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Growing seed

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SEAWEED EXTRACT'S USE IN AGRICULTURE

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Sourik Poddar

Dept. of Genetics and Plant Breeding, Uttar Banga KrishiVishwavidyalaya, Pundibari, Coochbehar, West Bengal, India

Email: sourikpoddar@gmail.com

When the world's population increases, so does the demand for food and fibre per unit area. As a result, the demand for chemical fertilisers rises in order to generate higher yields from a smaller area. Excessive use of chemical fertilisers is harmful to one's health and pollutes the atmosphere. As a result, many plant extracts have been used in agriculture in recent years. The use of natural seaweeds as fertiliser has enabled traditional synthetic fertilisers to be gradually phased out (Hong *et al.*, 2007).

The macroscopic marine algae are known as “Seaweeds”. They are used as human food, cattle feed, a chemical fertiliser substitute, and a source of various fine chemicals. Aside from that, it's used to make a variety of agricultural goods like agar and alginate (Khan *et al*., 2009). Since they contain several growth regulators such as, Cytokinins (Durand *et al.*, 2003), Auxins (Sahoo *et al.*, 2000), Gibberellins (Strik *et al.*, 1997 and Staden *et al.*, 1997) and various macro and micronutrients needed for plant growth and development, seaweed extracts are marketed as liquid fertilisers and bio-stimulants. It aids in the production of beneficial soil microorganisms (Khan *et al.*, 2009), develops tolerance against environmental stress (Zhang *et al.*, 2003), increases nutrient uptake from soil (Turan *et al.*, 2004 and Kose *et al.*, 2004) and enhances antioxidant properties (Verkleij *et al.*, 1992).

Around 700 species of marine algae are present in both the intertidal and deep-water regions of the Indian coast, with approximately 60 of them being commercially important. Tamil Nadu, Gujarat, Maharashtra, Goa, Lakshadweep, Andhra Pradesh, and Karnataka are the leading seaweed producers. A few species can also be found in West Bengal and Orissa, as well as the Andaman and Nicobar Islands (Tandel *et al.*, 2016).

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Significance in Agriculture

Seaweed extracts are currently used in agricultural practices and have already been commercialised.Sea weed is available in a number of types, including LSF (Liquid Seaweed Fertilizer), granular, and powder. The whole or finely chopped driven algal manure has been used, and all of them have been shown to support cereals, pulses, and a number of flowering plants. Seaweed manure has the advantage of being free of weed seeds and other pathogenic fungi.

The foliar spray of liquid extract from seaweed causes cereals, vegetables, fruit plants, and horticultural crops to grow faster and produce more (Elansary *et al.*, 2016).In many commercial crops, foliar spraying with seaweed extract is a popular practice to increase yield (Khan *et al.*, 2009). The aim of recent research is to implement new methods for preparing various seaweeds, such as mixed consortiums, for use in agricultural fields and to increase yield. Brown algae liquid extracts are sold under different brand names as bio-stimulants or biofertilizers. Seaweed extracts have been commercially available in recent years under various names as Maxicrop (Seaborn), Cytex, and Seacrop 16 (Gandhiyappan *et al.*, 2001 and Perumal *et al.*,2001) etc.

Effect on Germination

Many researchers have recorded the beneficial effects of seaweed on agricultural crop germination. Higher germination percentage, shoot and root length, and seedling vigor index was observed when rice seeds were soaked in lower concentrations of seaweed extracts (Layek *et al.*, 2018). In the case of maize, a similar result was also published. Seeds soaked in lower concentrations (5%) of both seaweed saps (*Kappaphycus* and *Gracilara* species) displayed a higher rate of germination, while seeds soaked in higher concentrations (15%) of extracts inhibited germination (Layek *et al.*, 2016).At low concentrations of seaweed extracts, an increase in germination and seedling vigor may be due to the presence of growth-promoting substances such as auxins, gibberellins, and phenylacetic acid (Sivasankari *et al.*, 2006) and other micro-nutrients (Layek *et al.*, 2014). The use of seaweed sap at a 15% concentration of either *Kappaphyccus* or *Gracilara* sap improved wheat germination significantly. However, when the concentration is either decreased to 2.5 percent or increased to 20 percent, germination is greatly reduced (Dilvarnaik *et al.*, 2017). The reduction may be due to high salt concentration in seaweed saps. Development promoting factors such as IAA

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and IBA Gibberlins (A & B), micronutrients, vitamins, and amino acids, which have a significant impact on crop germination, could explain the higher germination percentage at lower concentrations.

Effect on Crop Growth

With higher concentrations of seaweed extract, rice yield attributing characters such as the number of panicles hill^{-1} and number of effective grains panicle^{-1} increased, and the highest value was obtained for 15% K sap, which was statistically comparable to 10 and 5% K sap concentrations (Layek *et al.,* 2018). Furthermore, the application of both *Kappaphyccus* sap and *Gracilaria* sap at the same concentration improved the absorption of N and P by grain (Pramanick *et al.,* 2014).

When compared to a control, seaweed application increased crop growth while also increasing the number of active nodules. This may be because many cytokinins found in brown algal extracts, such as trans-zeatin riboside and its dihydro derivatives, are present (Saravanan *et al.*,2003). Due to increased plant height, number of pods plant^{-1}, number of grains plant^{-1}, number of branches, and improved nutrient uptake by plant, 15% seaweed extract from *Kappaphycus alvarezii* resulted in a 57% increase in grain yield in soybean (Rathore *et al.,* 2009).

Effect on Yield

In rainfed soybean production, foliar applications of seaweed extracts could be a promising choice for yield enhancement (Rathore *et al.,* 2009). The addition of seaweed to sunflower seed significantly increased oil content, oil yield, K, Na, and crude protein. It was confirmed that applying 0.6% concentrations of *Gracilaria dendroides,* and *Ulva lactuca* to sunflower resulted in higher oil content of 34.05 and 30.55%, respectively (Hannan *et al*., 2011 and Salem *et al.,* 2011).

To increase potato growth and yield, supplementing the prescribed fertiliser dose with extracts of either *Kappaphycus alvarezii* (K sap) *or Gracilari aedulis* (G sap) at a 10% concentration could be used (Prajapati *et al.,* 2016). Spraying seaweed extract on potato tubers 30 and 60 days after planting resulted in higher tuber yield, increased nitrogen, total soluble solids, and protein content (Haider *et al*., 2012).

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In the case of rice, a 15% *Kappaphyccus* (K) or *Gracilaria* (G) sap application resulted in an 18.0% increase in rice grain yield as compared to control (Layek *et al.,* 2018). The application of 7.5% and 5.0% concentrations of *K. alvarezii* and *G. edulis* sap, respectively, increased wheat grain yield by 19.74% and 13.16%, respectively, over the control (Shah *et al.,* 2013).

