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Gardening with Edible Flowers: A way to release stress amid COVID19

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ABSTRACT

Gardening is an important activity since ancient civilization. It affects human life and wellbeing in various ways. During the present Covid situation when people are confined to home or with limited movement, gardening in the form of container garden, terrace garden, kitchen garden, backyard garden etc provides suitable intervention to overcome stress, anger, fatigue, depression and anxiety. It should signify a place of beauty, meaning, and meditation. The garden consists of flowers, fruits, vegetables, herbs , shrubs depending on the nature, space and purpose. With the growing importance of pigments and nutraceuticals in human diet, colourful edibles are getting more importance. Thus edible flowers are very suitable for such intervention, as it give beauty, bounty and strength to fight the present situation.

Key Words: Covid, edible flowers, gardening, nasturtium, stress

INTRODUCTION

Gardening is one of the most common ways of interacting with nature and indeed is enjoyed as a popular pastime throughout the continent/world. Use of ornamental flowers in gardening is not a new idea. As colour is an integral part of human life, it affects the human wellbeing in various ways and gardens are the best way to get it. The style or design of a garden can be ornamental and it requires imagination and pre-planning. It was well adopted by French in their potagers (decorative kitchen gardens) for centuries. The mixed planting and skillful blending of vegetables, flowers and herbs with varying textures and colors gives excellent outlook.

Gardening and human stress

It is normal to feel sad, stressed and confused during a crisis. The present situation of lockdown arised due to Covid 19 pandemic resulted in home confinement of millions of people across the world. All our normal routine activities have been disrupted by this pandemic. The lockdown period resulted in stress, anger, fatigue, depression and anxiety among all the citizens of all countries. In long run it may create a number of health and behavioural problems. Several researchers highlighted the potential health benefits derived from gardening activities. It not only increases individual's life satisfaction but also psychological wellbeing and sense of belongingness. Thus, engagement with gardening has increasingly been recognized as not only a cost-effective health intervention but also a treatment for those with psychological health issues, so-called "horticultural therapy".

Importance of edible flowers

There are some flowers that may be eaten as vegetables or may be used as herbs. Edible flowers are used to garnish foods to provide colour, flavour and aroma. They are rich source of nutraceuticals. They can be eaten as part of a main dish or be incorporated into salads. Only petals are eaten and it is advisable to remove stamens, pistils and basal receptacle. As all flowers are not edible, it is important to choose those which are known and safe to eat. Since the petals are very delicate, the flowers which are to be used for consumption should not be sprayed with pesticides. These ornamentals can be planted in beds, borders, mass effect, pots and in combination with vegetables. Some commonly used flowers are peppery nasturtiums, cucumber-flavored borage, and onion-flavored chive blossoms.

Layout

The gardens are laid out in geometric shape and formal in design with pathways dissecting them. Generally these are edged with ornamental plants, boxed wood, etc. The orientation should be such that the plants should receive full sunlight. Trellis and arches are also a common features of such gardens. They not only give excellent backdrop but provide support to climbers and add height to the garden. However as per the latest trend and constrained space the choice in patterns/ design is endless and does not have to be limited to only formal designs. One can create their own design for an ornamental vegetable garden. Beginner can start with any design and it means designing the garden in a different way to make it more visually appealing. A well designed and built circular garden can become a focal point of the garden landscape.

Beds and borders

In a garden the beds can be prepared in various shapes *viz* square, rectangular, circular, oval, triangle, irregular, etc. The beds may be flat bed, raised bed, ridges or furrow. The border defines, where a bed begins and ends, and it also gives the scene a crisp, neat appearance.

The tall perennials and annuals, such as ornamental grasses, are excellent for creating privacy screens with seasonal interest. Always keep annuals and perennials separate in a home garden to make it easier to till and amend your annual beds.

Path

Pathways are another feature that gives an attractive look to a garden. Pebbles, stones, wood chips or crushed-gravel etc gives paths a descent look for walking. Stepping stones along with turf are also widely used for paths. Even granites, stones, interlocking tiles are suitable for paths/ roads and are suitable for movement of carts and heavy loads. Stone or pavers are good for formal architecture, while wood for informal styles.

Colour

Color plays an important role in the garden. It gives soothing effect to the eyes and reduces stress and other psychological ailments. As flowers are available in wide range of colours and thus garden become colourful. Therefore it is important to select garden materials that harmonize with the color scheme of garden.

Suitable Plants

A brief description of the suitable flowers is furnished below. For proper cultural hints of individual crop, one can refer to further reading sources given in the end of the document.

DESCRIPTION OF IMPORTANT EDIBLE FLOWERS USED IN GARDEN

Nasturtium (*Tropaeloum majus*): It is an important annual flower in a garden and widely used for hanging pots also. It last long in the garden and produce large seeds. All parts of the nasturtium have a pleasant, sweet, peppery flavour. Its leaves, flowers, and seeds are edible. The fresh seeds can be pickled like capers. The flowers are also used whole to decorate salads and a variety of other foods.

Pansy (*Viola spp*.): It is a very popular winter annuals grown in pots, ground cover and beds. They grow upto a height of 1-30 cm and behaves as perennial in some climates. It is also known as cat face. The flower petals are edible and highly decorative. The petals have little flavor and used for decorating fruit salads.

Rose (*Rosa damascena*): It is an important sweet scented edible flower crops. Its flower is mainly available during two flushes April- May and October- November. In India it is mainly cultivated in Hasayna (Aligarh), Kannauj and Sikandarpura (Ballia) in Uttar Pradesh and Pushkar (Ajmer) and Haldighati in Rajasthan. Well-drained sandy loam with pH of 6-7 is suitable for its cultivation. Moderately cool climate with bright sunshine and a temperature range of 15-27°C is ideal for flowers. The petals are edible and used for preparation of gulkand, essential oils, rose water and flavouring sweets and confectionary.

Calendula – It is herbaceous plant grown throughout the year under mild climate. However it prefers cool climate for quality flower production. The flowers are found in shades of yellow and orange. It is easy to grow and widely used in a garden for various purpose. Their flowers are edible and possess nice flavour that ranges from peppery to

bitter. The petals add bright yellow, gold, and orange colour to soups and salads. They are also used to tint dishes like saffron. The leaves are edible but are often not palatable.

Rosemary (*Rosmarinus officinalis*): It is a perennial herb mainly used for extraction of oil. It thrives well in cool climate with a temperature range of 15-20°C. The leaves contain more oil than the flowers and are used to sprinkle on salads, pasta, poultry-based soups.

Safflower (*Carthamus tinctorius*): It is an important oil yielding crop of the rabi season. It prefers deep, fertile, well-drained soils that have a high water holding capacity. It can withstand saline soil but not high rainfall. It is a versatile crop and can be successfully used in home garden also. The dried petals are used for various culinary purpose and extraction of saffron food dye. Its fresh petals are also used in salads, soups, and sauces. They have a very mild flavour of their own.

Scented geraniums (*Pelargonium spp*.): It is an aromatic perennial herb which prefers mild climate, suits very well in a garden. It is also used as cut flower for decoration. It behaves like perennials and growing to a height of 60 - 90 cm. The crop prefers well drained, light, deep soils with pH 5.5- 7.0. The essential oil of geranium is extensively used in expensive soaps and perfumes. Its flowers and leaves used to flavor jellies, sugar, butter, cakes, tea, honey. The flavors vary depending on variety.

Tuberous begonia (*Begonia spp*.): Both tuberous and wax begonias have edible flowers with a slightly bitter to sharp citrus flavour. Flower petals have a tangy citrus flavor and contain oxalic acid. People having kidney stones, gout, or rheumatism should not use the petals.

Tulip (*Tulipa spp*.): It is an important bulbous flower of temperate areas grown in pots, containers, beds, greenhouse and polyhouse. Depending upon the variety, the flower can grow to 10-70 cm and is available in single and multi-colours with different patterns. Flower petals have taste like lettuce with bean flavor and are used in salads with soft cheeses.

Hollyhock (*Althea rosea*): It is tall growing plant behaves like annual, biennial, or perennial plants. It prefers cool climate, but can grow throughout the year in mild climate. The large, brightly coloured flowers have no flavour of their own, but are used in salads or sprinkled over desserts.

Impatiens (*Impatiens walleriana*): It is a herbaceous perennial flowering plant growing upto a height of 15–60 cm. It is one of the most popular bedding plant, but can also be grown as pot plants. The plant bears bright white, red flowers. The petals are edible and have sweet taste. They can be torn into salad or mixed into fancy drinks.

English Daisy (*Bellis perennis*): It is a low growing herbaceous perennial grown in garden in temperate areas. The flowers are edible but have a bitter flavour. The petals have mild flavor and are generally sprinkled on the salads or other meals.

Dianthus (*Dianthus caryophyllus*): It is a herbaceous perennial flowering plant growing up to 80 cm and flowers throughout the year under mild climate. They are used as beds, borders and pot plants in a garden. The flower petals have a strong smell of cloves, used as a garnish in salads, for flavouring fruit, fruit salads, etc. They can also be used as a

substitute for rose petals in making a syrup. The petals should be removed from the calyx and their bitter white base should be removed.

Day Lily (*Hemerocallis species*): These are perennial bulbous plants of tropical and sub-tropical areas whose flowers typically last for a day. Day Lilies are actually cultivated as food crops in some countries, such as China and Japan. The petals are thick, crisp and juicy with a delicate sweetness at their base due to nectar. They have taste resembling green beans, melon or cucumber. They are used as salad or even cooked.

Cornflower (*Centaurea cyanus*): It is an annual flowering plant grows upto a height of 60-90 cm. The flower heads have blue, pink, or white ray florets that are attractive to butterflies and are commonly used as a fresh or dried flower in bouquets. The flowers have a slightly spicy, clove-like flavour with a subtle sweetness. The petals are used as a garnish in salad, or whole flowers in fancy drinks.

Chrysanthemum (*Dendranthema morifolium*): It is a herbaceous perennial plants grows upto a height of 40-90 cm during winter season. It is also known as mums/ winter queen and is a short day plant. The plants are widely used as loose flower, cut flower, pot plants, bedding plants, borders etc. The flowers are edible, but the flavor varies from sweet to tangy to bitter or peppery. It is used for Chrysanthemum Tea, Chrysanthemum Greens, Salads, Garnishing, Chrysanthemum Wine, etc. *Chrysanthemum cinerariaefolium* or *Chrysanthemum coccineum* should not be used for edible purpose as Pyrethrum (insecticide) is extracted from these species.

PEST AND DISEASES

There is hardly any cultivation without pest and diseases. Some insect pests and diseases often attack the crop in garden. As it is close to residence, it is not advisable to use toxic pesticides. Therefore it is advisable to adopt clean cultivation and always use botanicals like NSKE, Karanj oil, citrus peel extract (Limonene and Linalool), Pyrethrum / Pyrethrins, rotenone (from derris plant), Ryania, Sabadilla, *vitex negundo*, etc as prophylactic. Bio-pesticides like *Trichoderma viride*, *Trichoderma harzianum* (nematode and fungus), *Beauveria bassiana* (entomopathogenic fungi), *Bacillus sphaericus*, *Pseudomonas fluoresens* are also recommended. In case of pest severity chemical control may be adopted.

