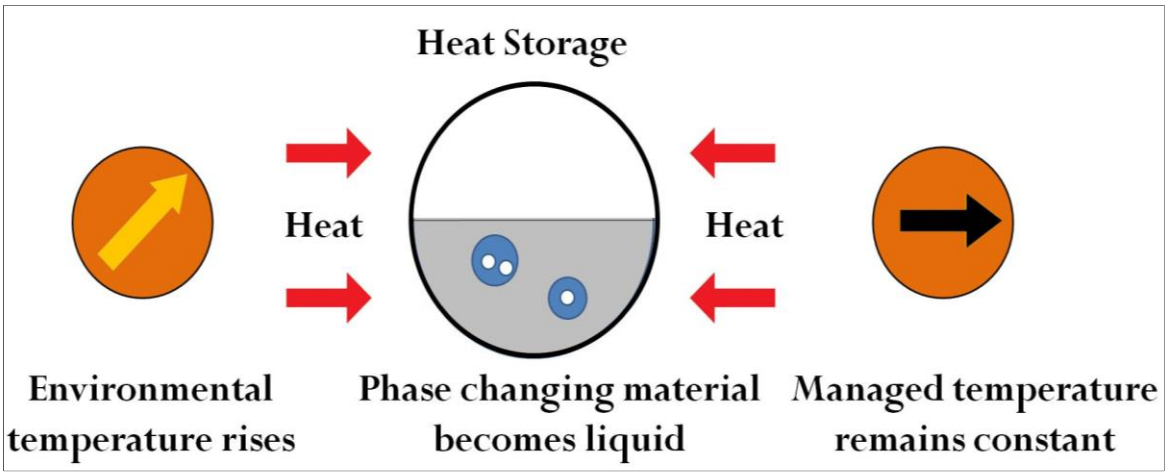

Fig. 1 Changes in phase change materials under hot environmental conditions

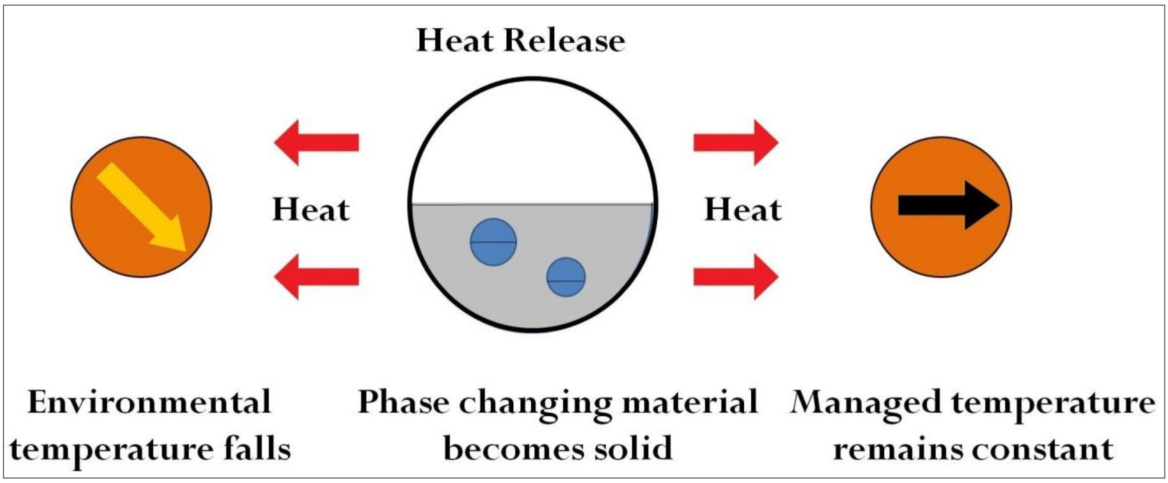

Fig. 2 Changes in phase change materials under cold environmental conditions

There are different kinds of PCMs available with different phase changing temperatures. For application in textiles, PCMs should be lie in the temperature range from 20 to 40°C and from 30 to 10°C for heat absorbing and heat releasing temperature, respectively (Ramesh Babu and Arunraj, 2018).

BASIC SELECTION CRITERIA FOR PCMs IN TEXTILES (Mondal, 2008)

- Melting temperature range from 15 to 35°C
- Large heat of fusion
- Low temperature gap between freezing and the melting point
- Stable at repetitive melting and freezing
- High thermal conductivity for quick heat transfer
- Chemically stable
- Compatible with the textile materials without any negative effects
- No toxicity
- Harmless to the environment
- Non-flammable
- Low cost
- Ease of availability

CLASSIFICATION OF PCMS

Currently, more that 500 number of organic and inorganic PCM material are available possessing different latent heat and melting points. Paraffins are the most commonly used PCMs with the sizein the range of 15 to 40 µm. It can be applied on textile in microencapsulated form either by coating, lamination or by incorporating into fiber (Pause, 2002).