Conclusion

In crop production, seaweeds and seaweed products are becoming more common. The mechanism(s) of action of seaweed extract-elicited physiological responses, on the other hand, is largely unknown. Since the genomes of a variety of plants have now been sequenced or are close to being sequenced, researchers will investigate the effects of seaweed extracts and components on the whole genome/transcriptome of plants to better understand the mechanisms of action of seaweed-induced growth response and stress alleviation. Climate change is likely to blame for the recent challenges to food production caused by an increase in the incidence of biotic and abiotic stresses, which would further reduce yields and/or have an effect on crops in the twenty-first century (IPCC 2007). As a result, research into finding long-term solutions to these stresses should be prioritised. Recent research has found that seaweed extracts protect plants from a range of biotic and abiotic stresses and that they may be used in the field.

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ROLE OF ORGANIC MULCH IN WEED MANAGEMENT

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[1]Saikat Biswas* and [2]Rupa Das

[1]Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India
[2]Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Email: sbsaikatbiswas27@gmail.com

Present day agriculture mostly suffers from high yield loss due to various biotic and abiotic factors. Consistent increase in population and low agricultural production creates a disparity between the demand and supply of food. Among various biotic factors affecting agricultural production, the weed problem is one of the key issues pertinent in almost all the crops and agro-climatic zones. Weed, on an average, causes 5%, 10%, and 25% yield losses in developed, developing, and least developing countries (Oerke, 2006). However, it has the potential to cause 100% yield loss if not checked on time. Modern day agriculture mostly relies on limited resources. Weed, being the competitor of the crop, steals the crop's valuable resources viz. land, nutrients, water, and sunlight. It also provides shelters for various pathogens and insects. Besides, it releases toxic chemicals, which hampers crop growth. Weeds provide competition to crop both above and underground. Hence, manual weed control is an uneconomical and temporary approach as the emergence of weeds occurs again after some days. Chemical weed control through herbicide creates residual toxicity to soil and leaves environmental health impact. Besides, repeated application of one herbicide builds up resistance in weeds against it. In this context, farmers are in search of suitable alternatives to chemical and hand weeding options. Organic mulching is one such suitable cultural approach that can be used for weed management in an environmentally safe way.

Organic mulching

It is the application of materials of natural origin on the surface of the soil with the objectives to protect the soil from erosion, conserve soil moisture and fertility status, control weeds, regulate soil temperature etc. Such materials are biodegradable. Hence, they naturally decay over time and improve soil health.

Types of organic mulch

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There are so many organic materials which are successfully utilised as mulching options. Some of them are straw, dry leaves, bark (softwood and/or hardwood), sawdust, compost/manure, grass clipping, living mulch, alfalfa, seaweed, coir, cocoa bean hulls, corn cobs, hops(spent), peanut hulls, hay, wood chips, municipal tree waste, pine needles, chopped leaves etc.

Organic mulch as weed management option

- Organic mulches, when applied on the soil surface, block sunlight transmission essential for photosynthesis and thereby check germination of already present weed seeds, especially of the dicot category.
- Organic mulches prevent weed seeds from transmission from outside to reach the soil and emerge.
- Several organic residues release allelopathic chemicals, which possess toxicity to many weeds (Saha *et al*., 2018). For instance, rye straw releases a toxic chemical that causes more damage to small seeded weeds as compared to large seeded weeds.
- As organic mulches exert a cooling effect on soil, the growth of some weeds such as pigweeds, purslane, Galinsogaetcwhich respond to high soil temperature (85-100 ^{0} F), are checked.
- Organic mulching, just after the harvest of the crop, controls the later emerging weeds.
- Organic mulches improve the growth and competitiveness of winter growing crops against weeds through modification of soil temperature, improvement of soil organic matter, and conservation of soil moisture.
- Organic mulches limit O_2 availability, which affects the germination of weed seeds. O_2 unavailability is increased with the increase of thickness of the mulch layer (Benvenuti *et al*., 2001).
- Live mulch (i.e. growing living vegetation before or after crop growth) covers the soil surface in such a way that weeds do not get the space to emerge.

Requisite for application of organic mulch

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- Replenishment of organic matter should be done periodically as decomposition of organic residue occurs easily.
- Thickness of organic mulching should be decided based on the types, extent of weed dominance etc. Organic mulching at the thickness of 3-5 t/acre suppresses small seeded broadleaf weeds whereas, organic mulching at the thickness of 7-10 t/acre is useful in controlling large seeded broadleaf weeds and grasses. The thin layer of organic mulching (1-2 t/acre) allows weed emergence and growth by conserving soil moisture and supplying essential nutrients.
- Adequate care should be taken to use mulch materials free from weed seeds admixture before application over the soil surface.
- Application of suitable mulch at the right time and quantity is important for effective weed control. Untimely application and wrong selection of organic mulches can hamper crop growth. For instance, straw mulch is harmful against tomatoes, melons etc, as it lowers down soil temperature. Besides, straw mulching decomposes quickly, and thereby, its weed control efficiency is confined for a short period of time. However, mulch with high C: N (like sawdust) slows down crop growth by immobilizing nitrogen.
- Organic mulching should be used after proper crop establishment and removal of existing weed flora from the field to reduce the crop-weed competition for resources.
- Live mulch should be harvested after the crop-weed competition is over. Otherwise, it will compete with the crop.

Limitations

- Organic mulching is only suitable for small seeded annual weeds. It has no or negligible use against large seeded perennial weeds. Perennial weeds easily penetrate through organic mulches.
- Excessive mulching lowers down the O_2 availability in soil, which ultimately hampers germination and root growth of crops.
- Due to its role in reducing soil temperature, organic mulching is more useful during hot summer over the winter season.
- Organic mulches cannot fully block sunlight creating partial windows for light entry, and thereby, some weeds emerge.

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- Organic mulches such as straw, hay, compost, leaves, grass clippings, tree barks etc., carry mature perennial weed seeds, which are very difficult to control if they emerge. It is worthy of mentioning that weeds growing through mulches are more difficult to control than weeds without mulches.
- Manual application of organic mulches is a labor consuming process. Hence, it is economically more feasible for small scale farming than others.
- Organic mulching invites disease, insect (bugs/termites etc) problems in many crops like lettuce, brassicas etc.
- Organic mulching provides effective weed control. However, their bulk amount needs high transportation costs unless they are produced on farm.

Some new and promising organic mulching interventions for weed management

Hydro compacting dust:

Hydro-compacting dust is a new and modified organic mulching option, which holds good promise for weed management. Organic fibers combined with adhesive substance based on polyvinyl alcohol. On adding water, this adhesive substance creates a compacted organic disk (Massa *et al*., 2019). It effectively blocks sunlight entry and prevents weed emergence. There are several benefits of hydro-compacting organic dust/disk like:

- It is more durable than common organic residues.
- As there is no opening for light penetration through this compact material, it is a highly efficient option in controlling weeds.
- It exerts low or negligible environmental impact.

Newspaper mulching:

2-3 layers of black and white newspapers are laid on the soil surface, followed by hay/leaf/grass clippings. It effectively checks weed emergence. Further, it decomposes subsequently and improves soil health for crop growth. Newspaper can also be applied in shredded form. According to Harrington and Bedford (2004), shredded newspaper glued between two sheets of the brown paper provides better weed control than plastic mulching. However, the use of newspaper is usually avoided in windy areas.