CONCLUSIONS

The importance of nutraceuticals in human diet is well known owing to its nutritional benefits. With the increasing awareness and enthusiasm, people often love to grow edible flower at their own at their space, be it open space or container garden. So in a small space people have diversified themselves with a number of flowers as well as vegetables. Since these are edible and have short growing cycle people love to grow it as much as possible. As landscaping design is more important, we can add colourful vegetables to harness additional benefits. It not only offers a source of healthy food but at the same time a beautiful garden design to the grower. Selection of plants plays an important role in such garden. Incorporation of indigenous species along with exotics is

highly recommended for sustenance of such garden. Thus ornamental garden with edible component helps in both ways to relive stress, involve people in it and create a sense of belongingness to themselves and society.

REFERENCE

Anonymous (2002). Handbook of Horticulture, ICAR, New Delhi.

Cindy Haynes (2000). The Ornamental Vegetable Garden, issue April 14, pp. 33-35.

Clatworthy, J., Hinds, J.M., Camic, P. (2013). Gardening as a mental health intervention: a review. *Ment. Health Rev. J.* 18, 214–225.

http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?taxonid=278036

http://www.vegetable-gardening-online.com/ornamental-vegetable-garden.html

https://en.wikipedia.org

https://gardeningsolutions.ifas.ufl.edu/plants/edibles/vegetables/ornamental-vegetables.html

https://www.britannica.com

https://www.countryliving.com/home-design/decorating-ideas/g923/beautiful-vegetable-garden-0310/

https://www.finegardening.com/article/who-says-a-kitchen-garden-cant-be-beautiful

https://www.gardeningknowhow.com/edible/vegetables/vgen/beautiful-vegetables-foliage.htm

https://extension.umn.edu/flowers/edible-flowers

https://en.wikipedia.org/wiki/Edible_flower

https://whatscookingamerica.net/EdibleFlowers/EdibleFlowersMain.htm

https://www.permaculture.co.uk/articles/top-10-perennialornamental-vegetables

https://www.veggiegardener.com/top-10-ornamental-vegetable-garden/

Jiri Mlcek and Otakar Rop (2011). Fresh edible flowers of ornamental plants – A new source of nutraceutical foods. Trends in Food Science & Technology Volume 22, Issue 10, October 2011, Pages 561-569.

Masashi Soga, Kevin J. Gaston and Yuichi Yamaura (2017) Gardening is beneficial for health: A meta-analysis, *Preventive Medicine Reports*, 5: 92-99.

Simina B. and Maria A. (2011). Possibilities of Using Ornamental Vegetables in Landscape Architecture, Bulletin UASVM Horticulture Print ISSN 1843-5254; Electronic ISSN 1843-5394, 68(1): 284-287.

Vaishali Kandpal (2014). Biopesticides. *International Journal of Environmental Research and Development*, 4 (2): 191-196.

Conservation Agriculture: Scope and Challenges

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ABSTRACT

Agriculture is one of the most important sector in the economies of most of the nations. Conservation is the use of resources in a manner that safely maintains a resource that can be used by humans but nowadays conservation agriculture has become critical because of adoption of intensive conventional tillage practices by farmers to achieve higher production to feed the growing population. Conservation Agriculture (CA) enhances biodiversity and natural biological process above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production. CA principles are universally applicable to all agricultural landscapes and land uses with locally adapted practices. Soil interventions such as mechanical soil disturbance are reduced to an absolute minimum or avoided, and external inputs such as agrochemicals and plant nutrients of mineral or organic origin are applied optimally and in ways and quantities that do not interfere with, or disrupt, the biological processes. It is a base for sustainable agricultural production intensification and opens increased options for integration of production sectors, such as crop-livestock integration and the integration of trees and pastures into agricultural landscapes

INTRODUCTION

Presently, India has attained self-sufficiency in food grain production but at the expense of degradation of natural resources and environmental pollution. One of the major concern in agriculture is land degradation. About 150 mha land is degraded which constitute 45.5% of the total geographical area. According to an estimates, 10 mha of good quality land is lost annually due to soil erosion and soil erosion takes place at an average of 16.5 t/ ha/yr, more than 50% of water erosion and about 60% of wind erosion occurs on cropland. On the other hand agriculture also contributes to 30% of the total GHG's emission. All these issues are causing great threat to food security and

agricultural sustainability which has emerged mainly due to intensive conventional tillage practiced by the farmers.

CONVENTIONAL TILLAGE

It refers to clean cultivation of land through intensive pre-planting tillage operations which leads to reduction of vegetative cover from soil due to burning of crop residues resulting in less infiltration and soil is more prone to run-off which leads to erosion and hence, more wastage of fertilizers and water occurs which increases the production cost due to increase in expenditure on inputs and also resulted in water pollution. Intensive tillage operations pulverize the surface layer due to which fine soil particles are easily blown away by wind causing wind erosion. Heavy machinery used in tillage operations led to compaction of underlying layer which increases the bulk density of soil and hence aeration is poor due to which poor root development occurs resulting in lower yields.

All these issues can be overcome by adoption of conservation agriculture which has emerged as an alternate strategy for long term sustainability.

CONSERVATION AGRICULTURE

Conservation agriculture (CA) is a concept of resource saving crop production that strives to achieve acceptable profits together with higher and sustained production level while concurrently conserving the environment**.**

GLOBAL ADOPTION OF CONSERVATION AGRICULTURE

About 125 mha area is under CA. USA being the pioneer country occupies maximum area of 26.5 mha followed by argentina, Brazil, Australia, Canada, Indo-Gangetic Plains respectively.

NEED FOR CONSERVATION AGRICULTURE?

- **To stabilize/reverse widespread soil degradation-** Rate of soil degradation occurs much faster than the rate of its formation by natural processes, hence through adoption of CA practices tillage is minimized which improve soil structure and soil aggregation. Crop residue act as a barrier against rain and wind and prevent soil erosion.
- **To enhance water productivity for Agro-ecosystem-** Due to less soil disturbance, infiltration and natural precipitation intake into soil profile increases which replenish the ground water table and reduces run-off. Incorporation of crop residue conserves soil moisture by preventing evaporation losseswhich reduces the irrigation water requirement of crops.
- **Minimize environmental pollution-**By eliminating burning of crop residues and limited use of machinery and less fuel consumption, emission of GHG's like CO_2, CO,CH_4 and N_2O into the atmosphere can be minimized.
- **Reduce production cost-** To compete with global market, per unit production cost must be minimized and adoption of CA practices restricts machinery use, reduces labor and input requirement and hence maximum output is obtained

from minimum input e.g. practicing zero tillage in wheat reduces the production cost by approx. □2000/ha.

- **Improve farm family livelihood-** CA increases the net farm income of farmers and hence their living standard is also increased. Nutritional status is also improved due to balanced diet.

Conventional Agriculture v/s Conservation Agriculture

Conventional Agriculture	**Conservation Agriculture**
Uses tillage as primary method of seed bed preparation	Strives to minimal soil disturbance
Promotes soil and water erosion	Reduces erosion through vegetative or residue cover
Deteriorate soil health	Improve soil health
Require more energy and water	Require less energy and save water
More capital and labor intensive	Less capital and labor intensive

Hence, we need to stop doing the following conventional practices

- **Excessive ploughing/tillage-** which led to compaction destroy soil structure and promotes erosion.
- **Removing crop residue-**Burning of crop residue should be avoided. According to an estimates, 392 MT of crop residues is produced in India out of which only 1/3 rd is available for soil incorporation and surface retention.
- **Monoculture-**This practice results in more incidence of insect-pests and diseases and also affect nutrient recycling as crops depletes nutrient from particular soil depth because of same rooting depth which also led to crust formation in the underlying layers.

PRINCIPLES OF CONSERVATION AGRICULTURE

CA is categorized by three basic principles-

1. Minimum soil disturbance- Tillage operations are reduced to no/minimum till and direct seeding is done in the moist zone by opening a small slit.

2. Permanent organic soil cover- Atleast 30% of ground must be covered with crop residue.Crop residue increases organic matter content of soil which serve as a source of nutrient,it also conserve soil moisture, moderates soil temperature, prevent weeds and soil erosion, increase infiltration and improves soil aggregation.

3. Crop diversification- It refers to diversification of crops in a sequence or in association through rotation. Crop rotation reduces the incidence of pests and diseases and improves soil fertility and nutrient recycling by growing different rooting pattern crops in sequence for e.g. growing shallow rooted crop followed by deep rooted crops.

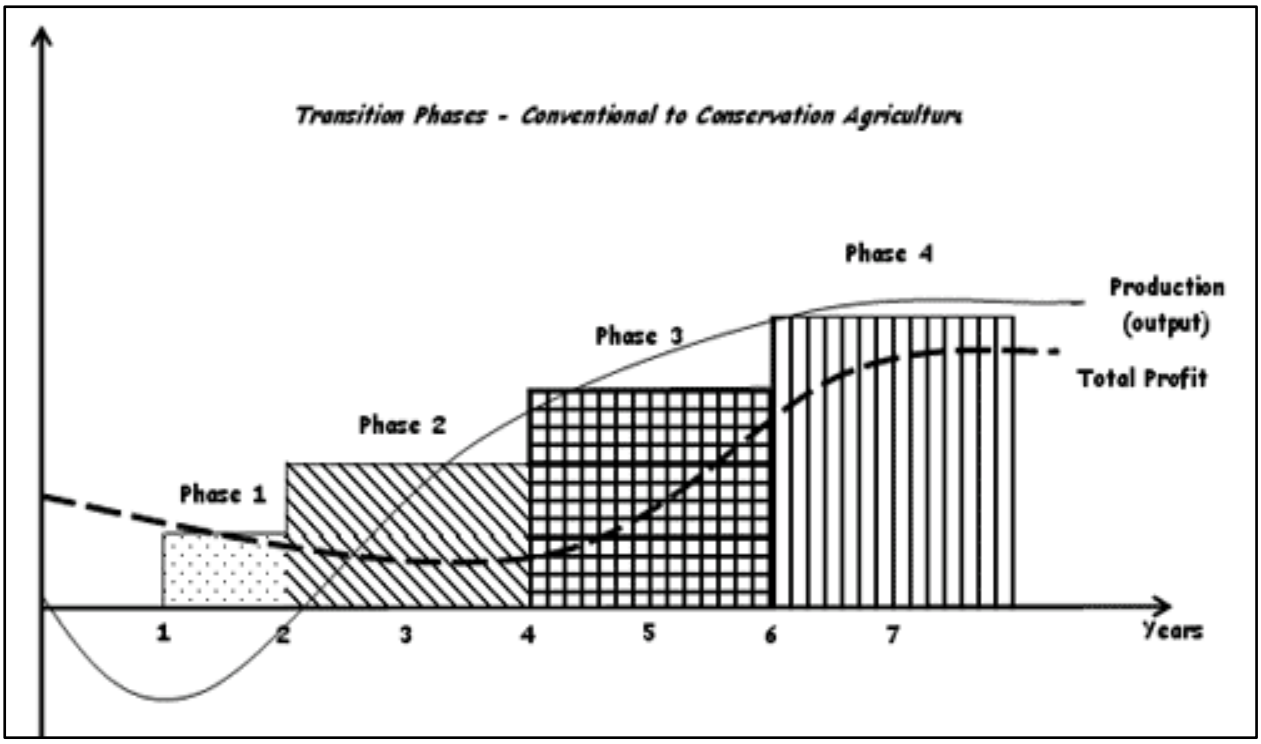

Fig.1 Transition phases for adoption of CA

Transition in any system is not an easy task. It requires lot of efforts to shift from one system to another system. Similar is in case with CA, transition from conventional to conservation agriculture is divided into 4 phases (Fig.1):

I phase-In this phase there is no increase in production, sometimes it is much lower than conventional agriculture but production cost is reduced due to limited machinery and labor use. Total profit is also reduced due to increase in family expenses to compensate reduction in yield as compared to conventional agriculture.