Table 1. Comparison of organic PCMs, inorganic PCMs, and eutectics

Classification	Advantages	Disadvantages
Organics	1. Non-toxic 2. High thermal and chemical stability 3. High heat of fusion and no corrosives 4. Offers large temperature range 5. Highly compatible with other materials	1. Poor thermal conductivity 2. Less phase change enthalpy 3. Relative large volume change 4. Inflammability 5. High cost
Inorganics	1. Excellent thermal conductivity 2. High phase change enthalpy 3. Low volume change and low cost	1. Corrosiveness to most metals 2. Instability leading to phase decomposition 3. Subcooling 4. Improper re-solidification

Eutectics	1. High volumetric thermal storage density 2. Sharp melting temperature	1. Low thermal conductivity 2. Corrosion in high temperature

(Source: Zalba et al. 2013; Haiting et al. 2003; Shenglin et al. 2004; Kenisarin 2010; Khare et al. 2012, Zhou et al. 2012).

INCORPORATION METHODS OF PCM IN TEXTILES

The fabric or fibre incorporated with PCMs could absorb and store the heat generated by body and release it back to body, when needed. The thermoregulatory properties can be imparted to manmade fibers by adding microencapsulated PCMs to polymer during extrusion process. By this way, PCM microcapsules are merged with the fiber itself. Some convenient techniques used for incorporation of PCMs into fabric material are melt spinning, coating lamination, fiber extrusion, injection moulding, foaming etc.

Fiber technology

Microencapsulation is an essential requirement for the incorporation of PCMs within a fiber matrix. For this, PCMs are shelled inside suitable polymer or base material, then integrated into fibre by conventional methods such as dry or wet spinning and polymer extrusion etc. (Mondal, 2008). The microencapsulated PCM based fibres have ability to store heat for longer time. These fibers radiate heat slowly when there is a temperature drop.

Coatings

For coating on textile material, a homogeneous solution of microencapsulated PCM dispersed in a binder, dispersant, antifoaming agent, surfactant, and thickener is prepared. This solution will be then applied to a textile surface. Acrylic and polyurethane are widely used polymers for PCM coatings. The coating can be done by any of the available processes such as pad-dry-cure, knife-over-roll, dip coating, knife-over-air, gravure etc. (Mondal, 2008).

Lamination

To enhance comfort properties (thermo-physiological) of protective garments, lamination process can be opted by incorporating PCM material in a thin polymer film followed by application to inside of the fabric (Mondal, 2008).

VARIOUS USES OF PCMS IN TEXTILES

Application of PCM in textiles field (Mondal, 2008; Ying et al., 2004; Shisho, 2002) are listed as follows:

- Aerospace textiles (space suit and gloves)
- Sportswear (active wear, snowboard gloves, ice climbing and underwear for cycling as well as running)

- Medical textiles (surgical apparel such as gloves, caps, gowns, bedding materials, bandages and products for maintaining temperature of patients in ICUs)
- Bedding and accessories (blankets, quilts, pillow, mattress)
- Automobile textiles (seat cover, helmets)
- Fire retardant fabrics (firefighters' outfits and gloves)
- Shoes (skiing boots, mountaineering boots, race car drivers boots, golf shoes etc.)

SUMMARY

PCM based textiles can be refereed as smart textiles due to their capability of sensing surrounding temperature fluctuations by absorbing as well as releasing latent heat during melting and cooling process, respectively and thus produce a thermo-regulating effect. The use of PCMs for development of thermoregulatory textile was witnessed since 1980s. In recent years, research has gained momentum in improving cutting edges to manufacture PCMs and applying them in textiles using various processing technologies. The use of PCMs in textile provides good opportunity to industry to fabricate smart and innovative textile products.

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TEMPERATURE HUMIDITY INDEX - AN EASY MEASURE TO IDENTIFY THE HEAT STRESS IN DAIRY CATTLE

Nikhil Kumar Tej J[1*] and Vasantha SeshuKumari I

Department of Veterinary Physiology, NTR College of Veterinary Science, Gannavaram, AP-521102

**Corresponding author* email: *nikhilkumartej.j@gmail.com*

ABSTRACT

Assessment of heat stress in dairy cattle had become crucial in order to adopt managmental strategies to optimize production. Several techniques have been evolved to measure heat stress in cattle. Among all, temperature humidity index (THI) stands as simple, cheap and best measure of heat stress in cattle. A low THI value of below 72 determines comfort zone while, a high THI indicates emergency state. THI value was also negatively correlated with milk production in animals. Further, THI could be used as early warning system and adopt management strategies under adverse environment conditions. Though, THI does not take in to the account of all the weather parameters THI is still the best technique to evaluate heat stress in dairy cattle.