Jute mulching mat:

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It is a hairy mulching disc which is laid on the soil surface and contains a central hole through which plant emerge. The size of the hole depends on plant size. It is primarily used in the suppression of weeds and soil moisture conservation. It protects plant root damage by weeds.

Cardboard mulching:

Such kind of mulching includes either layer or shredded form of cardboards. It is placed beneath compost materials or grass clippings. It checks grass and other weeds. It is a 100% biodegradable weed management option.

Conclusion

Although organic mulching cannot fully protect the crop from weeds due to several limitations, it is still a very promising option in effective weed management from the crop field. Considering its role on environmental safety along with some added advantages other than weed management, organic mulching should be given a try through various multi-locational trials, particularly in dryland areas, and possible outcomes should be interpreted for its recommendation as the suitable and environmentally safe option of management of agricultural weeds.

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IMPORTANCE OF SUSTAINABLE AQUACULTURE AND ITS PRACTICES

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Bhenkatesh Padhan

Tamil Nadu Dr.J.Jayalalithaa Fisheries University, Nagapattinum, Tamilnadu, India

Email: bhenkateshpadhan@gmail.com

In the recent context of food production on the Earth, aquaculture stands as a sunrise sector. According to FAO, aquaculture is the commercial production practice of aquatic organisms like fishes, molluscs, crustaceans, and aquatic plants. Over the last few decades, the fisheries and aquaculture sector have seen a dramatic change in its dynamics with an overall expansion of production capacity, trade business, and food consumption. Although the capture fisheries showing a little stagnation trend for few decades, the aquaculture sector is booming. Emerging aquaculture production systems have a significant potential to curb the global food security problems and to meet human nutritional needs with improved environmental performance.

Aquaculture sector comprising of a wide range of culture practices of various species starting from finfishes, crustaceans, seaweeds, molluscs, and other aquatic organisms. Because of this aquaculture sector is opening up the windows of opportunities for urban as well as rural areas in their socio-economic developments.

But as the aquaculture industry expanding, the sector is also facing some problems like environmental degradation, water scarcity, limited availability of land for aquaculture, high input costs etc. So, sustainability in the aquaculture sector is the need of the hours.

What is Sustainable Development?

Although living resources are self-renewable, the focus needs to be on sustainability before resource utilization. Sustainable development focuses on the management and conservation of natural resources and the orientation of technological and institutional changes in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in agriculture, forestry, fisheries sectors) conserves land, water, plant, and animal resources are

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environmentally non-degrading, technically appropriate, economically viable, and socially acceptable. (code of conduct, FAO,1995).

What is Sustainable Aquaculture?

Sustainable aquaculture can be defined as the aquaculture practice which focuses on environmental, economic, and social sustainability to improve capacity building and utilize land effectively for the aquaculture sector.

- *Environmental sustainability-*
  Aquaculture practice should be eco-friendly. It should not impose any significant disruption to biodiversity.
- *Economic sustainability-*
  The aquaculture practice should be profitable with good long-term prospects.
- *Social sustainability-*
  Aquaculture practice must be socially responsible and contribute to the wellbeing of the local community.

Key Challenges Faced by Aquaculture Sector

With the passage of time aquaculture sector also facing some problems, which are included as follows,

- According to FAO, there are nearly 870 million people out of 7.1 billion world population are suffering from malnutrition.
- By 2050 the food consumption will have expected to increase from 2400 kcal/day to 3000 kcal/day.
- Share of calories derived from cereals is declining in India.
- There will be around 70 million undernourished people in India by 2050.
- Over the years, there is shrinkage of freshwater resources.
- Unavoidable intensification of aquaculture leading to environmental pollution, unprecedented disease occurrence, and causing a heavy loss in the end.
- Input costs for aquaculture are rapidly increasing.

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Potential of Sustainable Aquaculture

To address these key challenges faced by aquaculture sector. The future perspective of this sector will rely on the importance towards the capacity to deal with global challenges due to social and economic pressure on natural resources and aquatic ecosystems, including environmental degradation, water scarcity, population explosion, food scarcity, global hunger etc.

Sustainable aquaculture can be emerged as rays of hope to deal with these challenges in the present as well as near future also. The role of fisheries and aquaculture is inevitable in food security and to livelihood of millions of people. It also a helping hand for millions of people as;

- A creator of employment.
- Supplier of nutritious food.
- Generator of income and economic growth.

In addition to that, a global opinion of scientists is that aquaculture is a very efficient producer of high value proteins essential for human health and wellbeing in terms of its resource utilization like space, food, energy, and water. Modern sustainable approach of aquaculture produces less waste and lower carbon-nitrogen footprints than agriculture production sector. So there is a need for sustainable development in aquaculture, which has the potential to address the challenges aquaculture facing today.

Different Approaches for Making Aquaculture Sustainable

1. Focus on environmental impacts –

- ✓ Development of suitable technology for environmentally feasible aquaculture practice.
- ✓ Mitigation strategies for environmental pollution through microbial, Nanotechnology, practicing holistic methods like multi-trophic and organic aquaculture.

2. Use of renewable energy sources-

- ✓ The use of renewable energy in aquaculture can be a boon as it is cost effective, environmentally friendly, and carbon neutral technology.

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- ✓ There is a wide variety of renewable energy techniques entering into aquaculture industry, such as wind-powered water pumps and solar-powered water heating systems etc.
- ✓ Investigating in these technologies reduces the long-term operating costs and reducing environmental implications.

3. Reduce dependency on fishmeal as feed ingredient-

- ✓ As feed cost in aquaculture is skyrocketing due to the increased demand for fishmeal which also causing overexploitation of capture fisheries.
- ✓ Shifting of dependency over animal-based feed ingredients to plant-based can be served as a way for sustainable practice.
- ✓ Research on waste to wealth as a feed ingredient also should be promoted.

4. Promotion of sustainable aquaculture-

- ✓ Rewarding sustainable farming practices in aquaculture through government policies can be done.
- ✓ Subsidy on input costs for sustainable aquaculture farmers should be done.
- ✓ Awareness and encouragement for sustainable aquaculture can be practiced.

5. Practice of sustainable organic aquaculture

- ✓ Organic aquaculture is based on the use of organic inputs in aquaculture.
- ✓ No use of inorganic fertilizer, pesticides, antibiotics.
- ✓ It produces healthy fish which is completely devoid of any pesticide, antibiotic residues.
- ✓ Many organic aquaculture issues still needed to be resolved; steps should be taken to encourage and enhance organic aquaculture as sustainable practice of aquaculture.

6. Investment on new sustainable technologies

A. Aquaponics

- ✓ Aquaponics is an integration of aquaculture and hydroponics techniques to produce both fish and plants in the same system.

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- ✓ The system has high sustainable potential, such as less water requirements, minimum environmental impacts, and organic food production.
- ✓ It has potential to produce value added products like fish and a high yield variety of vegetables with less labor and land, less chemical use, and not much water usage.
- ✓ It can also be adapted to diverse and changing conditions.