II phase- Improvement in soil conditions and soil fertility occurs in this phase as a result output increases, consequently net farm income of farmers is also increased.

III phase-Diversification of cropping system occurs in this phase which further improves soil fertility and hence yield increases and total profit is also increased.

IV phase-In this phase, stability in the production and productivity is achieved which is similar or higher than conventional agriculture.

Therefore, the above mentioned Fig.reflects that during transition from conventional agriculture to conservation agriculture, difficulties are faced during initial few years only but after few years CA gives similar or higher benefits than conventional agriculture.

LASER LAND LEVELING

It is a precursor technology in transition to conservation agriculture as it

- Reduces time and irrigation water required to irrigate the fields due to less elevations.
- Results in uniform distribution of water due to smooth surface.
- Led to less/no soil erosion loss as there is no uneven surface thus, infiltration increases and run-off is reduced.

- Finely prepared seed bed ensure good germination, crop growth and ultimately gives higher yield.

CHALLENGES IN ADOPTION OF CONSERVATION AGRICULTURE

- **Mindset-** Changing mindset of farmers is one of the major challenge. They lack knowledge and experience about this new production system. They believe in short term gain without realizing its future consequences and think more tillage will result in higher yield and incorporation of crop residue led to more incidences of pest and diseases.
- **Technological challenges-** It includes unavailability of appropriate machinery and equipments needed in CA. The machines which are available they are either too costly that small and marginal farmers could not afford to buy or they require technical specialization to operate it.
- **Residue retention-** Mixed farming is practiced in most of the countries on large scale in which there is widespread integration of crops and livestock as a result after harvest of the crop, residues are either fed to animals or used as fuel for cooking purpose therefore no crop residue is available for soil incorporation or surface retention.
- **Lack of research and government policies-** No blueprints or scientific documentation on CA is available with the scientists and no scientific studies has been conducted so far. In most of the countries no effective policies has been planned and formulated to encourage CA among farmers.
- **Long term research perspective-** CA does not gives benefits in early stages rather it provides benefit gradually after a certain period of time but farmers require immediate returns hence a long term research perspective is needed.
- **Financial constraints-** Most of the farmers are small and marginal, they are not financially strong to purchase costly machines required in CA and due to lack of credit facilities they are not able to purchase it on time.

STEPS NEEDED TO ADDRESS THESE CHALLENGES

- **More emphasis and support by government-** In order to encourage and promote CA among farmers,government should provide subsidies on machinery and equipments, give incentives and high price on produce to farmers undertaking CA, provides credit facilities with low interest rates and within short span of time and developing public-private partnership.
- **Effective extension services and proper training to the farmers-** Most crucial responsibility lies on extension department to disseminate awareness among farmers regarding CA through large scale field demonstration and by conducting training programs and counseling for farmers.
- **Intensive work in the field of R & D and education-** To develop sound technology that suits well to different Agro-climatic situations and lies within the purchasable limit of farmers and imparting proper education on how to use machinery and manage crop residues.

- **Technology in a comprehensive mode (complete package)-** Technology should be provided in a comprehensive mode i.e. complete package of practices should be provided to farmers right from seed sowing till harvesting of crops.
- **Custom hiring-** It has emerged as an effective tool to overcome the pitfall of costly machines needed in CA. Farmers who are not able to purchase costly machinery can hire these machinery on rent basis and enjoys the benefits of CA.

CONCLUSION

After having a brief overview on Conservation Agriculture, it can be concluded that CA has emerged as a new paradigm to achieve sustainable crop production through various resource conserving technologies which prevents natural resource degradation, preserves biodiversity and safeguards environment. CA utilizes less inputs, improve soil health, maximize profit and minimize production cost. Therefore, implementation of CA is need of the hour to enhance system productivity and profitability while conserving the natural resources.

Persimon: Physiological disorder, Insect-pest, Diseases and their control measures

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Persimmon seeds first came to the United States in 1856. Today, persimmons are grown in a plethora of varieties in China, Burma, Northern India, and Australia; in the US, it grows in Southern and Southwestern states, predominantly California. Persimmons are red-brown or orange fruits that grow on trees like plums and look like a small, rather flat tomato capped by a calyx. The two varieties are stringent and non-astringent, the latter being pleasingly sweet. To avoid bitterness, the paler varieties should be eaten only when very ripe, usually peeled. Persimmons are one of a few foods associated with killing breast cancer cells without harming normal breast cells, according to one new study. Scientists attributed this to the flavonoid fisetin, present in several fruits and vegetables, but in persimmons specifically.

Every fruit tree has the future potential for disease and insect damage. Factors such as location and weather will play a part in which issues your tree encounters. If available, disease-resistant trees are the best option for easy care; and for all trees, proper maintenance (such as watering, fertilizing, pruning, spraying, weeding, and fall cleanup) can help keep most insects and diseases at bay. The following are the physiological disorder, Insect pest and disease of persimmon with their proper control measures

1. Physiological disorder:

a) CHILLING INJURY

Occurrence: The incidence and severity of chilling injury depend upon the cultivar, storage temperature and duration.

Symptoms

Chilling injury can be a major cause of deterioration of persimmons during marketing after exposure to temperatures 15ºC (59ºF). Symptom development is fastest at 5-7ºC (41-45ºF) and slowest at 0ºC (32ºF), which is the recommended storage and transport temperature for persimmons.

Physiology

Persimmons exhibit chilling injury symptoms if kept at temperatures between 2ºC (36ºF) and 15ºC (59ºF). Upon transfer to higher temperatures the severity of the symptoms (flesh softening, browning, and water-soaked appearance) increases an renders the fruits unmarketable. Respiration and ethylene production rates of chilled persimmons are higher than those of nonchilled fruits. Exposure to ethylene at 1 ppm or higher aggravates chilling symptoms of persimmons, while controlled atmospheres ameliorate these symptoms.

Control

Avoid exposure of persimmons to temperatures between 2ºC (36ºF) and 15ºC (59ºF). Optimum storage and transport temperature is 0ºC (32ºF). Avoid exposure to ethylene above 1ppm throughout postharvest handling of persimmons. Use of controlled atmosphere of 3-5% O2 + 5-8% CO2 at temperatures below 5ºC (41ºF) reduced chilling injury.

b) PHYSIOLOGICAL FRUIT DROP

The physiological fruit drop may cause

2. Physiological fruit drop is a constraint in production of persimmon. Early fruit drop occurs in virtually all cultivars after flower to July in Bhaderwah climatic conditions . The higher the ability of parthenocarpy or the large the number of seeds formed even in cultivars with low parthenocarpy ability, the less the early fruit drop.
3. The fertilizer nutrient poor to nutrient imbalance fruit drop during the shoot growth, nutrient consumption for the growth of new shoots to promote fruit drop. Flower bud differentiation is not complete, cause early fruit drop.
4. Poor pollination, no pollination, some species, such as a large disc, with this feature was not easily physiological drop varieties. Some species, in particular, have most of the Japanese persimmon variety, must be configured to pollination tree, or fruit can not be development, early fruit drop serious. In case of rainy flowering, affecting pollination, also easy to fruit drop.
5. The tree structure is irrational, tall trees, branches too close, bad air and light, organic nutrients may affect the accumulation of branches, resulting in tree growth of the thin section, so that the fruit may be easily removed from the branches.
6. Lss fertilizer and water the soil a long dry, poor soil, fertilizer and water absorption difficulties, resulting in more fruit drop; soil moisture for a long time the root was decreased absorption capacity, even more have applied the fertilizer, the tree is also difficult to absorb, but also due to insufficient supply of nutrients fruit drop.

7. Early fruit drop of persimmon rainfall and rainfall related to precipitation as many fruit drop more. This is because the lack of rainfall and sunshine (Suzuki *et al*.1989; Kitajima *et al*.1990; Yakushiji and Hase 1991)., photosynthesis decreased, so that part of the adverse position in the fertilizer nutrients in fruit may not fully get off of nutrients.
8. Pollinated "Fuyu" fruit containing three or more seeds hardly dropped even when the light intensity was reduced to 18% (Yakushiji and Hase 1991) the endogenous (IAA) level of the calyx in the fruit that stayed on the tree was higher than that of the flesh during early fruit drop (Suzuki et al.1989). It was reported that early fruit drop is induced by an imbalance of the IAA levels between flash and calyx a few days before abscission. kitajima et al (1990) reported that fruit abscission was induced by compition for photosynthesis that in fruit organs. Moreover they revalled that a major factor in fruit set was competition between parthencorpic fruit and seeded fruit on the same tree.

MEASURES TO PREVENT THE PERSIMMON FRUIT DROP WAS

1. Strengthening the fertilizer and water management to maintain robust growth of trees, leaves too enhance the assimilation capacity to adjust the branches have the internal nutrient allocation, growth and easing competition for nutrients between the results obtained contradiction.
2. Proper pruning especially to strengthen the summer pruning, removal of unwanted and excess have branches, to promote air and light, too light to ensure adequate conditions, and remove stagnant water in the rainy season, dry season irrigation in a timely manner to maintain tree vigor vigorous growth, fruit well developed.
3. The most appropriate varieties of persimmon varieties pollination Hunzai only female flowers, although there are male flowers have Hunzai varieties, but what only a few, for the sake of those born male pollinator effective use of trees, should be the line of artificial pollination, due to environmental climate is different Persimmon spent there first, after opening, it should be 3-4 times of artificial pollination carried out, pollination can be reliable and can effectively prevent the physiological fruit drop.
4. Flowering tree girdling on too strong for girdling the trunk or main branch, not only can promote the differentiation, early results, and can reduce the physiological fruit drop, fruit ripening ahead of schedule. Suitable ring peeling half of the general flowering in persimmon when, during the late or peeling rate is too large, the wound healing problems, resulting in weak grower, or even the whole branch or whole plant dead, peeling width is limited to 1.5 cm, depth to achieve the formation of layers for the degree. Although many advantages peeling, but not every year, or more easy to make weak tree vigor, resulting in shortened life expectancy. In addition, strengthened after girdling fertilizer supply.
5. Application of regulators and foliar spray 500ppm flower or young fruit was GA and single-jet or adding 1% urea was effective prevention and treatment of fruit drop

c) Disorders induced by low O2 and/or high CO2:

Exposure to oxygen levels below 3% during storage for longer than one month can result in failure of persimmons to ripen and off flavors. Exposure to carbon dioxide levels above 10% during storage for longer than one month can cause brown discoloration of the flesh and off-flavors.

d) Calyx Separation

Calyx separation is a physiological disorder which may affect certain cultivars; it has caused losses in New Zealand. Growing conditions are all-important, and excessive nitrogen fertilization should be avoided. If the plants are thinned early in the season, this will enhance calyx growth and help to prevent the disorder.