INTRODUCTION

India is the largest milk producer in the world with a milk production of 198 million tonnes. Though, India is the largest milk producer, many factors were found to negatively affect animal health and milk production. Environment, photoperiod, geographical location, nutrition, water, disease and management are some of the factors. Among all the factors, heat stress poses a substantial menace to the existence of animals and the effects triggered by heat stress are ample harmful. Heat stress is the incapability of the animal to loose heat to the surroundings. Ambient temperature (AT), relative humidity (RH), wind and solar radiation are the climatic elements that contribute to heat stress. Under heat stress numerous behavioural and physiological responses are activated (reduced dry matter intake, increased respiratory rate, excess sweating and altered hemato-biochemical and hormonal profile) to maintain thermoregulation while compromising production behind. Research revealed a 30-40% decline in milk production in livestock due to heat stress. Several techniques have been evolved to measure the risk of heat stress in cattle which includes the use of haematological, biochemical, endocrine and molecular markers (Tej *et al.*, 2017). Unfortunately these advanced techniques involve a huge investment of money and time which cannot be adopted by farmers to assess heat stress in animals. One of the simple and most practical technique measuring heat stress is temperature humidity index (THI).

TEMPERATURE HUMIDITY INDEX AND ITS ROLE IN ASSESSING HEAT STRESS

Thom (1959) developed a discomfort index (DI) to measure the level of dis comfort for humans based on AT and RH. Later the same has been renamed as THI to assess heat stress in animals. THI is a linear equation that takes in to account the combined effect of ambient temperature and relative humidity, the resultant value obtained after solving the equation provides a measure of heat stress (Akyuz *et al.*, 2010). A THI of < 74 indicate no heat stress, 75 to 78 indicate moderate heat stress (alert), 79 to 83 causes severe heat stress (livestock danger) and a THI of 84 and more causes very severe heat stress (livestock emergency) (Thom, 1959, LCI, 1970, Fig.1). Although THI does not take in to account the effect of solar radiation and air speed (Gaughan *et al.*, 2012) nevertheless, THI is still one of the best methods to assess heat stress in animals (Marai and haeeb, 2010). The effect of THI on livestock has been shown in Table 1 and some of the most commonly used THI formulas have been presented in Table 2.

IMPORTANCE OF THI

- It is easy to calculate, can also be adopted by farmers
- Data loggers/HOBO loggers can be purchased by farmers for continuous recording of weather parameters
- Easy bench mark to assess heat stress in cattle
- Determines the impact of heat stress on animals
- Can be used as early warning system
- Modify the microenvironment of the animal when THI crosses 72.
- For dairy cows management strategies should be taken when THI goes above 68
- Overlook of high THI causes heavy economic loss to the farmers

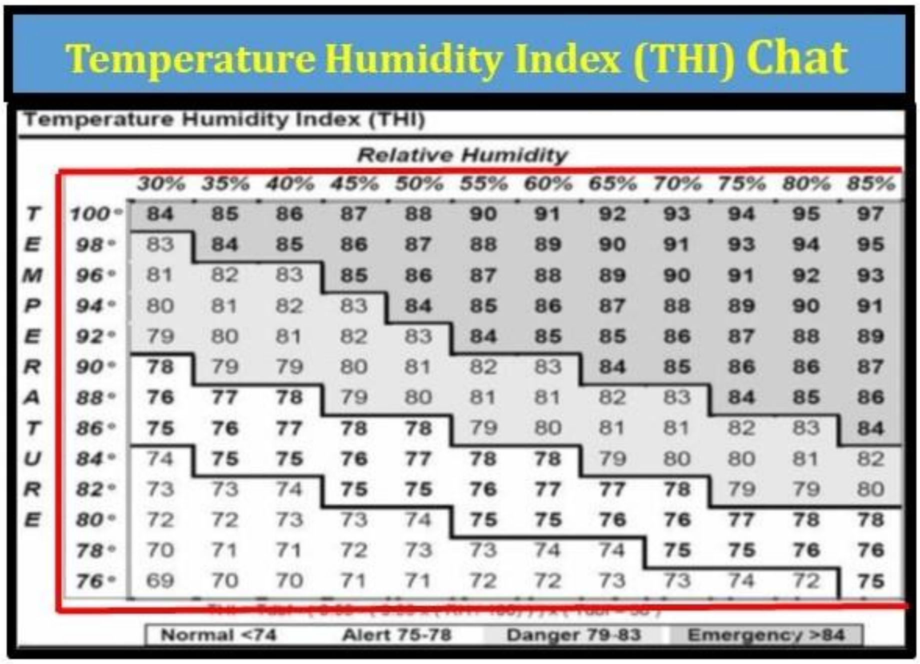
EFFECT OF THI ON MILK PRODUCTION

A unit rise in THI significantly ($p<0.01$) decreased the average daily milk production of lactating crossbred (Holstein Fresian × Indigenous local) cows inhabiting Bihar (Das, 2012). Bouraoui *et al.* (2002) reported that milk production decreases 0.41kg/cow/day when THI was above 69. Recent research showed that milk yield starts to decline at a THI of 68 (zimbleman *et al.*, 2009).