B. Integrated multi-trophic aquaculture systems(IMTA)

- ✓ IMTA is based on the principle of polyculture and wastes utilization from the system by culture species.
- ✓ In the system, the particulate wastes materials are absorbed by filter feeder bivalves, while water-soluble wastes materials absorbed by algae.
- ✓ Along with the culture of fish and crustaceans, bivalves, algae, seaweeds can be cultured, which also maximizes profit margin.

C. In-pond raceways(IPR)

- ✓ IPR is like cage culture techniques but can be applicable to almost any water bodies which have the advantage of controlled
- ✓ water movement. This improves water quality and provides scope for more stocking density.
- ✓ IPR is more sustainable than cages, raceways, and intensive open pond culture.
- ✓ But still, further research is needed about the waste disposal of solid and liquid wastes.

D. Re-circulatory aquaculture system(RAS)

- ✓ RAS is based on the principle of water conservation and reduced waste discharge.
- ✓ It consists of a culture chamber, settling chamber, and biological filter. The water flows from the culture chamber to the settling chamber and then the biological chamber, which filters the water for reuse in the culture system.
- ✓ It has the potential for culturing in high stocking density, which maximizes the profit.
- ✓ RAS system conserves the water and reduces pollution.

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- ✓ Fewer biological risks such as disease issues relative to farming in the natural environment.
- ✓ Lower environmental compliances.
- ✓ It has the ability to control the cultural environment, which improves FCR and reduces need for chemicals and drug use.
- ✓ Thus RAS can be an efficient, useful tool for sustainable aquaculture.

E. Bio-floc technology(BFT)

- ✓ BFT technique is based on in situ remediations by which heterotrophic microbes culture is enhanced by C: N ration and constant aeration.
- ✓ Generates a floc-like structure that is nothing but aggregates of various living and dead microbes, which provide a good nutritional value for culture organisms.
- ✓ BFT reduces feed conversion ratio (FCR) and decreases feed costs.
- ✓ This natural productivity plays an important role in recycling nutrients and maintaining the water quality.
- ✓ It conserves water, utilizes waste, and reduces pollution.
- ✓ Less investment as compared to other.
- ✓ The BFT is much more sustainability potential than any other cultural system

Conclusion

Aquaculture sector will face an immense challenge ahead. But with the industry growing and evolving simultaneously, the goal of feeding the world in a sustainable manner becomes an achievable goal. For that, sustainable aquaculture practice can be the best possible option available. Also, for this, it needs more investment into sustainable aquaculture, which has an immense potential to deliver healthy, sustainable food to meet the rapidly growing demand.

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BREAKTHROUGH IN DOMESTICATION OF GUCCHI MUSHROOM (*Morchella* spp) IN INDIA

Article Id: AL2021160

[1]Anil Kumar*, [1]VP Sharma and [1]Satish Kumar

[1]ICAR- Directorate of Mushroom Research, Chambagaht, Solan (HP), India

Email: anilrao_mpp@yahoo.co.in

In the present scenario, mushrooms have become the most sought after nutritious food in the world. They are broadly divided into two classes; ascomycetous and basidiomycetous mushrooms. Basidiomycetous class includes the commonly grown mushrooms such as button mushroom (*Agaricus* spp), oyster mushroom (*Pleurotus* spp), paddy straw mushroom (*Volvariella* mushroom) etc. Whereas, ascomycetous class is dominated by *Morchella*spp (True morels) and tubers. *Morchella* spp. belongs to Ascomycota, Pezizomycetes, Pezizales, Morchellaceae, and Morchella Dill. ex Pers. All species in this genus are edible.

General Nutrition

Morchella mushroom is commonly referred as Gucchi in India and is one of the costliest edible fungi of the world. Gucci is well known for their culinary aspects and gastronomical delights, and excellent flavor. It is used for number of purposes like treating arthritis, anemia, tumor etc., which are mainly attributed to the content of total polysaccharides, glucosamine, vitamin D, antioxidants etc. Apothecia- an ascocarp of morels possess the real economic value. They are primarily exported from India to Europe and the United States of America.

Cultivation Status

Due to difficulties in artificial cultivation of Gucchi mushrooms, the wild morels have become a profitable business. Gucchi is admired by human being from the ancient time. Its

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appearance in the forest areas was correlated with many myths such as magic and thunderstorm etc. but without any scientific basis. Gradually the peoples were attracted by its nutraceutical values of Gucchi and forced them to think about its artificial cultivation. Earlier, Gucchi mushrooms were considered as obligate parasite because of the association of its fruit bodies with plant roots. Thereafter, scientists proved that Gucchi could be mycorrizal as well as saprophytic. Obligate mycorrizal association of Gucchi was considered as the major cause of failure of earlier attempts to cultivate Gucchi mushroom in India and other part of the world. The real success in Gucchi domestication was achieved through scientific intervention in 1882 in France. There it was cultivated outdoor through artificial inoculation. Later on in 1904, its cultivation was claimed on apple compost but couldn't make significant impact. 1982, succeeded for the first time to Gucchi mushroom was produced under artificial conditions for the first in 1982. First detailed studies on the life cycle of Gucchi mushrooms were performed in 1990 to study its various development stages. In continuation to this, few more patents were granted on Gucchi mushroom cultivation till 2012. Recently, in 2019 studies in the USA claimed new technique of outdoor cultivation of Gucchi. However, many doubts still exist on ascomata induction of morels which are certainly required to be clarified.

Availability

So far in India, the morels are collected from their wild habitats in North-Western Himalaya. Fructification of morels may be found under forest trees, in fruit orchards, open grassland, under the shrubs, and rarely in old cemented structures. The best time for the morels collection is spring and summer. However, they may also be found in rainy and autumn seasons occasionally. So far, more about 90 species of genus Morchella have been reported from all over the world. Till date, in India, only six species have been recognized. They are common moreles, delicious morels, conical morels, thick stemmed morel, black morel, and Hybrid morels. In nature, the fresh morel mushroom season is very short, and they are typically found in the markets for only a few weeks, mainly in the spring. In addition, the accumulation of heavy metals in the ascocarps that are picked from natural habitats has been reported.

General Uses

In India, local people cook Gucchi mixed with rice and vegetables and consider it as nutritious as meat or fish. It is also used in health care, and medicinal purposes differ among

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traditional hill societies isolated by linguistic, cultural, and terrain barriers. Tribal peoples use Gucchiby boiling the fruiting bodies in water; local communities in the Kullu District of Himachal Pradesh (western Himalaya) boil it in milk. Mushroom metabolites are also used as adaptogens and immune stimulants and now are considered to be one of the most useful antitumor agents for clinical use. It is noticed that it appears in a large scale during the month of March, and its collection starts between April and June. Local people set the ground on fire every year during October/November, assuming that such a practice will improve Gucchi yield. There is a need for the scientific evaluation of ecological and economic implications of such traditional practices.