9. Insect-Pest:

Persimmons are relatively free of pests and diseases. Mealybugs and scale in association with ants can sometimes cause problems. Ant control is the best method to control these pests. Occasional pests include white flies, thrips and a mite that is blamed for the brown lace collar near the calyx

Control

Non-Chemical:

The only non-chemical control for ants is Tanglefoot or Stickum.

Chemical:

● *Bacillus thuringiensis* – Label rates vary by formulation. 4-hour REI. 0-day PHI. In 1997, 0.41 lb a.i. was applied to 0.2 acres of persimmons 2 times at a median application rate of 0.7 lb a.i./acre

● **Pyrethrins/Rotenone** – 4-hour REI. In 1997, 0.1 lb pyrethrins and 0.09 lb rotenone were applied to 1% of the persimmon acreage 1 time at a median application rate of 0.01 lb a.i./acre

Vertebrate Pests

Vertebrate pests of persimmon include squirrels, deer, coyote, rats, opossums, birds and gophers. Most of the pests are interested in the fruit; however, gophers attack the roots.

Controls:

Chemical:

● **Aluminum phosphide** – 2 lbs a.i. were applied to 1.6% of the persimmon acreage 1 time at a median application rate of 0.04 lb a.i./acre.

● **Chlorophacinone** (0.005% bait) – 0 lb a.i. was applied to 9 persimmon acres 1 time

● **Strychnine** (0.5% bait) – 0.08 lb a.i. was applied to 0.8% of the persimmon acreage 2 times (4).

● **Zinc phosphide** (2% bait) – 1 lb a.i. was applied to 0.8% of the persimmon acreage 1 time at a median application rate of 0.1 lb a.i./acre.

10. Diseases:

Alternaria rot is caused by *Alternaria alternata* which attacks developing fruits. Infections remain quiescent until after harvest, and black spots become apparent as the fruits ripen in store. Wound infection results in earlier appearnace of symtoms. Other causes of decay in persimmons include species of *Botrytis, Cladosporium, Colletotrichum, Mucor, Penicillium, Phoma* and
Rhizopus.

Control:

control pests and diseases of the anthrax, before the germination was lime sulfur spray 4-5 degrees Baume, in June on the mid-August on the middle of the Bordeaux mixture sprayed once. Shidi winter Guapi of insects, put off the tree was left in Shidi, centralized destruction. 6 and 8 months in late mid to late larvae of timely removal of hazardous fruit thoroughly, has got to pick up a net fall, with deep, this can reduce the damage the next generation or second year too. Persimmon bud germination by 48% of Lisbon 1000-1500 times, 10 days after flower with a 1.8% abamectin 4000-5000 times, which can effectively control scale insects, improve fruit set.

Chelates - To Improve Micronutrient Use Efficiency

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There are 17 nutrients established as essential for plant growth and higher yield, among those 6 nutrients viz., zinc, boron, iron, manganese, molybdenum and copper are required in small quantities and therefore called micronutrients. Though the requirement of micronutrient is less, their role in plants for the sustainable yield is very important. The deficiency of micronutrients can be recognized by yellowing of leaves, stunted growth and delayed maturity. The severe deficiency of any one of the nutrient will drastically reduce the crop yield as well as the quality of the produce. In India due to intensive agriculture, low usage of organic manures and indiscriminate use of straight fertilisers micronutrient deficiency is increasing gradually. As these micronutrients are exhausted from the soil reserve external application through soil or foliar sprays are important for sustaining the crop productivity and the quality of the produce. Zinc is deficient in 36.5 % of Indian soils followed by 23.2 % Boron, 12.8% Iron, 7.1 % Manganese and 4.2 % Copper (Shukla., et al. 2018).

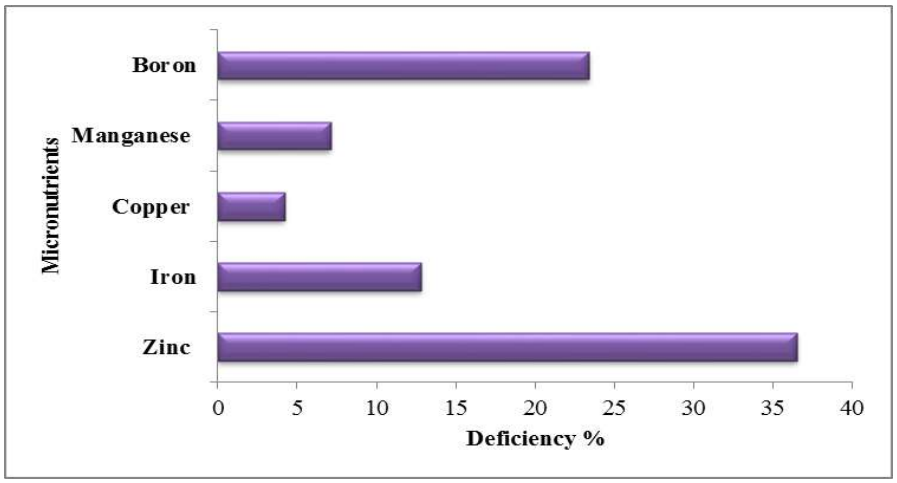

Fig 1. Micronutrient deficiency in Indian Soils

The micro nutrient fertilisers are directly applied to the soil and the nutrients will interact with soil making the nutrient unavailable to the plants. Most of the micronutrients like Fe, Mn, Zn, and Cu are easily oxidized or precipitated in soil and may

not be utilized by crops. Soil pH is a major factor which influence the bioavailability of micronutrients to the crop. Specifically in the alkaline soils having pH greater than 6.5 bioavailability of the micronutrients is limited. All these process reduce the use efficiency of micronutrients very low as 2 to 5 %. In this condition, Chelates are the wise option to increase the use efficiency of the micronutrients.

Chelates

The word chelate derived from the Greek word "chel", meaning a **crab's claw**, and refers to the pincer-like manner in which the metal nutrient ion is encircled by the larger organic molecule (the claw), usually called a ligand. Commonly the chelation refers to inorganic nutrients that are enclosed by an organic molecule to increase the nutrient use efficiency of a particular nutrient. These chelates are useful particularly to increase the use efficiency of micronutrients applied to alkaline soils.

Principle of chelation

Chelation is a very important process as it converts the unavailable form of nutrient ions to easily available for the plants uptake. The positively charged ions, such as Zn^{+2}, Mn^{+2}, Cu^{+2} and Fe^{+2} can readily react with negatively charged hydroxide ions (OH^-) and converted as unavailable forms. Normally these OH^- ions are abundant in alkaline as well as neutral soils. Once the chelation is done the organic coating in the chelate will protect the nutrient ion reacting with the surrounding OH^- ions. The plant roots easily uptake the chelated nutrient from the soil. Once the nutrient is taken up by the plant the nutrient will be released from the chelate within the plant making the unavailable nutrient to available for the plant. Chelated nutrients can be applied through soil or by foliar application. The wax coating in plant leaf surface repels water and inorganic substances, making difficult for inorganic nutrients to penetrate into the leaf, but these organic molecules can penetrate the wax and they readily dissolve inside the plants when applied through foliar.

Ideal chelating agent

An ideal chelating agent should have the following characters to be effective in increasing the micronutrient use efficiency.

- The bond between the chelate and the inorganic nutrient must be strong enough to protect the nutrient from the other irons to react with, but at the same time it must be weak enough to release the nutrients inside the plant.
- The organic chelating agent should not cause any harmful effects to the plants.
- Among the nutrients Iron, zinc, copper, manganese, calcium and magnesium only can be chelated.

Ethylene Diamine Tetra Acetic acid (EDTA) is the popular chelating agent used in the fertilizer industry. In alkaline soils Diethylene Triamine Penta Acetic acid (DTPA) is more effective than EDTA. In the soil with high pH Iron chelates from Hydroxyethyl Ethylene Diamine Tetra Acetic acid (HEDTA) and Ethylene Diamine 2-Hydroxy Phenyl Acetic Acid (EDDHA) are very effective. These synthetic chelating agents are

comparatively expensive than the natural ones. Natural chelators such as humic acid, fulvic acid, amino acids and polyflavonoids and low molecular weight compounds like citric acid, ascorbic acid, and tartaric acid are economical and easily diffusing into cell cytoplasm. These organic chelating agents are not phytotoxic and safe to use on any crops.

SIGNIFICANCE OF CHELATION PROCESS IN SOIL

1. Increase the availability of nutrients.

Nutrients applied in soil are liable to react with other cations and anions present in the soil and become unavailable to plants. Chelating agents will bind these insoluble ions particularly in high pH soils and make them available to plants. The ligand formed on the nutrients will protects the irons from any kind of reaction so that they will be available to plants. Hence, plants will spend less energy for uptake of the nutrients as it is available at near free energy level.

2. Reduce toxicity of some metal ions to plants.

The amount of freely available toxic level micronutrients are reduced by the chelation. Hence some metal ions either micronutrients or heavy metals will become non-toxic in soil. This process is usually accomplished by high-molecular-weight components of organic matter like humic acid.

3. Prevent nutrients from leaching.

Chelated micronutrients are protected from oxidation, precipitation, and immobilization. Metal ions forming chelates are more stable than the free ions. Chelation process reduces the loss of nutrients through leaching.

4. Suppress the growth of plant pathogens.

Some chelating agents may suppress the growth of plant pathogens by depriving of metal ions and hence favor plant growth.

APPLICATION OF CHELATED MICRONUTRIENTS :

- The chelated micronutrient can be applied to the soil by placement method. The organic coating in the chelate prevents the reaction like oxidation, precipitation and immobilization occurring in the soil. Plant roots take up the chelated nutrient and the chelate releases the nutrient within the plant.
- Chelated nutrients also can be applied through foliar application as it facilitate nutrient uptake efficiency, because crop leaves are naturally coated with wax that repels water and charged substances, such as ferrous ions. The organic ligand around the chelated micronutrient can penetrate the wax layer, thus increasing iron uptake

CONCLUSION:

The concept of chelated-nutrient application will help the farmers not only ascertaining the soil quality but also to improve the nutrient use efficiency of

micronutrients. The chelated micronutrients are less reactive to soil by which the bioavailability and plant uptakes are increasing. Application of micronutrient fertilizers mixing with chelates improve the use efficiency especially the soils with pH more than 6.5. Our Indian farmers are using micronutrient fertilisers, as our soils are deficient in micronutrients. If, the farmers apply micronutrients with chelates, it will reduce the input cost as well as increase the yield.