Figure 1. Stressed animal

MANAGEMENT STRATEGIES AT HIGH THI

- Feed management - providing adequate green and succulent forages during hotter part of the day and less energy diet feed
- Shelter management - by improving heat exchange mechanisms (water sprinklers, fans)
- Increase water service points and provide cool, clean and fresh water
- Avoid handling and transportation hotter part of the day



Temperature Humidity Index (THI) Chat

Temperature Humidity Index (THI)

TEMPERATURE	Relative Humidity 30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
100°	84	85	86	87	88	90	91	92	93	94	95	97
98°	83	84	85	86	87	88	89	90	91	93	94	95
96°	81	82	83	85	86	87	88	89	90	91	92	93
94°	80	81	82	83	84	85	86	87	88	89	90	91
92°	79	80	81	82	83	84	85	85	86	87	88	89
90°	78	79	79	80	81	82	83	84	85	86	86	87
88°	76	77	78	79	80	81	81	82	83	84	85	86
86°	75	76	77	78	78	79	80	81	81	82	83	84
84°	74	75	75	76	77	78	78	79	80	80	81	82
82°	73	73	74	75	75	76	77	77	78	79	79	80
80°	72	72	73	73	74	75	75	76	76	77	78	78
78°	70	71	71	72	73	73	74	74	75	75	76	76
76°	69	70	70	71	71	72	72	73	73	74	72	75

Normal <74 | Alert 75-78 | Danger 79-83 | Emergency >84

Figure 2. THI chart and associated livestock weather safety index categories (obtained from Thom, 1959, LCI, 1970 and modified accordingly)

Table. 1: Effect of THI on livestock health and Production

THI	Level of heat stress	Effect on Livestock
<74	No heat stress	• No heat related problems • No extra energy is deviated for energy production
75- 78	Moderate heat stress (livestock alert)	• Shade seeking, decreased intake of feed and increased water intake • Behavioural and physiological responses • Increased respiratory rate and cardiovascular changes • Reduced feed intake • low milk production
79-83	Severe heat stress (livestock danger)	• Reduced weight gain, low milk production, mortality may occur
84	Very severe heat stress (livestock emergency)	• Mortality of animals if further stressed by activity

CONCLUSION

THI which accounts for the collective effect of temperature and humidity, provides a measure of heat stress. Earlier studies showed a unit rise in THI from 72 caused heat stress in dairy cattle. However, recent findings revealed that dairy cattle begin to experience heat stress and reduce milk production at a THI of 68. THI also helps in determining the impact of heat stress and as a warning system. Based on THI values, micro climate around the animal can be modified and management strategies can be adopted for mitigating heat stress One of the major advantages of using THI as a measure of heat stress is that farmers can also effectively use it to assess heat stress in animals.

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QUALITY ASSESSMENT FOR DISEASE FREE HEALTHY PLANTING MATERIAL PRODUCTION AND ITS IMPACT ON FLORICULTURE

Poonam Kumari[1*], Surinder Paul[2], Pramod Kumar Sahu[2], Udai Bhan Singh[2], and V. Mageshwaran[2]

[1*]Division of Agrotechnology, CSIR-Institute of Himalayan Bioresource Technology, Palampur, Himachal Pradesh 176 061, India

[2]ICAR-National Bureau of Agriculturally Important Microorganisms, Kushmaur, Uttar Pradesh 275101, India

*Corresponding author email: poonamjaswalfls@gmail.com

ABSTRACT

The quality of planting material is very important aspect in the floriculture industry. Poor quality planting material in floricultural crops Inferior quality planting material has detrimental impacts on overall production and quality of the produce. It may badly affect the important traits of floricultural crops viz. size, colour, quality and stalk length etc. use of diseased planting material can cause severe spread of the many plant pathogens including viruses, fungi and bacteria. All these factors may lead to severe economic loss to the floriculture industries. In the present article we have discussed about various Priority areas for quality planting materials for floriculture crops, impact of the non-standred planting material usage on floriculture sector and some methods of selection of production of healthy planting material in floriculture crops.

INTRODUCTION

Plants in the floriculture industry are propagated in both sexual and asexual ways. Seeds, bulbs, bulblets, corms, cormels, rhizomes, stolons, layers, tubers, suckers, off shoots, slips, cuttings, budded, and grafted plants are all examples of planting material in floriculture. The quality planting materials influences the production of ornamental crops (Sankari et al., 2020). The lack of high-quality planting material is the most significant impediment to India's floriculture potential. Commercial flower manufacturing, pot plant cultivation, and landscaping all require various types of planting material. These requirements were formerly satisfied by local nurseries with inferior local material, but as urbanization and per capita income levels have increased, demand for novel floriculture products has surged, resulting in a dramatic spike in the demand for quality planting material. The major challenge which floriculture industry face is lack of quality planting material.