Challenges

In India, since the inception of ICAR- Directorate of Mushroom Research, Solan (HP), attempts were made on domestication of Gucchi mushrooms. However, no significant results were obtained out of it. Viewing all the above mentioned facts and recommendations of Research Advisory Committee (RAC), in 2019, ICAR-DMR, Solan resumed its emphasis to explore the possibilities of Morel cultivation in India. Dr. VP Sharma, Director ICAR-DMR, Solan (HP), assigned this challenge to Dr. Anil Kumar, Scientist. An institutional research project entitled "Standardization of cultivation technique for Morchella mushroom" was prepared by Dr. Anil Kumar (Principal Investigator). Investigations were started with strain selection, sclerotial production potential of the strains, mode of nutrition, and standardization of spawn production technique. Cultures of Morchella genus with high sclerotial production potential were selected for our investigations. Substrate preparation technique was standardized for cultivation of Gucchi mushroom. Under continuous rigorous *in vitro* trials on induction of ascoma (fruit bodies) in *Morchella* spp (Gucchi), three small ascomata of 0.5 to 1cm were obtained. Under the first seasonal cultivation trial in 2019, a mature ascoma of a total 13cm length was recorded under greenhouse on 13th April 2020. It was not considered as a success even on getting positive results at the initial stage of experimentation. The major reasons of dissatisfaction were such as less numbers of ascomata and uncertainties about repeatability of the experimental data. Dr. Anil was motivated and encouraged by Dr. VP Sharma, Director ICAR-DMR, Solan (HP), for his valuable breakthrough in the history of Indian mushroom science. Overall, the findings of the first outdoor trial were considered as the positive direction of their experimentation and not as the endpoint of their experiments. With continuous efforts, Dr. Anilsucceeded to induce 215

ascomata (fruit bodies) in the second research trial under greenhouse in 2021. In this technique, spawn was mainly prepared in forest soil and sown in the soil beds. After the colonization of the subsrtae continuous moisture was provided to the fungus, which resulted into ascomata (fruitbody) formation.

Conclusion

This is for the first time in history that India succeeded in producing fruit bodies (ascomata) of Gucchi mushrooms. As a result of this achievement, India entered in the list of few countries like USA, China, France etc. who successfully attempted to cultivate Gucchi mushroom under artificial conditions. However, still there is a need to improvise our technology before it is transferred to the farm communities. Hopefully, in the next 2-3 years, it will be transferred to the farmers. In India, the average per Kg cost of true morels may vary from Rs. 10000 to 30000. In the future, the Gucchi mushroom will revolutionize the Indian mushroom industry and help in the upliftment of farmers.

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THE FRUITS OF THE BEEDI LEAF-BEARING TREE (PERSIMMON) ARE RICH IN NUTRIENTS

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[1]Ravi Kondle* and [1]Sarad Gurung

[1]Department of Pomology and Postharvest Technology, U.B.K.V, Pundibari, Cooch behar, West Bengal, India.

Email: kondleravi27@gmail.com

Thuniki/Temburni (Telugu), Tendu (Hindi), Kendu (Odisha, Jharkhand, and Assam) (*Diospyros melanoxylon* Roxb.) fruit belongs to Ebenaceae family and Diospyros species. It is origin to India and Sri Lanka. Its trade name is ebony, tendu/kendu, Thuniki/Temburni, and is also called as coromandel ebony or East Indian ebony. There are so many economic uses of this species, and all the plant parts starting from bark, leaves, fruits, and seeds are important for various commercial purposes. Both unripe and ripe fruits have been used in folk-medicine by tribal communities. It's also called as a poor man's cigarette

Tendu is a dioecious, long lived, medium-sized tree up to 25-30 m and 1.9 m girth. In a dry locality, it's leafless for a short life in the hot weather; reproduce its leaves in May-June. In a moist locality, it's evergreen. The primary root is long, thick, and fleshy at first, afterward woody, greyish, often swollen in the upper part near ground level. Leaves opposite and coriaceus, up to 35 cm long, tomentose presence on both sides when it is young, becoming glabrous above when fully grown. The flowers are produced from April to June on new shoots, and the fruit ripens after 1 year. Persimmon flowers are yellowish white and 0.75 inches long. Male and female flowers are usually borne on separate trees; sometimes, perfect or female flowers are found on male trees, and occasionally male flowers on female trees. Male flowers, in groups of 3 in the leaf axils, have 18- 24 stamens in 2 rows. Female flowers, solitary, have a large leaflike calyx, and pale-yellow corolla, 8 undeveloped stamens, and oblate or rounded ovary bearing the style and stigma. Perfect flowers are intermediate

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between the two. Fruits are usually set in clusters which hang on the branches during winter. The fruit is usually capped by the persistent calyx. The colour of ripe fruit ranges from light yellow-orange to dark red-orange depending on the species and variety. In some species, it is black as well. Fruits vary in size from 1.5 to 9 cm in diameter, and in shape. They may be spherical, acorn, or pumpkin shaped. The calyx becomes easy to remove once the fruit is ripe. Generally, the pulp is bitter and astringent until fully ripe, when it becomes soft, sweet, and pleasant, but dark-fleshed types may be non-astringent, crisp, sweet, and edible even before full ripening. Like the tomato, persimmons are not popularly considered to be berries, but in terms of botanical morphology, the fruit is in fact, a berry.

Nutritional Use of Kendu

Fruits

Kendu fruit is globose in shape with 3-4 cm diameter. It usually contains 3 to 4 seeds which are brown in colour, compressed, and oblong in shape. These fruits are rich in sugars, proteins, fibre and vitamin C.

Carbohydrate	81%	Protein	2%
Fat	2%	Fibre	11%
Caloric value	349 Kcal	Calcium	11.8 %
Magnesium	62 %	Zinc	1.28 %
Copper	0.2 %	Vitamin C	49 mg %
β-carotene	260 µg %)		

- The fruit has a cooling and astringent effect. Agency people use this fruit against **intense summer heat**. Tribal's using this fruit for extra vigour and efficiency to work for long hours without exhaustion.
- Unripe fruit is useful in relieving flatulence, and ripe fruit is used to check excessive bile secretion. Fruit extract relieves **fistula problems** and is also used as a **skincare** agent.
- The tannin content in dried powdered fruit is 15%, and that of half ripe fruit is 23%. It is used as a carminative and astringent.

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- In ethnomedicine, it is also used against rheumatoid arthritis and abdominal pain. Methanolic extract of *kendu* is reported to possess saponins, tannins, terpenoids, flavonoids, alkaloids, and essential oils.
- Tendu fruit wine is popular among the tribal community. An analysis of wine prepared from kendu fruits reveals that it contains

Total sugar	3.78 g/100ml	Lactic acid	0.39 mg/100 mL
Titratable acid	1.32 g/100 ml	Methanol	3.5 % (v/v)
pH	3.12	Ethanol	6.8 % (v/v)
Total phenolics	0.95 g/100 ml	ascorbic acid	1.52 mg/ 100 mL
β-carotene	8 µg/100 mL		

Leaves

- The leaves are reported to contain crude fibre (25.28%) and crude protein (7.12%).
- Leaves are used as a styptic in the treatment of scabies and old wounds and as a laxative and carminative medicine.
- The leaves possess antimicrobial properties due to the presence of "*Pentacyclic triterpenes*"
- The leaves are commonly used for making beedis (an indigenous conventional cigarette which uses the kendu leaf for wrapped around of tobacco instead of paper).