Uzifly- The invincible enemy of sericulture industry

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ABSTRACT

Sericulture is composed of enormous activities starting from the rearing of silkworm to the production of silk. The great architects of silk "the silkworms" are the focal point of this industry on whom the whole sericulture is dependent. Among all the problems encountered on the silkworms, uzi fly is the primary headache for silkworm rearers. Uzi fly is an endo-larval parasitoid on silkworm. Uzi fly, *Exoristasorbillans*attacks onmulberry silkworm, *Bombyx mori*while another uzi fly species, *Blepharipazebina*is a parasitoid of tasar silkworm, *Antheraeamylitta.* The uzi fly maggots cause characteristics symptom of black scar by puncturing on the late instar larval body. Improved IPM module needs to be implemented for effective control of uzi fly in order to prosper the silk industry.

Key words: Silkworm, Uzi fly, Life cycle, Damage symptoms, IPM module.

INTRODUCTION

Sericulture, an agro-based industry is supporting many agricultural entrepreneurs in India. Silkworm rearing in India has an importance from time immemorial.The silk industry flourished well up to 1980. A new threat was encountered in the form of a pest named as Uzi fly during 1980 (Anonymous, 1980).Uzi fly, *Exoristasorbillans*Wiedemann (Syn.: *Exoristabombycis*Louis, *Tricholygabombycis* Beck, *Tricholygasorbillans* Wiedemann, *Tachinasorbillans* Wiedemann) is an endo-larval parasitoid on silkworm, *Bombyx mori* L. causing huge loss to silkworm rearing in many silk producing countries including India(Narayanaswamy *et al*., 1994).*Exoristasorbillans* is a member of the subfamily Goniinae, the family Tachinidae and the order Diptera (Crosskey, 1976). Uzifly was confined to the North-Eastern sericultural regions of India, especially Bengal and Assam. For the first time, it wasrecorded in Bailanarasapura village in Bangalore District, Karnataka by introducing through Nistari seed cocoons brought from West Bengal during May, 1980 (Mahadevappa, 1992). Besides it, another uzifly, *Blepharipazebina* (Walker)is also encountered on tasar silkworm, *Antheraeamylitta* Drury which is common in tasar silk producing states.

LIFE STAGES OF UZI FLY

Female of *E. sorbillans* lays eggs on silkworm that hatched in 2 to 5 days; the hatched out uzimaggot penetrates into its host (silkworm larva) and comes out by killing the host within 6 to 8 days. The pupal period is observed to be 10 to 12 days and the total developmental period from 17 to 22 days (Srihara*et al.,* 1971; Datta and Mukharji, 1978). Uzi fly prefers to deposit eggs on older silkworm larvae (late age), particularly the fourth and fifth instar silkworm. The fly travels for more than 2.5 km in search of host. A single mated female can lay eggs about 300 to 1000 depending upon season, for a period of 9 to 25 days(Sengupta *et al.*, 1990; Chamundeswari, 1994).

1. Egg: Eggs are creamy white in colour which measure 0.45-0.56 mm in length and 0.25-0.30 mm in width. They are oblong in shape and hatch in about 2-5 days after oviposition depending upon the climatic condition. After hatching, the maggot penetrates into the body of the silkworm immediately. *E. sorbillans*females prefer to lay eggs on the lateral side of the larval body of *B. mori* (Tewari *et al.,* 1995).

2.Maggot: After hatching takes place, the young maggot directly penetrates into the silkworm body. This stage comprises of three instars. In the first two instars, they develop just below the skin of the larval body while, in the final instar, they move into the body cavity. Maggots have eleven body segments. After attainingcomplete maturation, maggots escape from the host body by piercing the integument by its pro-thoracic hooks. They feed on various tissues of the silk worm body and the larva dies by the time the maggots escape out from its body.

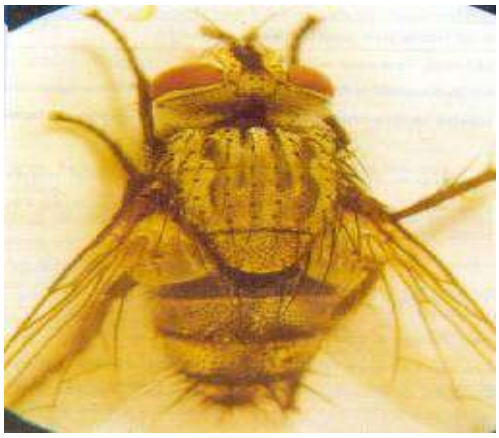
3. Pupa: Pupae are oblong in shapes somewhat oval anteriorly and round posteriorly. Pupationtakes place in darker area in and around the silkworm rearing house, in the cervices of the rearing room. Pupa are light reddish brown to dark reddish brown in colour having 11 body segments and measuring 0.9-1.2 cm in length and 0.4-0.6 cm in lateral width. Pupae takes 10-12 days to emerge into adult.

4. Adults: Male is longer than female.Adults are blackish grey in colour with conical abdomen. There are four longitudinal black bands on the dorsal side of the thorax. The first abdominal segment is black and the rest are greyish-yellow. Life span of adult flies varies with sex and season. Males survive for about 10-18 days. Females live 2-3 days longer than the males. Survival period is less during summer months.

Damage Symptom on silkworm:

Uzi fly, *Exoristabombycis*inflicts 10-15% damage to the silkworm cocoon crop in the premier silk producing states of South India particularly, Karnataka, Andhra Pradesh and Tamil Nadu. It attacks the silkworm cocoons severely during the rainy and winter seasons. Presence of black scars on the silkworm body and maggot emergence hole at the tip of the cocoon are the typical symptoms of uzi fly attack. It lays one or two eggs on each silkworm larvaafter entering into rearing house. If the uzi fly infests at last instar, the uzi maggots come out after cocoon formation by making a circular hole.The silkworm larvae infested up to early fifth instar will die before they reach the spinning stage. If infestations take places in the late fifth instar, the mature maggot emerges out by piercing the cocoons and thereby rendering the cocoons unfit for mass reeling.

Infested silkworms can be identified by the presence of black scar on the part of the skin where the maggot penetrates into its body.



(i)

(ii)

(i) Adult uzi fly (ii) Black scar on silkworm body after maggot penetration (Ref.: Pest management- Mulberry silkworm, http://agritech.tnau.ac.in/sericulture/pest%20mgt_silkworm.html)

IPM (Integrated Pest Management) module for uzi fly management:

1. Exclusion method • Wire mesh/nylon net should be provided on allwindows/doors • Doors should be facilitated with automatic closingmechanism • Anteroom at the entrance of the rearing house should be made • Uzi fly should be observed by keeping the leaves on the verandah before shifting leaf into the rearing house	 **(iii)**
2. Cultural method • The rearing room should be kept clean • Silkworm litters should be separated from the mulberry twigs • Litters, the pupation site for uzi maggots, should not be thrown, rather it should be buried or burnt immediately	 **(iv)**
3. Physical and mechanical method • Uzi traps are used to control both sexes of uzi fly • One tablet is dissolved in one litre of water and kept in a container both inside and outside the rearing room	 **(v)**

• Therearing rooms should be kept monitored at the window entrances by keeping the uzi traps	
4. Biological method • An ecto-pupal parasitoid, *Nesolynx thymus* is used as bioagent against uzi fly • It is mass produced on the house fly pupae and packed is a nylon net pouch (50ml of parasitized pupae per pack) • The pupae should be applied between 3rd to 5th day of 5th instar larvae @ 2 pouches per 100 dfls • The same pouch should be placed at the manure pit after harvesting the cocoons	 **(vi)**

(iii) Nylon net fixation on the entrance of the rearing room (iv) Burning of silkworm litters (v) Uzi trap installation outside the rearing rooms (vi)Parasitization of uzi maggots by *Nesolynx thymus*(Ref.: Diseases and pests of mulberry silkworm, http://silks.csb.gov.in/coochbehar/wp-content/themes/common_district/coochbehar/dpm-frame2.html**)**

CONCLUSION

Uzi fly, truly an invincible enemy of sericulture industry, causes a great loss to silk production every year. Silkworm rearers and silk entrepreneurs need to be taught about the uzi fly life cycle, their damage symptoms etc. at the grass-root level. It is the responsibility of the state sericulture departments to infuse technical know how and develop knowledge based improved models to control the uzi fly menace at village level rearing units. If this invincible enemy is wiped out from the sericulture industry, the silk production will improve manifold, thereby improving the socio-economic condition of silk growers.

REFERENCES

Anonymous. (1980). The winged menace. *Indian silk*, **14**: 5-6.

Chamundeswari, P. (1994). Comparative study on uzi fly, *Exoristasorbillans*(Wiedemann) infested silkworm *Bombyx mori* L. in two pure races and their hybrids, Ph. D., Thesis, Sri Krishnadevaraya University, Anantapur, Andhra Pradesh, India.

Crosskey, R. W. (1976). A taxonomic conspectus of the Tachinidae (Diptera) of the oriental region. *Bull. Br. Mus. (Nat. Hist.) Entomol. Supplement*,**26**: 1-357.

Datta, R. K. and Mukharjee, P. K. (1978). Life history of *Tricholygabombycis* (Diptera: tachinidae), a parasite of *Bombyx Mori* (Lepidoptera: Bombycidae).*Ann. ent. soc. America*, **71**: 767-770.

Diseases and pests of mulberry silkworm,http://silks.csb.gov.in/coochbehar/wp-content/themes/common_district/coochbehar/dpm-frame2.html , 21st June 2020.

Mahadevappa, D. (1992). Uzi fly infestation and silkworm crop loss. *Proc. Nat. Semi*. Uzi fly and its control. Karnataka state Sericulture research and development institute, Bangalore, India.

Narayanaswamy, K.C., Devaiah, M.C. and Govindan, R. (1994). Ovipositional preference and biology of uzifly*Exoristabombysis* (Louis) on some races and hybrids of silkworm *Bombyx mori* L., Karnataka *J. Agric. Sci.*, **7(1)**: 32-35.

Pest management- Mulberry silkworm, http://agritech.tnau.ac.in/sericulture/pest%20mgt_silkworm.html , 21st June 2020.

Sengupta, K., Kumar, P., Baig, M. and Govindaiah. (1990). Pests of mulberry silkworm and their control. In:*Hand book of pests and disease control of mulberry and silkworm,* Economic and social commission for Asia and the pacific, United Nations, Bangkog, Thailand, pp. 67-77.

Sriharan, T.P., Samson, M.V., Krishnaswami, S. and Datta, R.K. (1971). Laboratory investigation on uzi fly, *Trichologabombycis* Beck., a tachinid parasite of silkworm (*Bombyx mori* L.), *Indian J. Seric.*, **10**: 14-22.

Tewari, S.K., Kumar, V., Awasthi, A.K. and Datta, R.K. (1995). Surface Morphology of Egg Chorion of the Uzi Fly, *Exoristabombycis* (Louis), (Diptera: Tachinidae) - an Endoparasite of the Silkworm, *Bombyx mori* Linn. *Zoological Studies*,**34(1)**: 62-66.