PRIORITY AREAS FOR QUALITY PLANTING MATERIALS FOR FLORICULTURE CROPS

The standards for high-quality planting materials are not uniform. There is a need to develop global quality standards for various crops so that the plants produced can compete on a worldwide scale.

Priority areas for quality planting material include:

- Strengthening model floriculture centers established by State Department of horticulture /Agriculture.
- Set up a mechanism for multiplication of varieties developed by SAUs and institutes through a National Level Multiplication Agency like National Seed Corporation.
- Tissue culture techniques should be used wherever possible, in addition to using the services of certified growers for the multiplication of novel plant varieties.
- New seed and planting material should meet the requirement for international trade.
- An existing protocol for micro propagation of floral plants might be enhanced and tested on a large scale.
- Should develop protocol of multiplication on flower crops which are difficult to propagate and also for new exotic material.
- Establish cutting-edge infrastructure such as tissue culture labs, polyhouses, mist chambers, net-houses, micro irrigation, and hardening facilities etc.
- Improve nursery propagation strategies for the mother plant as well as secondary materials.
- Develop a standard for micro propagated flower and foliage plants in terms of media and containers.
- Develop/manufacture indigenous seed-processing machinery and equipment.
- Develop male sterile lines in annual flower crops for the development of F1 hybrids, as well as standardize hybrid seed production technology for a variety of annual flower crops.
- Establish proper handling and storage procedures for a variety of plant materials and annual seed.

IMPACT OF POOR QUALITY ON FLORICULTURE INDUSTRY

In the nursery industry, the spread of bacterial, fungal, and viral disease is a major concern. The problem of disease spread is exacerbated by unsanitary propagation instruments, improper practices, and messy nursery premises. There is no system in place to identify the mother stock and verify that it is clear of disease. In recent years, there have been classic examples demonstrating the rapid development of crown gall disease caused by agrobacterium in greenhouse grown roses, which had spread predominantly through the planting material. In none of the decorative crops is a viral indexing system in place. As a result, the disease-free nature of the planting material produced by nurseries cannot be guaranteed. To assure the production of disease-free planting material, viral indexing processes should be established in some of the major nurseries in the public and commercial sectors.

When it comes to roses that are propagated by budding, disease-free rootstock production is critical. As a result, the rootstock material must be regularly monitored because there is a high risk of infection by viruses, bacteria, and fungus, which are typically spread by insects or by manual labour.

In the case of bulbous ornamentals, such as gladioli, iris, and tulips, light and clean soil are required to produce healthy bulbs. To attain an appropriate flower-grade size, bulbs are usually grown for two to three years (for expansion). The same is true for Lilium, whether it is propagated through scales or tissue culture. To avoid disease buildup in the growing medium, it is highly advised that the growing substrate (soil) be changed every year.

The cultivation of bulbs for expansion in Lilium is not difficult if the farm has some required facilities such as a cold room and a storage room. In the case of tulips and iris bulbs, cool room management is critical for delivering on time, sound material that is ready to flower according to the cropping schedule. This problem is avoided in the manufacture of tropical bulbs (caladium, hippeastrum, ginger, alpine, glories, and so on). Bulbs that do not respond to cool treatments and are grown in a tropical environment are excellent for growing and increasing.

Starting with clean propagation material is an important part of plant health management. Because most ornamentals are propagated by vegetative means rather than seed, there is a higher risk of disease transmission. In order to offer new lines more quickly, the bedding plant sector is increasingly using vegetative propagation for the development of new annuals. Unrooted cuttings taken from mother plants are used to propagate them (Daughtrey and Benson, 2005).

SELECTION OF DISEASE FREE HEALTHY PLANT MATERIAL

VIRUS INDEXING

Virus and viroid indexing techniques is progressed over the time. The traditional bioassays are still in use but to favour speedier methods, they have mostly been abandoned. Enzyme-Linked Immunosorbent Assay (ELISA), a serological approach, has recently become the gold standard for virus testing.

CULTURE INDEXING FOR BACTERIAL AND FUNGAL PATHOGENS

Systemic illnesses is a key restrictive problem in the production of conventional flower crops in the mid-twentieth century. Prior to meristem tip culture, technology was established to ensure a clean start by using culture indexing to destroy viruses. To ensure that only healthy plant material is used for production, an indexing algorithm is employed to systematically identify and removel of diseased propagation material (Daughtrey and Benson, 2005).

ADOPTION OF HI –TECH HORTICULTURE PRACTICES

- Hi-tech horticulture practices such as micro-irrigation via drip and sprinkler systems, greenhouse/playhouse for propagation, mist chambers, net/shade house, and use of latest varieties of mother plants propagated from elite clones are out of reach for a large numbers of smaller nurseries, which is one of the main reasons for the variable quality planting material produced by them.
- Some public-sector nurseries need to upgrade their infrastructure in order to deliver high-quality planting on a commercial scale and compete with the private sector. With absolute technology, many of the state department's nurseries, state agricultural universities, and smaller commercial nurseries are unnecessary. Tissue culture propagation must be strengthened to support traditional propagation methods in order to generate uniformly high-quality planting material.