Bark:

- The bark colour is as pelican, exfoliating in rectangular scales.
- The bark is used to "cure" small-pox by negative people.
- The bark of Tendu tree found in India has determined to have significant Antiplasmodial effect against *Plasmodium falciparum*, which causes malaria in humans.

Flowers

- Dried flowers are observed to be useful in urinary, skin and blood diseases.

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Seeds

Powdered seeds are also sold in markets along with fruits, and the seeds have been prescribed in India as a cure for mental disorders, nervous breakdowns, and palpitations of the heart.

Timber

Wood is hard, whitish-pink, tough, fairly durable, and used for building shoulder poles, mine props and shafts of carriages. The wood of this tree is also utilized for making boxes, combs, ploughs and beams. *Diospyros melanoxylon* is reported to be good fuelwood; the calorific value of sapwood is (4957 kcal/kg) and of heartwood (5030 kcal/kg).

Conclusion

The Kendu angiospermous tree being rich in nutritional, medicinal, and processing qualities can play a really significant role within the livelihood security communities through enhanced household income, employment generation, and environmental protection. Kendu fruits have an excellent potential; there is a scope of accelerating the world and production of this lesser known fruit and their products from the various parts of the tree. Value addition their nutritional and medicinal properties may be a future strategy, and government and non-government organizations should play an important role in value addition and popularization of the kendu tree.

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PRODUCTION TECHNOLOGY AND POST-HARVEST HANDLING OF SUMMER GREEN GRAM IN CENTRAL INDIA

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[1]Venkteshwar Jallaraph*, [2]Pragya Singh and [2]Rajendra Verma

[1]ICAR - Agricultural Technology Application Research Institute, Zone-IX, Jabalpur (M.P.), India.

[2]Rajmata Vijyaraje Scindia Krishi Vishwa Vidhyalaya, Gwalior (M.P.), India.

Email: vjallaraph@gmail.com

Green gram is one of India's most valuable pulse crops. Green gram is a native of India and Central Asia and has grown in these regions since prehistoric times. Green gram is widely cultivated throughout Asia, including India, Pakistan, Bangladesh, Sri Lanka, Thailand, Laos, Cambodia, Vietnam, Indonesia, Malaysia, South China, and Formosa. Green gram (*Vigna radiate*) is an annual herb with a height of 45-75 cm that belongs to the Leguminosae family. It is an erect to sub-erect, deep-rooted, heavily branched, and very hairy annual herb. Plants are usually branched, and the cultivated types' habits range from erect to sub-erect. It may tend to twine sometimes. The stem is furrowed, squarish, and hairy with green and purple pigmentation, and the root system is an extensive taproot. Nodules on the roots fix atmospheric nitrogen through a symbiotic relationship with the bacterium Rhizobium. When mature, the pod colour ranges from brown to light grey. Green gram is a high-protein (around 25%), which is almost three times that of cereals and low-carbohydrate staple food. It meets the protein needs of the country's vegetarian population. In addition to being an essential source of human and animal nutrition, green gram helps to maintain soil fertility by enhancing soil physical properties and fixing atmospheric nitrogen. It is a drought-resistant crop that is well-suited to dryland farming and is commonly used as an intercrop.

Soil and Climatic Requirements

Green gram thrives in rich, sandy loam soils with excellent internal drainage and a pH of 6.3 to 7.2. For best results, it requires slightly acidic soil. On more alkaline soils, it cannot withstand salinity and can develop extreme iron chlorosis symptoms as well as micronutrient deficiencies. On heavy clays, root growth can be restricted. Green gram is a warm-season crop that takes 60-65 days to mature from seed to harvest in the summer season. The ideal

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temperature range for plant growth is 27°C to 35°C. Green gram is heat and drought resistant since it can withstand higher temperatures. The green gram responds to the day length. Short days result in early flowering, while long days result in late flowering. Different green gram varieties vary in their photoperiod response.

Field Preparation

For proper germination and crop establishment, a well-prepared seedbed is needed. To make the seedbed free of clods and weeds, 2–3 ploughings followed by planking are needed. For summer cultivation after the harvest of preceding crops, pre-sowing irrigation before tillage should be ensured. If there is no wheat straw in the field, summer green gram can be grown without any preparatory tillage after the wheat harvest with the aid of a zero-till drill. Zero tillage saves time, resources, and money. Carbaryl 5 percent powder should be mixed during the last stage of field preparation in sandy soils where termite infestation is common.

Choice of Variety

The choice of variety depends on the prevalent cropping system, time of sowing, and source of irrigation in the area of cultivation. The varieties which mature in 60-65 days are appropriate for the summer season. Cultivation of short-duration varieties in summer ensures that the succeeding crop is sown well in time besides saving the crop from damage due to early summer monsoon showers, which may lead to deterioration of seed quality and pre-harvest sprouting of grains. The summer varieties should have good initial vigour and grow profusely in the first 25-35 days so that they are well established before the onset of flowering. The green gram varieties cultivated in Madhya Pradesh and Chhattisgarh state are given in Table.

State	Name of varieties
Madhya Pradesh & Chhattisgarh	Malviya Janchetna (HUM-12), Malviya Jankalyani (HUM-16), TJM-3, IPM-02-03 (Diksha), Azad-1, Swati, MH 421, PDM-139, HUM-1, BM-4, Type-9, Type-44, K-851

Sowing Time

Summer green gram should be sown as soon as the previous crop is harvested (wheat, mustard, cotton, potato, sugarcane, mustard, and cotton, etc.). The first fortnight of March is

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most suitable for the sowing of the summer crop. Due to high temperature, the late sown green gram suffers more losses during the flowering stage and reducing yield.

Crop Geometry and Seed Rate

Seeds should be sown in 4 to 5 cm deep lines in a well-prepared seedbed with a good of moisture. If the surface layers are dry, the seed depth can be increased in those soils which do not form crust. The crop should be sown at a row spacing of 20 to 25 cm, with a seed rate of 20–30 kg/ha recommended for the summer season. A slightly higher seed rate is recommended for broad seeded varieties. Sowing can be done behind the local plough or with the help of a seed drill.