Biofortification of Cereals- An answer to hidden hunger

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Cereal grain crops are grown in greater quantities and provide more food energy worldwide than any other type of crop and are therefore staple crops. In their natural, unprocessed form, cereals are a rich source of vitamins, minerals, carbohydrates, fats, oils, and protein. When processed by the removal of the bran, and germ, the remaining endosperm is mostly carbohydrate. In some developing countries, grain in the form of rice, wheat, millet, or maize constitutes a majority of daily sustenance.

Wheat is a significant food for human nutrition, particularly in the least developed countries. It is an important source of carbohydrates and a major source for natural and biofortified nutrient supplementation, including dietary fiber, protein and dietary minerals like manganese, phosphorus, niacin and several B vitamins. But the proteins present in the wheat endosperm (gluten proteins) are particularly poor in lysine, white flours are more deficient in lysine compared with whole grains.

Rice is the staple food of over half the world's population especially for the people in developing countries. Rice is a good source of protein and a staple food in many parts of the world, but it is not a complete protein: it does not contain all of the essential amino acids in sufficient amounts for good health, and should be combined with other sources of protein, such as nuts, seeds, beans, fish, or meat.

The total production of maize surpasses that of wheat or rice as it has become a staple food in many parts of the world. Maize is generally not consumed directly by humans and most is used for corn ethanol, animal feed and other maize products, such as corn starch and corn syrup.Raw, yellow, sweet maize kernels are a good source of the B vitamins, thiamin, niacin , pantothenic acid (B5) and folate. They also supply dietary fiber and the essential minerals, magnesium and phosphorus whereas other nutrients are in low amounts. The amountsof the essential amino acids tryptophan and lysine are very low in maize making it a poor source of protein.

The Global Hunger Index (GHI) Report in 2016 reported that India has 25% of world's hungry population, despite increased production of food grains. People suffer from "hidden hunger," which occurs when individuals eat foods that don't provide the nutrients they need to lead healthy, productive lives. Hidden hunger is more prevalent

in developing countries that rely heavily on staple crops like wheat, maize, and rice. These populations often do not have access to nutrient-rich foods, such as fruits, vegetables, and fish, and tend to suffer from vitamin A and zinc deficiencies. Children who suffer from hidden hunger have more difficulty developing to their full mental and physical potential.

Malnutrition problems can be resolved by including dietary supplements and food fortification programmes. In the Indian situation, dietary diversification is not viable considering the inadequate purchasing power of the poor people. Hence biofortification strategy can be considered as a long term solution for alleviating this problem. Biofortification is the process of improving the bioavailability of essential nutrients in food crops either through conventional breeding or modern biotechnology techniques. Maize, wheat and rice are ideal targets for improving nutrition through biofortification as they form staple foods for majority of the world population.

Various agricultural strategies are used to improve the nutritional value of crop plants. They include genetic biofortification, which is based on classical plant breeding or genetic engineering and agronomic biofortification, which is based on optimized fertilizer applications.

AGRONOMIC BIOFORTIFICATION

Biofortification through agronomic practices can be performed through fertilizer or foliar feeding. Several crucial factors may contribute to the nutrient loss at different stages such as bioavailability of nutrient uptake from the soil, nutrient distribution in different parts of the plants, milling or dehusking during food processing, and the ability of human to absorb and utilize the nutrients. It is determined by various factors due to the potential nutrient loss during the transition at different stages such as from the soil to the plants, plants to food, and finally to humans. Soil conditions such as pH, soil composition, aeration, and moisture are important for iron availability and uptake in plants.

- Foliar spray –Foliar application of iron and zinc has improved the accumulation and bioavailability of these minerals in rice, wheat and maize
- Fertilizer application - Zinc concentration and zinc availability in rice grain can be improved by application of Zn to the soil as fertilizer in addition to a foliar spray. Application of compound fertilizers supplemented with selenium is also found to be beneficial in rice, wheat and maize.
- Seed priming – Seed priming is described as treatment of seeds prior to sowing with different solutions or nutrients. Commonly used practices are hydro-priming and osmo-priming. Seed priming is usually performed to improve the germination and tolerance against different abiotic stresses at early stages. Seed priming with $ZnSO_4$ showed the increase in grain yield of maize.
- Integrated use of organic and chemical fertilizers and zinc biofortification using *Bacillus aryabhatta* has helped in the iron biofortification in wheat

CONVENTIONAL BREEDING

Biofortification by breeding is the most accepted method of biofortification. The advantages are that it is sustainable and cost-effective. Conventional breeding will not be feasible if sufficient genotypic variation is not present. Parent lines with high nutrients are crossed with recipient line with desirable agronomic traits over several generations to produce plants with desired nutrient and agronomic traits. In some cases, crossing to distant relatives and thus moving the trait slowly into the commercial cultivars may be adopted. New traits can be introduced directly into commercial varieties by mutagenesis also.

RICE

- BRRIdhan 62, BRRIdhan 72, and BRRIdhan 64 - The world's first zinc enriched rice varieties developed by HarvestPlus, released in 2013 by the Bangladesh Rice Research Institute.
- IR68144-3B-2-2-3 - An improved line identified in a cross between a high-yielding variety (IR72) and a tall, traditional variety (ZawaBonday) with a high concentration of grain iron.
- Jalmagna - A traditional variety which had almost double the iron concentration of common rice variety and zinc concentration.
- CRR Dhan 310 - A pure line variety with >10% protein in polished rice developed by NRRI, which has been nationally released with an average grain yield of 45.0 q/ha (quintal/hectare).
- DRR Dhan 45 - A pure line variety and possesses high zinc (22.6 ppm) in polished grain with an average grain yield of 50.0 q/ha.
- DRR Dhan 49 - A pure line variety with high zinc (25.2 ppm) in polished grain. Its average grain yield is 50.0 q/ha.

WHEAT

- PusaTejas - Wheat variety rich in protein, iron and zinc
- BHU 1, BHU 3, BHU 5, BHU 6, BHU 7, and BHU 18 - Six varieties of high zinc wheat were released in India in 2014
- NR 419, 42, 421, and Zincol – high zinc varieties released in Pakistan in 2015
    - PBW1Zn - Variety with high zinc released by Punjab Agricultural University, India.
    - WB2 - Variety with high zinc and iron content developed and released by Indian Institute of Wheat and Barley Research, India
    - HI 8627 - High provitamin A durum wheat variety released by the Indian Agricultural Research Institute (IARI), India in 2005.

MAIZE

- ICTA HB-18 and ICTA B-15 - Zn-enriched maize varieties were developed by the International Maize and Wheat Improvement Center (CIMMYT) with collaboration of CGIAR Research Program on Maize (MAIZE), CGIAR Research Program on

Agriculture for Nutrition and Health (A4NH) and Guatemala's Institute for Agricultural Science and Technology (ICTA) with support of HarvestPlus. Guatemala is the first country to release the Zn-enriched maize hybrids.

- BIO-MZN01 - Zn-enriched maize variety developed by CIMMYT with collaboration of HarvestPlus, International Center for Tropical Agriculture (CIAT), CGIAR Research Program on Maize (MAIZE) and CGIAR Research Program on Agriculture for Nutrition and Health (A4NH).
- PusaVivek QPM9 Improved - maize hybrid rich in provitamin A, lysine and tryptophan
- GV662A, GV664A, and GV665A - Biofortified orange maize varieties have been grown commercially in Zambia
- Ife maizehyb-3, Ife maizehyb-4, Sammaz 38 (OPV), Sammaz 39 (OPV) - Nigeria
- CSIR-CRI Honampa (OPV) - Ghana since 2013
- Maize genotypes with four nutritional traits namely high lysine, tryptophan, provitamin A and vitamin E have been developed and currently under evaluation at multilocations.

TRANSGENIC APPROACH

When the genetic variation is limited transgenic approach can be a valid alternative for the development of biofortified crops. Transgenic approaches can also be used for the simultaneous incorporation of genes involved in the enhancement of micronutrient concentration, their bioavailability, and reduction in the concentration of antinutrients which limit the bioavailability of nutrients in plants. Development of transgenicallybiofortified crops initially involves substantial amount of time, efforts, and investment during research and development stage, but in a long run, it is a cost-effective and sustainable approach, unlike nutrition-based organizational and agronomic biofortification programs. Numerous crops have been genetically modified to enhance their micronutrient contents. Among micronutrients, vitamins, minerals, essential amino acids, and essential fatty acids have been targeted by the use of various genes from different sources to enhance the food crop nutritional level.

RICE

- 'Golden rice' lines with high provitamin A have been developed by NARS. Three research groups in India, viz. IARI, IIRR and Tamil Nadu Agricultural University (TNAU) have been involved in the development of Indian versions of golden rice in collaboration with the International Rice Research Institute (IRRI) supported by the Department of Biotechnology (DBT), India.
- In addition to the released varieties there are many reports of increased folate content, iron content, zinc content, increased iron accumulation, reduced antinutrient compounds like phytic acid, increased essential amino acid content, increases polyunsaturated fatty acid content etc. which can yield biofortified rice varieties.

WHEAT

There are various studies which reported enhanced provitamin A content (bacterial *PSY* and carotene desaturase genes), iron content (ferritin gene from soybean), iron bioavailability,phytase activity, phytic acid content, protein content, especially essential amino acids lysine, methionine, cysteine, and tyrosine contents and antioxidant activity in wheat.

MAIZE

- Mavrea™YieldGardMaize andMavera™ Maize (LY038) –Lysine rich varieties.
- BVLA4 30101 - variety released by Origin Agritech in China has been biofortified for phytate degradation.
- Efforts are also being made to improve the contents of provitaminA (carotenoids), Vitamin E, Vitamin C, iron utilization and amino acids lysine, tryptophan and methionine in maize kernels.

Biofortification is a promising strategy for sustainable long-term approach in combating micronutrient deficiency but successful biofortification at the cost of the environmental damage is not acceptable. It has various advantages when utilized as part of an integrated strategy to reduce malnutrition and alleviate micronutrient deficiencies:

- It forms a part of the daily intake of food within households there by not incurring any additional cost
- The recurrent costs are low since, developing biofortified crops is a one-time investment.
- Biofortified crop systems are highly sustainable; the varieties developed and released will continue to be grown and consumed year after year

High value Low Volume Vegetable Confetti: Microgreens

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ABSTRACT

Microgreens with high nutrient density are the latest emerging foods that have tremendously popped up in top-end restaurants and grocery stores in the contemporary era. Due to high concentrations of phytonutrients viz. carotenoids, ascorbic acid, tocopherols and phylloquinone etc., these young seedlings are adjudged as fresh and functional food that provide humans with a full-fledged nutrient package against various health associated risks. Although, little relevant scientific evidence on microgreens is available yet but still numerous research projects are going on to explore their nutritional value, post-harvest quality, consumer acceptance, sensory aspects and microbiological safety.

Keywords: Microgreens, Phytonutrients, Post-harvest quality.