- Scientific management is inadequate in the majority of nurseries. Healthy clones require proper spacing and planting material in the nursery, as well as better management. Nursery stock is frequently of poor quality because to a lack of information about soil, water management, and plant protection measures.

CONCLUSION

Floriculture is playing important role in improving the economic status of the farmers. To fulfil High demand of the floriculture based various sectors we need to produce high quality disease free planting material for the flower growers. We can fulfil the high demand of quality planting material by following the priority area based set standards for floriculture, utilizing upgraded scientific technology for the production of planting material and selection of pathogen free planting by utilizing advanced methods of pathogen indexing of the planting material.

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REGENERATIVE AGRICULTURE AS A BOON TO SOIL HEALTH

Divya Sharma

PhD scholar (Division of Soil Science and Agriculture Chemistry, SKUAST (Jammu)

**Corresponding author* email: *sharmadivya.soil@gmail.com*

ABSTRACT

Regenerative agriculture (RA) has been advocated as a way for achieving sustainable food systems. RA is seen differently by various actors, and there is no precise scientific description. Our findings reveal convergence in goals that improve the environment and emphasise the relevance of socioeconomic elements that contribute to food security. However, the aims of RA in regard to socioeconomic factors are broad and require a structure for execution. Based on our findings, we propose a preliminary definition of RA as a farming practise that leverages soil conservation as a starting point to regenerate and contribute to diverse ecosystem services.

INTRODUCTION

Soil health is important not just for enhancing the quality and amount of food produced, but also for making plants more resistant to pests and adverse weather. Given the current scenario, the concept of soil health has been modified and articulated as follows: "the continued capacity of a specific kind of soil to function as a vital living system within natural or managed ecosystem boundaries, to sustain animal and plant productivity, to maintain or enhance the quality of air and water environment, and to support human health and habitation" (Doran and Zeiss, 2000). Soil health is more than just improved crop output; it's a delicate balance of multiple soil functions, environmental protection, and plant and animal health (Doran, 2002).Taking care of the soil can reduce the level of inputs required for a given amount of quality produce. Agriculture contributes significantly to land degradation as a result of unsustainable management practises that impair soil quality and operational capability (Gibbs and Salmon, 2015).Regenerative agriculture is a farming method that focuses on preserving and restoring farmland and its ecology. In reality, agricultural and grazing practises help to mitigate climate change by restoring damaged soil biodiversity while also regenerating soil organic matter.

WHAT DOES REGENERATIVE AGRICULTURE INTENDS TO ACHIEVE?

The loss of healthy soil and biodiversity across the world as well as of local seeds and knowledge, poses a serious danger to our existence. Soil scientists predict that if present rates of soil destruction continue, we will not only face serious public health consequences from a degraded food supply, but we will also run out of arable topsoil. Feeding the globe, keeping global warming below 2 degrees Celsius, and ending biodiversity loss would be difficult without preserving and replenishing the soil. In addition to supplying surplus food to the country through intensive agriculture over time, the Green Revolution has deteriorated India's delicate Agro-ecosystems (Rahman, 2015).

The cornerstone of regenerative agriculture is that it not only "does no harm" to the land, but actively improves it via the use of technology that regenerate and revitalize the soil and ecosystem. Regenerative agriculture produces healthy soil that can produce nutrients dense food as well as improve, rather than degrade land, which eventually results in productive farms and a strong economy. It incorporates permaculture and organic farming to increase food production, farmers' incomes, and topsoil, including cover crops, crop rotations, composting, mobile animal shelters, and pasture cropping.

REGENERATIVE PRINCIPLES

- Tillage should be reduced or eliminated.
- Cover the soil to keep it secure.
- Use living roots to keep the soil alive.
- Boost biodiversity.

- Integrate livestock

NO TILL OR LOW TILL: By minimizing disruption to the soil ecosystem, plant roots are exposed to soil microorganisms that support healthy soil and carbon storage.

COVER CROPS: There are several advantages to covering the ground with plants. The soil has the ability to absorb water and carbon, which keeps the soil alive, avoids soil erosion by keeping the dirt from blowing away, and prevents desertification.

DIVERSIFIED PRODUCTION SYSTEMS: To mimic natural ecosystems and boost biodiversity, several crops are cycled in fields, potentially with animals, contributing to healthy soil.

***REDUCTION OR REMOVAL OF SYNTHETIC CHEMICALS*:** Plants are less likely to utilize soil microorganisms and obtain nutrients deep in the soil when synthetic chemical fertilizers are used, resulting in reduced carbon sequestration. Chemical pesticides harm biodiversity and contribute to contaminated water and soil, in addition to changing the soil microbial population. Pesticides may also be present in the food we eat, the air we breathe, and the water we drink, and they can cause birth abnormalities, cancer, and neurological diseases, among other things.