Seed Inoculation or Seed Dressing

For the prevention of soil and seed-borne diseases and better yield, seeds should be treated with antifungal bioagents, Rhizobium, and Phosphorus Solubilising Bacteria (PSB). Seed should be treated with 5–10 g Trichoderma or 2.5 g Thiram or 2 g Carbendazim/kg of seed for the prevention of soil-borne diseases. After seed dressing, the seed should be mixed with Rhizobium culture. One packet of Rhizobium culture (250g) is sufficient for a 10 kg seed. Rhizobium treatment increases nodule formation, leading to a 10-15% increase in yield, and also minimizes the use of nitrogenous fertilizers for the subsequent crop. Rhizobium culture is more significant for the summer crop as the number of natural microbes decreases during this season. For seed treatment, 50 g of molasses should be mixed with a half-liter of

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water and 250 g of Rhizobium (local strain to be preferred). The mixture should be used to treat 10 kg of seed. The treated seed should be dried in the shade for 2-3 hours before sowing.

Fertilizer Requirement

In green gram, nitrogen fertilizer is typically not needed at higher doses because the crop fixes a significant amount of nitrogen on its own. Green gram grew after potatoes, peas and mustard, does not need nitrogen because the available residual nitrogen is adequate for this short-term crop. Green gram, like other legumes, has phosphorus, potassium, calcium, magnesium, and sulphur requirements that must be met with exogenous fertilizer if the soil is deficient in these nutrients. Phosphate fertilizer is usually required at a higher amount in irrigated crops or on severely P-deficient soils. It is always advisable to conduct soil tests and follow the recommended schedule, of fertilizer use while considering the anticipated yield. 10 kg nitrogen and 35 kg phosphorus should be added at the time of sowing for summer green gram grown after wheat.

Irrigation Management

Summer green gram is grown under assured irrigation only. This crop needs less water than many other crops due to its shorter life cycle. The flowering and early pod fill stage is the most crucial period for irrigation. It is essential to manage irrigation carefully to provide sufficient moisture at the time of pod filling, but it should not be high enough to delay the maturity. Depending on the climatic conditions and the soil's water holding capacity, 3–4 irrigations are usually adequate for the summer season green gram crop.

Weed Management

Crop-weed rivalry peaks between 20-25 days after sowing. Weeds reduce the grain yield of a green gram by 30-50 percent. However, the extent of the loss varies depending on the intensity and type of weed flora. *Cyperus rotundus*, *Amaranthus viridis*, *Trianthema monogyna*, *Digitaria sanguinalis*, and *Ageratum conyzoides* are the most common weeds in the summer green gram crop.

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Amaranthus viridis

Ageratum conyzoides

Trianthema monogyna

Cyperus rotundus

Digitaria sanguinalis

As a result, it's important to pay close attention to their management. Hand weeding is advantageous around 20-25 days after sowing. Hoeing by hand should be performed once or twice to encourage good cultivation practices. To remove weeds before flower initiation, rotary hoeing should be done as appropriate. Weeds that emerge late have a smaller impact on yield than weeds that emerge early. Pendimethalin 30 EC @ 3.75 ml/l can be used as a pre-emergence spray in green gram to effectively suppress weeds.

Plant Protection of Green Gram

Major Diseases and their Management

a) Yellow Mosaic Virus Disease

Yellow Mosaic Virus, a member of the Geminivirus family, causes this disease, which is spread by whiteflies (*Bemisia tabaci*). Yellow mosaic spots appear on the tender leaves, which grow larger over time and eventually turn completely yellow. Flowering and pod growth are hampered by yellowing. Early infection often leads to necrosis and the death of plants.

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Control measures

1) Grow-resistant varieties reduce the infestation of yellow mosaic virus disease in green gram.
2) Diseased plants should be rouged out and buried or destroyed to prevent the further spread of the disease.
3) Whitefly (*Bemisia* spp.) infestation may be controlled by the spray of Triazophos 40 EC or Malathion 50 EC @ 2.0 ml/l or Oxydemeton methyl 25 EC @ 2.0 ml/l at 10-15 days intervals if required.

b) Macrophomina Blight (*Macrophomina phaseolina*)

Root rot, collar rot, seedling blight, stem rot, leaf blight, pod, and seed infection are all caused by *Macrophomina phaseolina* in green gram. The fungus causes seed rot and seedling mortality during the pre-emergence period. Seedling blight occurs in the post-emergence stage as a result of soil or seed-borne infection. The primary signs are secondary root decay and tap root cortex shredding. At ground level, the fungus attacks the stem, causing localized dark brown patches to coalesce and encircle it. On the outer tissue of the stem and root, black dots resembling sclerotia appear on the surface and beneath the epidermis. The disease develops rapidly and causes severe infestation under high temperature and water stress conditions.

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Control measures

1) The diseased plants should be uprooted and destroyed so that the sclerotia do not form or survive.
2) Seeds treated with Trichoderma @ 5–10 g/kg of seed or Captan 75 WP @ 2.5 g/l and Thiram 80% WP @ 2 g/l before sowing provides significant protection.
3) The crop should be sprayed with Carbendazim 50 WP @ 1.0 g/l at an interval of 15 days with the appearance of the symptoms.

c) Rhizoctonia Blight (*Rhizoctonia solani*)

Rhizoctonia is a fungus that grows in soil. *Rhizoctonia solani* is the fungus that causes blight. It begins with the leaf lamina, petioles, or young branches. Eventually, the top of plants become blighted, and patches of such plants are conspicuously seen in the field. In humid conditions, a whitish web-like growth appears on the leaves. Infected tissues produce dark brown sclerotia. There are several collaterals and alternate hosts, including the prevailing weeds, which are the source of infection to the green gram.

Major Insects and their Management

a. Thrips (*Megaluro thrips distalis*)

Thrips (*Megaluro thrips distalis*), tiny dark brown insects that feed on the stigma within the flower, summer green gram, causing the flower to shed before opening and the terminal shoot to elongate. In case of serious infestation, the plants grow bushy, and the plant turns dark green, bearing few pods with shriveled grains. Sometimes there may be a complete failure of the crop.

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Control Measures

(1) Timely irrigation at an interval of 15 days results in the low build-up of thrips.
(2) Seed treatment with Thiomethoxam 70 WS 0.2% + foliar spray of Thiomethoxam 25 WG 0.02% is quite effective in controlling thrips.
(3) Spray the crop at bud initiation stage with triazophos 40 EC @ 2.0 ml/l or dimethoate 30 EC or melathion 50 EC @ 2 ml/l.
(4) Spray Neem Seed Kernel Extract (50 g/l) and neem oil 3000 ppm @ 20 ml/l.

b. Tobacco Caterpillar (*Spodoptera litura*)

The tobacco caterpillar is a polyphagous pest. Its moth lays eggs in masses on leaves. After hatching, first and second instar larvae feed gregariously on the leaf surface for about 2-3 days and leave behind the whitish membranous leaf only. In the solitary phase, the fully-grown larvae scatter throughout the entire field. The larvae make irregular holes on the leaf surface, and in severe infestation, they skeletonize the foliage and destroy the crop.



Control measures

(1) Egg masses and young larvae feeding on leaves should be collected and destroyed to reduce infestation.
(2) Foliar spray of Malathion 50 EC @ 2.0 ml/l or Novaluron 10 EC @ 0.75 ml/l is quite effective.
(3) A spray of microbial pesticides like SNPV [500 LE/ha or 500 ml (1x109 POB/ml)] or *Bacillus thuringiensis* formulations in synchrony with early larval instars is effective against the pest.