INTRODUCTION

Population explosion, increased erratic weather events due to climate change, high and volatile food prices, constant monetary and economic crises alleviates the goal of sustainable development consequently inflating the population number owing to suffer from hunger (FAO 2011). Lessened carbohydrate and protein ingestion from staple food is acknowledged as hunger and malnutrition is consumption of micronutrients-less food, further recognized as hidden hunger. Fresh fruits and vegetables are full of micronutrients(Ebert, 2012) hence,altered combination of consuming diet of pulses, fruits and vegetables can possibly solve the mineral and vitamin paucity allied with malnutrition and persistent diseases (Yang et al. 2007; Keatinge et al. 2011; Jamnadass et al. 2011). Intake of healthy food and alteration in feeding patterns can deflect the pernicious effects of malnutrition and modern agriculture (Ebert, 2012). Epidemiological studies that consumption of adequate fruits and vegetables is associated with reduction in the development of chronic disease, such as cancer and cardiovascular disease (Bergquist et al., 2006; Hung et al., 2004). Diets rich in fruits and vegetables provide an abundance of phytonutrients (Craig & Beck, 1999), such as ascorbic acid (vitamin C), phylloquinone (vitamin K1), carotenoids (provitamin A

compounds) and tocopherols (vitamin E), which are known to have health protective benefits against cancer and cardiovascular diseases (Catherine Rice-Evans, 1995). The new *Dietary Guidelines for Americans* (2010) released by the U.S. Department of Agriculture (USDA) in affiliation with Department of Health and Human Services (DHHS) specifically recommends Americans to fill half of their plate with fruits and vegetables because they possess miraculous benefits for human health. Therefore, burgeoning interest in fresh and functional food coupled with proper health and longevity compels the demand of leafy vegetable production at micro scale for improving nutritional aspects of diet.

WHAT ARE MICROGREENS?

Microgreens, also called vegetable confetti are a new class of specialty crops that are defined as young, tender, lively green seedlings of vegetables, herbs and grains containing high levels of biofortified phytonutrients and have potential bioactive value. These are typically used to garnish a wide variety of main dishes, salads, sandwiches, soups, drinks and desserts etc. to enhance theircolor, texture or flavor. They are harvested 7-14 days after germinationdepending upon different species at the cotyledon stage i.e., first true leaf stage and are consumed immature. Irrespective of their small size, the microgreens have a diversity of impressive colors, fine texture, unique favors, varieties and shapes. Microgreens are different from sprouts and baby-greens. Sprouts are the germinated seeds consumed as a whole plant (root, stem, shoot) and are the youngest. In microgreens, 2 inches tall are larger than sprouts while the

Figure 1 Microgreens in various colours

baby-greens are the largest having height of 3-4 inches.Seeds grown for microgreens

have high potential value in terms of texture, flavor and color. The phytochemical composition of microgreens is greater than their mature counterparts on the basis of fresh weight .They are full of bioactive compounds like ascorbic acid, phylloquinone, tocopherol, beta-carotenoids,xanthophyll carotenoids (lutein, zeaxanthin), polyphenols, glucosinolatesand minerals like calcium, magnesium, iron, manganese, zinc, molybdenum, selenium. The nitrate content is lower and the antioxidant activity is quite high. The young baby shoots are chiefly attracted by chefs of high-end restaurants, greenhouse farmers, urban and peri-urban farmers and upscale markets because of their short production cycle and intense potential as superfood.

PHYTONUTRIENTS PRESENT IN MICROGREENS AND THEIR BENEFITS

Naturally, plants contain numerous chemicals termed as phytonutrients or phytochemicals that keep them healthy through protection from insect attacks, UV rays, germs and pathogens etc. Phytonutrients can prove advantageous humans who consume plant foods. They are not as essential as the proteins, carbohydrates, fats, vitamins and minerals but somehow play a significant role in enhancing overall immunity of human body against various diseases and lead to maintenance of proper growth and development by acting as antioxidants and anti-inflammatory agents. Phytonutrients are also important for intensification of the intercellular communication, detoxification of carcinogens, alteration in estrogen metabolism and DNA repairment. According to the U.S. Department of Agriculture phytonutrient-rich diet sounds to be an effective strategy for alleviating cancer and heart associated disease risks. According to Kris-Ethertone*t al* (2002), these chemicals or compounds differ extensively in their chemical structures and functions.

Ascorbic Acid

Ascorbic acid is a naturally occurring water soluble vitamin that helps in reducing bacterial infections through its antioxidant properties. It is abundantly found in citrus fruits (Citrus L.), peppers (Capsicum annuum L.), strawberries (Fragaria × ananassa D.), tomatoes (Solanum lycopersicum L.), broccoli (Brassica oleracea L. var. italica), Brussels sprouts (Brassica oleracea L. var. gemmifera), turnips (Brassica rapaL.var. rapa) and other leafy vegetables. Its deficiency leads to scurvy disease in humans. Plants mainly contain two available forms viz. vitamin-C reduced form L-ascorbic acid) and oxidized form (dehydroascorbic acid). When plants are subjected to physiological stress i.e. chilling, irradiation, and harvesting injury, the L-ascorbic acid oxidizes into dehydroascorbic acid (Hodges et al., 2001). Various studies show that vitamin-C is protective against stress-related disease such as cancer, cardiovascular disease, aging and cataract formation (Steinmetz & Potter, 1996; Iqbal et al., 2004)

Carotenoids

Carotenoids are naturally occurring plant pigments responsible for providing bright red, yellow and orange hues in diverse fruits and also in many dark green vegetables (Rao & Rao, 2007). Carotenoids like β-carotene, α-carotene, and cryptoxanthin functions as provitamin-A, that turn into vitamin A in the body and

therefore, performs the same function as that of vitamin A (Stahl &Sies, 2003). Food sources for carotenoids include carrots (Daucus carota L.), sweet potatoes (Ipomoea batatas (L.) Lam.), kale (Brassica oleracea L. var. acephala), collard greens (Brassica oleracea L. var. acephala), spinach (Spinacia oleracea L.), bell peppers (Capsicum annuum L.), tomatoes (Solanum lycopersicum L.) and papayas (Carica papaya L.). Experimental studies observed that people ingesting more carotenoids experience lower risk of various chronic diseases such as cancer, cardiovascular diseases, cataracts (Mayne, 1996) as well as there is reduced risk of breast cancer (Kaur & Kapoor, 2001).

Tocopherols

Vitamin-E primarily consists combination of organic chemical compounds like tocopherols and tocotrienols. Both are made up of four isomers individually i.e. α-, β-, γ- and δ-, that naturally occurs in plants (Papas, 1999). Abundant amounts may be found in vegetable oils, nuts and numerous plant tissues, ranging from kale and broccoli to cereal grains and nuts (Piironen et al., 1986). Clinicalchemoprevention study observed that vitamin E may decrease the risk of prostate cancer and epidemiological studies support its protective role against colon cancer (Kaur & Kapoor, 2001).

Polyphenols

Polyphenols includes a sub-category called flavonoids that are plant-based compounds found in fruits, vegetables, cereals and beverages. Recent studies revealed the antioxidant capacity (free radical scavenging and metal chelating activities) and the possible beneficial implications in human health due to presence of these phenolics (Xiao *et al* 2012). Various studies observed that specific flavonoids suppress tumor growth, prevent blood clots, interfere with sexual hormones and have anti-inflammatory properties (Xiao *et al* 2012). Also, the flavonoids present in dark chocolate acts as health protective (Kris-Etherton et al., 2002).

Phytoestrogens

Phytoestrogens are plant derived substances also known as isoflavones and act same as female hormone estrogen. A high ingestion of soy, which contains isoflavones, may lower symptoms caused by estrogen depletion during menopause. Many phytoestrogens are present in flaxseed oil, fruits, whole grains and vegetables (Xiao *et al* 2012). Lignan is another phytoestrogen found in the fiber layers of whole-grains, berries, few seeds, some vegetables and fruits. In laboratory studies, it seems to have anti-cancer properties (Xiao *et al* 2012).

Sulphur-containing Compounds

Organo-sulfurs are organic compounds belonging to allium family of phytonutrients that contains sulfur. Compounds like allicin may improve the immune system, helps liver in making carcinogens harmless, and lower the levels of cholesterol in the liver (Xiao *et al* 2012). These compounds are found in garlic, leeks, scallions, onions, chives and shallots (Kris-Etherton et al., 2002). Isothiocyanates and related substances, indoles (also known as mustard oils) are responsible for the sharp taste in

cruciferous vegetables. Such vegetables include broccoli, collard greens cabbage, Brussels sprouts, kale, kohlrabi (Brassica oleracea L. var. gongylodes), cauliflower (Brassica oleracea L. var. botrytis) mustard greens (Brassica juncea L.), rutabaga (Brassica napobrassica (L.) Mill.), turnips, and bok choy (Brassica rapa L. var. chinensis). Isothiocyanates stimulate enzymes that convert estrogen to a more benign form and may block steroid hormones that promote breast and prostate cancers.

MAJOR REQUIREMENTS DURING MICROGREEN PRODUCTION:

1. SEEDS -Wide range of seeds like cabbage, carrot, kale, beet, mustard, broccoli, basil, onion, fennel, lemongrass, popcorn, spinach, buckwheat, coriander, pea, celery, radish, amaranth etc. can be used to grow microgreens. Among all, cabbage, broccoli, cauliflower, mustard, sunflower, buckwheat are among the easiest to grow. The seeds should be soaked in water prior to sowing for effective germination.Osmopriming and matrix priming are also helpful in advancing seed germination.Organic seeds should be selected to get healthy and nutritious yields. Seed treatment or sanitization is done before sowing to get rid of spores of disease-causing pathogens like fungal spores, bacteria etc. Seed treatment can be done with 3% solution of hydrogen peroxide. It is a diluted solution and does not harm the seeds.After treatment, rinse the seeds properly under tap water to wash the excess solution. Preliminary germination tests are advisable for adjustments in sowing rate. Pre-sowing treatments are important for standardizing and abridging the production cycle. Sowing rate primarily depends upon type of crop, seed weight and population density.

2. FERTILIZER- Microgreens do not need fertilizer when grown in high quality soil because soil has innate potential of providing enough nutrients to keep the microgreens strong and healthy. But in case of soilless medium or hydroponic medium, fertilizer application is done to provide essential plant nutrients. Chemical fertilizers include urea, calcium nitrate, ammonium nitrate, calcium chloride etc. Fertilizer can be substituted by using compost. Other important fertilizers include:

Liquid kelp- It is extracted from sea weeds and contains high amounts of nutrients. It possesses high amount of plant growth hormone, cytokinin.

Azomite- It is a powdered fertilizer made up of volcanic ash and is overloaded with earth minerals and elements. The breakdown of azomite makes the nutrients immediately available to the plants.

Floragro-It is a water-soluble fertilizer. It is mixed in water before application and contains multitude of plant nutrients.

3. GROWING MEDIA-There are plenty of options for the growing mediato produce microgreens. Growing media should have electrical conductivity less than 500μS/cm, ph between 5.5-6.5, water holding capacity of about 50-70% v/v and aeration, 20-30% v/v.