***PLANNED GRAZING*:** It will prevent overgrazing, and dung fertilizes the soil while also sequestering carbon. Pastured animals' health has improved, and they no longer require antibiotic treatment to be healthy. The following are some of the additional advantages of using regenerative agricultural practices:

- ***WATER AND SOIL HEALTH*:** The health of the soil and the health of waterways are inextricably linked. Healthy soil has a water-holding capacity of 20 times its weight in water, reducing runoff and ensuring drought resilience.
- ***INCREASED FARMER INCOME:*** Plants that are healthy, disease-resistant, and pest-tolerant grow in good soil, reducing the need for expensive fertilizers and pesticides. A farmer can also profit from ecosystem services provided by regenerative produced food by selling it at a premium price.
- ***SECURE FOOD FUTURE*:** Regenerative strategies to develop healthy soil, minimize agricultural pesticide usage, and increase crop resilience against a wide range of meteorological extremes will be critical to maintaining high levels of food production and ensuring better food security for people in the future.

A SHIFT TO REGENERATIVE AGRICULTURE ON A GLOBAL SCALE WILL:

- ***FEED THE WORLD:*** The small farmers currently with a small portion of land cultivate to feed the huge population.

- ***DECREASE GHG EMISSIONS:*** A new food system might be a significant driver of climate change solutions as existing system contributes between 44 and 57 percent of global GHG emissions.
- ***REVERSE CLIMATE CHANGE:*** Reductions in emissions are insufficient on their own. Fortunately, evidence suggests that boosting soil carbon stores can help counteract climate change. Soil organic carbon accounts for around half of all organic matter in the soil (Pribyl, 2010).
- ***IMPROVE YIELDS:*** Organic farms provide much better yields than conventional farms in the face of harsh weather and climate change.
- ***CREATE DROUGHT-RESISTANT SOIL:*** The incorporation of organic matter into the soil enhances its ability to hold water. Organic soil organic matter is increased via regenerative organic agriculture.
- ***REVITALIZE LOCAL ECONOMIES:*** Family farming provides an opportunity to assist local economies thrive.
- ***PRESERVE TRADITIONAL KNOWLEDGE:*** Understanding indigenous farming practices gives important ecological insights for developing regenerative organic agricultural systems.
- ***NURTURE BIODIVERSITY:*** Biodiversity is essential for agricultural productivity and food security, as well as an important component of environmental protection.
- **RESTORE GRASSLANDS:** Grassland makes up one-third of the planet's surface and is 70% degraded. We can assist them in recovering by implementing a comprehensive grazing strategy.
- ***IMPROVE NUTRITION:*** To generate a more diversified nutritional output from agricultural systems, nutritionists are increasingly highlighting the necessity of more diverse agro-ecosystems.

CONCLUSION

Producers that practise regenerative agriculture aren't only preserving the existing land resource so that it may be used in the future. They're really upgrading what's already there to make it better for future generations. It's a win-win-win situation: climate change mitigation, improved profit for farmers, and increased climatic resilience.

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CHICKEN EMBRYO FIBROBLAST CULTURE AS AN *IN VITRO* MODEL FOR ANIMAL SCIENCE RESEARCH

Shyma K. Latheef[1], Hari Abdul Samad[2], Pronab Dhar[1], Vikramaditya Upmanyu[1], Chayna Singha Mahapatra[1] and Aruna Kuniyal[1]

[1]Division of Biological Standardization, [2]Division of physiology & Climatology
ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, U.P., India - 243122

**Corresponding author email: shyma05vet@gmail.com*

ABSTRACT

Cell culture systems offer potential alternate platform for *invivo* or living models so that extensive researches are possible in virus propagation, physiological changes and for vaccine development. Chicken embryo fibroblast (CEF) culture is a primary type of cell culture which has much application in poultry virus as well as physiological researches. This technical article explains the procedure for successfully establishing a CEF culture system in laboratory along with images.

INTRODUCTION

Cell culture systems are established in the laboratory when cells of animal origin are cultured at sterile *in vitro* environment with appropriate and supplemented media. This has been followed from 19th century onwards and used mainly for isolation and propagation of viruses which can survive and multiply only in a living system. Subsequently, Based on the tissue of origin and nature of cell multiplication, cell cultures are basically of three types: **primary culture** (freshly isolated cell from animal tissue, heterogeneous and slow growing in nature), **secondary culture** (cells isolated from primary culture, modified for longer life and multiplication) and **cell lines** (permanent cells which can be propagated continuously and indefinitely). Chicken embryo fibroblast culture is one of the primary cell culture system prepared from embryonated chicken of 9-11 days old. At this stage of chicken embryo, fibroblast cells are the predominant one in the muscle tissues which will be collected aseptically and treated to form single cell suspension. Successfully established fibroblast culture can be used for propagation of viruses especially of Herpes viridae family (Marek's disease virus, Duck Plague virus etc.) and as an *in vitro* model for exploring various physiological responses.