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c. Pod Borer (*Helicoverpa armigera*)

Helicoverpa being a polyphagous pest of crops, also infests green gram. The immature larvae of the borer feed on leaves, flowers, pods, and seeds in pods, thus causing heavy losses in yield. Pod borer defoliation is characterized by rounded chew marks and angular holes. A high population in the drought-stressed crop can cause considerable damage if vegetative terminals and stems are eaten.



Control measures

(1) Spray Spinosad 45 SC @ 150ml/ha at the appearance of larvae in the field.
(2) Spray of Emamectin benzoate 5 SG @ 0.2 g/l effectively manages the larval population or Profenopohos 50 EC @ 2 ml/l or rynaxypyr 20 SC @ 0.15 ml/l.
(3) Spray HaNPV @ 1ml/l or NSKE or crude neem 5% @ 50 g/l or neem oil 3000ppm @ 20ml/l.

d. Whitefly (*Bemisia tabaci*)

Whitefly nymphs and adults suck sap from leaves and make the plants very weak, showing downward cupping of the leaves, giving a sickly look, and the plant may die eventually due to severe attack of the pest. The insect secretes honeydew, which promotes the development of sooty mould, resulting in leaf blackening, a drastic reduction in photosynthetic rate, and leaf drying, ultimately leading to crop failure. The whitefly is a carrier of a variety of viruses, including the green gram yellow mosaic virus (YMV).

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Control measures

(1) Seed treatment with Imidacloprid 17.8 SL @ 3ml/kg of seed and 2 sprays of Imidacloprid 17.8 SL @ 0.2ml/l at 15 days of intervals is effective in reducing the incidence of whitefly and YMV disease and is a common practice.

(2) Spray Acephate 75 SP @ 1.0 g/l and neem oil 3000 ppm @ 20 ml/l for reducing the whitefly population and YMV incidence in green gram.

Harvesting and Threshing

Summer green gram matures in 60 to 65 days. However, pod maturity is generally not uniform because the plants use to flower over an extended period. Therefore, it is sometimes difficult to decide a suitable time of harvest of the crop. Regardless, harvesting should start when two-thirds of the pods are mature. Harvesting immature pods too early can result in losses, while harvesting too late can result in pod shattering losses. Harvesting is done either manually or by machines. Green gram stalks with pods should be sun-dried for 3-4 days after harvesting. Spike tooth type power thresher for wheat with some modifications can be used for threshing green gram.

Harvesting Care

During harvesting, proper care should be taken to minimize quantitative and qualitative losses. *The Following caution should be taken during harvesting:*

- Harvesting should be done at proper maturity to ensure optimum grain quality and consumer acceptance.
- Harvesting before the crop's maturity usually results in lower yields, a higher proportion of immature seeds, poor grain quality, and more chances of infestation during storage.

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- Delay in the harvesting of green gram results in shattering of pods and other losses caused by birds, rats, insects, etc.
- The best time to harvest the crop, when large i.e. 80 percent of the pods are fully matured.
- Avoid harvesting during adverse weather conditions i.e. rains and overcast weather.
- Use the right kind of harvest equipment for harvesting green gram (sickle).
- Avoid pest infestation before harvesting.
- The harvested bundles should be kept in one direction to ascertain efficient threshing.
- Keep the harvested bundles for drying in the field after cutting on the threshing floor, if weather permits.
- The harvested produce should be stacked in a dry, clean place in a cubical way to facilitate the circulation of the air around.
- Rogue out the admixtures before harvesting.
- Keep the harvested Green gram separately from one variety to another to get true to type variety (grains).

Post-Harvest Handling

There is a sizeable quantitative and qualitative loss of green gram during different post-harvest operations like threshing, winnowing, transportation, processing, and storage. Hence, it is appropriate to give due emphasis to reduce qualitative as well as quantitative losses of green gram during post-harvest operations. It has been reported that about 2.38 percent of losses occurred during post-harvest operations at the producers' level. The details are as under:

Estimated Post-Harvest Losses of a Green Gram at Producers Level

Sl. No.	Stages	Production loss (%)
1.	Losses in transport from field to threshing floor	0.67
2.	Losses in threshing	0.63
3.	Losses in winnowing	0.61
4.	Losses in transport from threshing floor to storage	0.19
5.	Losses in storage at producers level	0.29
	Total losses at producers level	**2.38**

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Source: Report on Marketable Surplus and post-harvest losses of a Green gram in India-2002, DMI

The post-harvest losses of a green gram can be minimized in the process of threshing, winnowing, storage, processing, handling, and transportation.

(a) Threshing and Winnowing

It has been reported that 0.63 percent losses occur during threshing and 0.61 percent losses occur during winnowing. To minimize losses, threshing and winnowing operations on the pucca platform must be completed in a short time using improved equipment.

(b) Transport Losses

It has been observed that 0.67 percent of the produce is lost during transportation from the field to the threshing floor. Transporting of produce from the threshing floor to storage results in 0.19 percent of the loss. To minimize losses, efficient and fast transportation is needed, as well as good packaging material.

(c) Processing

The loss at this point has been estimated to be up to 1% due to the use of old and obsolete processing methods. Improved dal milling method should be used to minimize milling losses and increase performance.

(d) Storage

Bean weevils can be controlled by storing seeds with about 12 percent moisture in standard grain bins that have been fumigated. If seeds have moisture content greater than 12%, they can be dried by blowing unheated air through thin layers until the moisture content is close to or equal to 12 percent. Bruchids can cause up to 100% losses if the crop does not care properly. These are reported to infest the crop at the drying stage and in barnyards; however, they generally attack under storage conditions. The adults are small brownish beetles, with characteristic emarginated eyes. Eggs are laid, stuck on the outer sides of the pods by the female beetle which may lay up to 90 eggs. Eggs are laid directly into the seed if the pods have dehisced. The newly emerged larvae bore into the seeds and feed on them. For control of this pest, stores should be cleaned and the residual bruchid population should be destroyed. Seeds can only be stored in boiled and dried gunny bags. During storage, a loss of

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around 7.5 percent is estimated due to inefficient and ineffective storage methods. Quantitative losses are mostly caused by spoilage, driage, or loss of a portion of the produce, as well as insect, rodent, or bird infestation. Improved scientific storage facilities should be adopted to reduce the losses considerably.

Conclusion

Green gram is a most important pulse crop with around 25% protein content which is almost three times that of cereals. It meets the protein needs of the country's vegetarian population. In addition to being an essential source of human and animal nutrition, green gram helps to maintain soil fertility by enhancing soil physical properties and fixing atmospheric nitrogen. In green gram, there is a sizeable quantitative and qualitative loss of green gram during different post-harvest operations like threshing, winnowing, transportation, processing, and storage. It has been reported that about 2.38 percent of losses occurred during post-harvest operations at the producers' level. Proper post-harvest operations practices should be adopted to reduce qualitative as well as quantitative losses of green gram in the summer season.

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