REQUIREMENTS

Aseptic environment is mandatory for establishing a successful cell culture system in the laboratory. Handling of the tissues and cell preparation are to be done only inside a biosafety cabinet. All the reagents, glasswares and plasticwares used are to be ensured for sterility. Reagents include Hank's Balanced Salt Solution (HBSS), Antibiotic-antimycotic solution, 0.25% Trypsin, growth medium (DMEM) with 10% serum Foetal bovine Serum (FBS).

PROCEDURE

Chicken embryo fibroblast culture is established from aseptically collected chicken embryo (of 9-11 days old) following the standard protocol. Briefly, egg sterilized with 70% alcohol is kept upright with air space on top, break the egg at air space, and embryo is carefully taken out into sterile petri plate containing HBSS. After slight washing in HBSS, head, four appendages and viscera are carefully removed and skin is peeled off. Muscle part containing fibroblast is put into another petri plate, washed twice with HBSS and cut into pieces. Tissue is added with trypsin (0.25%)-HBSS mixture and kept on magnetic stirrer for 10 min at spinning rate of 400-500 for trypsinization. Mixture will be strained into sterile beaker to obtain single cell suspension and supplemented with growth media (preferably DMEM containing 10% serum and 1xantibiotic-antimycotic solution). Cells will be pelleted by centrifugation (1000rpm for 5-10 min), finally collected cells will be resuspended in 3-5ml growth media. After assessing the cell concentration, additional growth medium can be added to make up the required cell concentration (1-2x10^6 cells per ml concentration) and cells can be cultured in tissue culture flask or plates at 37◦C in a humidified chamber with 5% CO2 level. About 6ml cells are added in each 25cm^2 culture flask while 1ml cells are added per well in 12-well plate. Once the cells attain 90% confluency by 24-48 hrs incubation, media need to be changed and cells can be infected with virus for cultivation or titration. Media change is needed at every alternate day. Virus induced microscopic lesions in the cells (in the form of plaques) will be evident from 3-4 days onwards and enumerated by 6 day.

APPLICATIONS

Successful establishment of cell cultures for the vaccine research at both human and veterinary sectors paved way for the development of various vaccines that include hepatitis vaccine, rabies vaccine, flu vaccines, etc. for human use and FMD vaccine, Rinderpest vaccine, PPR vaccine, Goatpox vaccine and recently Classical Swine fever vaccine for veterinary use. Chicken embryo fibroblast culture is mainly used for the production of Marek's disease (MD) virus vaccine production since the virus is propagated and titrated in this culture system. MD produce plaques in the fibroblast after 4-5days incubation and these plaques are counted for assessing the titre of the virus in terms of plaque forming units (PFU). CEF cultures are also been explored for bioenergetics, molecular events and cellular events involved in muscle tissue proliferation and differentiation.

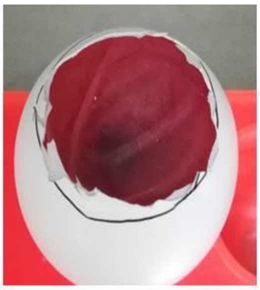

Fig 1: 10-day old embryonated chicken egg - opened at air space

Fig 2: 10-day old chicken embryo

Fig 3: 10-day old chicken embryo-with parts removed

Fig 4: muscle pieces collected from 10-day old chicken embryo for fibroblast culture

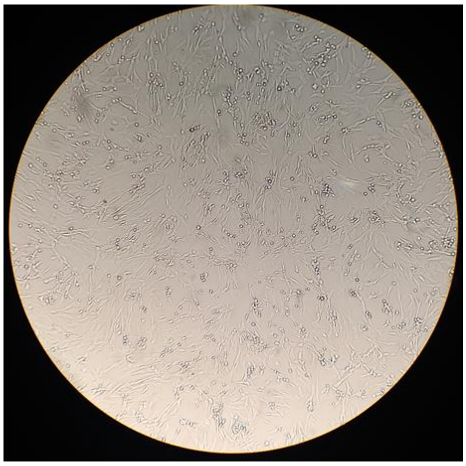

Fig 5: Chicken embryo fibroblasts after 24 hrs incubation

Fig 6 : Plaques formed in chicken embryo fibroblasts culture after 4days of MDV infection

CONCLUSION

Successful establishment of cell cultures for the vaccine research at both human and veterinary sectors paved way for the development of various vaccines that include hepatitis vaccine, rabies vaccine, flu vaccines, etc. for human use and FMD vaccine, Rinderpest vaccine, PPR vaccine, Goatpox vaccine and recently Classical Swine fever vaccine for veterinary use. CEF offers a much easier platform for various researches in the field of vaccine development, immunological and physiological changes etc. especially in poultry.

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