A) Soil- It is important to use high quality soil rich in plant nutrients especially N, P and K. The 3 important things that must be present in quality soil include nutrients, water holding capacity and proper aeration. Nutrients are important to improve the growth of microgreens. Without proper nutrients, the stems will be thin and weak. Water retention is crucial for seed germination and to avoid wilting of shoots. The container

should be porous to prevent overwatering. An adequate airflow increases root respiration and help in water drainage. Peat moss, vermiculite, perlite, compost or worm castings are added to make a good quality soil. Compost is tremendously important in case of homemade soil. It provides available nutrients to the plants.

B)Coconut Coir-It is a fibrous material made from coconut husks. It is thicker and porous making the water retention comparatively less. It is highly convenient because overwatering is hindered. It is cleaner and cost effective than soil.

C) Hemp mats – It is a super sustainable medium made of 100% natural hemp fiber. It is a biodegradable and clean growing medium with high water and nutrient holding capacity.

D) Hydroponic medium – Microgreens are grown in water medium full of essential nutrients and minerals to augment its overall growth. The pH of water should be 5.5-6.5 which is most favorable for microgreens. A growing pad is placed above the water and is gently pressed to saturate it with water. Fertilizers are added to the water in case the plant shows wilting or yellowing symptoms.

E) Vermiculite- It is a natural clay mineral which can be used for growing microgreens. It uplifts the airflow, balance the pH and is resistant to mold. Thin layer of vermiculite helps to maintain proper moisture and facilitates seed germination.

In addition to these, synthetic fibrous mediums like polyethylene terephthalate (PET) androckwool, natural fiber made mediums like recycled jute fiber, cellulose pulp, cotton fiber, kenaf and other admixtures of medium are commonly used as potential growing media. However, such medias are either fortified to enhance nutritional value of microgreens or inoculated with friendly microorganisms to control pathogens and to induce plant growth and development.

4. ENVIRONMENT- Microgreens adapt to various environments like indoor, protected environment, open air etc. depending upon the production scale. Containerization helps in both micro and macro level production for selling in markets. Light conditions predominantly influence biosynthesis of phytochemicals and morphology of microgreens particularly in controlled atmospheric conditions like greenhouse. Auxiliary light sources include metal halide, LED, high pressure sodium etc. light intensity and photoperiod play a significant role in regulating physiological metabolism of microgreens.

5. HARVESTING- It is very laborious and time-consuming part that can directly affect the production cost. Harvesting is performed at first true leaves stage with fully expanded cotyledons having a height of about 5-10 cm. Manual or mechanical cutting few millimeters above the growing media is adopted for obtaining well developed and turgid stems. Mechanical injuries during cutting and handling, temperature abuse, desiccation, compact packing can alleviate the shelf life of microgreensand therefore,standardized precautionary measures should be considered to avoid maximum damage. After harvesting, immediate washing with chilled water is recommended to avoid microbial growth via nutrient rich exudates released from cut ends. Time of harvesting is species specific and affects the bioactive composition and shelf life.

COMMERCIALIZATION

Seed companies provide vast range of species, varieties and mixtures for microgreen production at commercial ground. Some of the major microgreens are listed below.

Pic. 2:25 commercially available microgreens (Xiao *et al* 2012)

Table.1: Commercial names, family and plant colors of 25 commercial grown microgreens (Xiao *et al* 2012)

COMMERCIAL NAME	FAMILY	PLANT COLOR
Wasabi	Brassicaceae	Green
Sorrel	polygonaceae	Green
Red sorrel	polygonaceae	Reddish green
Red cabbage	brassicaceae	Purplish-green
Red mustard	Brassicaceae	Purplish-green
Red orach	chenopodiaceae	Red
Arugula	Brassicaceae	Green
Celery	Apiaceae	Green
Bull's blood beet	Chenopodiaceae	Reddish-green
China rose radish	Brassicaceae	Purplish-green
Cilantro	Apiaceae	Green
Golden pea tendrils	Fabaceae	Yellow
Red beet	Chenopodiaceae	Reddish-green
Purple kohlrabi	Brassicaceae	Purplish-green
Garnet amaranth	Amaranthaceae	Red
Green basil	Lamiaceae	Green
Purple mustard	Brassicaceae	Purplish-green
Popcorn shoots	Poaceae	Yellow
Peppercress	Brassicaceae	Green
Green daikon radish	Brassicaceae	Green
Magenta spinach	Chenopodiaceae	Red
Mizuna	Brassicaceae	Green
Opal basil	Lamiaceae	Greenish-purple
Opal radish	Brassicaceae	Greenish-purple
Pea tendrils	Fabaceae	Green

Coda (Xiao *et al* 2012)

Microgreens haveeye-catching appearance, tender quality and intense flavor that in combination providestremendous healthful nutrients. According to the USDA's National Nutrient Database, microgreens are richer in nutrients than the mature parts. All microgreens evaluated by Xiao et al (2022) demonstrated "good" to "excellent" consumer acceptance stipulating qualitative nutritional profile.Therefore, overall acceptability of microgreens is strongly correlated to flavor acceptability. Moreover, as compared to sprouts, microgreens sound to bear relatively lower safety risks.

FUTURE ASPECTS

Chemical, Enzymatic and Molecular Analysis of Microgreens

For thorough investigation underlying the mechanism of microgreens as more nutrient-dense than mature plants, nutrient biosynthesis during growth and gene expression is highly relevant. For an instance, ascorbic acid is synthesized from L-galactono-1, 4-lactone by L-galactono-γ-lactone dehydrogenase (GLDH; EC 1.3.2.3); therefore, enzymatic and molecular analysis of plants at different growth stages can provide us the information about changes in enzymatic activity and gene expression that occur during seed germination and plant growth.

Ready-to-eat (RTE) Microgreens Versus Living Microgreens

Various experimental studies recognize that microgreens have optimal conditions for postharvest storage,thoughthe wash treatment does not work well on developing ready-to-eat microgreens products. Nil availability of RTE's in supermarkets necessitates the development of such ready-to-eat microgreens with good quality, long shelf life and ensured safety. Appropriate washing and drying processes, well-performed packaging materials and effective sanitizers need to be acknowledged to minimize the safety risk of microgreens consumption.

As seen in some restaurants and grocery stores, microgreens are sold as living forms in containers with growth medium in it. It seems like the living microgreens look fresher and have longer shelf life. Is it true? As living plants, microgreens need adequate light exposure to maintain photosynthesis, otherwise, yellowing and wilting is a consequence. During transportation and storage, living microgreens may undergo a long period of dark time, which may have an impact on sensorial and nutritional quality. It will be of interest to carry out a comparative postharvest study between ready-to-eat microgreens and living microgreens.

Microbiological Safety Study of Microgreens

Research findings on the comparison of *E. coli* growth on sprouts and microgreens shows the lower food safety risks of microgreens. Therefore, the mechanisms of bacterial distribution, attachment and interaction with the microgreen plants can be further investigated. As reported, specific virulence genes are required for bacterial attachment to plant tissues (Barak et al., 2005); therefore, molecular genetic analysis would help to explore the interaction of pathogens and microgreens. In addition,

microscopy strategy, such as confocal scanning laser microscopy, can be used to observe the morphology of pathogen and plant cells and interaction between them.

REFERENCES

Bergquist, S.A.M., Gertsson, U.E., Olsson, M.E., 2006. Influence of growth stage and postharvest storage on ascorbic acid and carotenoid content and visual quality of baby spinach (*Spinacia oleracea* L.). J. Sci. Food Agr. 86, 346-355.

Catherine Rice-Evans, N.J.M., 1995. Antioxidants - the case for fruit and vegetables in the diet. Brit. Food J. 97, 35 - 40.

Craig, W., Beck, L., 1999. Phytochemicals: Health Protective Effects. Can. J. Diet Pract. Res. 60, 78 -84

Ebert, A. (2012). Sprouts, microgreens, and edible flowers: The potential for high value specialty produce in Asia. In Proceedings SEAVEG 2012, Chiang Mai, Thailand, 24e26 January 2012. High value vegetables in southeast Asia: Production, supply and demand (pp. 216e227). Asian Vegetable Research and Development Center (AVRDC).

FAO-OECD (2011). Price volatility in food and agricultural markets. Policy responses. Report including contributions by FAO, IFAD, IMF, OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI and the UN HLTF. Accessed July 2011, available at http://www.oecd.org/document/20/0,3746,en_2649_37401_48152724_1_1_1_37 4 01,00.html.

Hodges, D.M., Forney, C.F., Wismer, W.V., 2001. Antioxidant responses in harvested leaves of two cultivars of spinach differing in senescence rates. J. Am. Soc. Hortic. Sci. 126, 611-617.

Hung, H.C., Joshipura, K.J., Jiang, R., Hu, F.B., Hunter, D., Smith-Warner, S.A., Colditz, G.A., Rosner, B., Spiegelman, D., Willett, W.C., 2004. Fruit and vegetable intake and risk of major chronic disease. J. Natl. Cancer Inst. 96, 1577-1584.

Iqbal, K., Khan, A., Khattak, M., 2004. Biological significance of ascorbic acid (vitamin C) in human health - a review. Pakistan J. Nutr. 3, 5-13.

Jamnadass RH, Dawson IK, Franzel S, Leakey RRB, Mitho¨fer D, Akinnifesi FK, Tchoundjeu Z (2011) Improving livelihoods and nutrition in sub-Saharan Africa through the promotion of indigenous and exotic fruit production in smallholders' agroforestry systems: a review. International Forest Review 13:338–354

Kaur, C., Kapoor, H.C., 2001. Antioxidants in fruits and vegetables-the millennium‟s health. Int. J. Food Sci. Tech. 36, 703-725

Keatinge, J.D.H.; Yang, R.-Y.; Hughes, J.d'A.; Easdown, W.J.; Holmer, R. The importance of vegetables in ensuring both food and nutritional security in attainment of the Millennium Development Goals. Food Sci. 2011, 3, 491–501

Kris-Etherton, P.M., Hecker, K.D., Bonanome, A., Coval, S.M., Binkoski, A.E., Hilpert, K.F., Griel, A.E., Etherton, T.D., 2002. Bioactive compounds in foods: their role in the prevention of cardiovascular disease and cancer. Am. J. Med. 113, 71-88.

Mayne, S.T., 1996. Beta-carotene, carotenoids, and disease prevention in humans. The FASEB Journal 10, 690-701.

Papas, A.M., 1999. The Vitamin E Factor, HarperCollins Publishers, Inc., New York, NY.

Piironen, V., Syvaoja, E., Varo, P., Salminen, K., Koivistoinen, P., 1986. Tocopherols and tocotrienols in cereal products from Finland. Cereal Chem. 63, 78-81.

Rao, A., Rao, L.G., 2007. Carotenoids and human health. Pharmacol. Res. 55, 207-216.

Stahl, W., Sies, H., 2003. Antioxidant activity of carotenoids. Mol. Aspects Med. 24, 345-351.

Steinmetz, K.A., Potter, J.D., 1996. Vegetables, fruit, and cancer prevention: a review. J. Am. Diet. Assoc. 96, 1027-1039.

USDA, 2011. National Nutrient Database for Standard Reference, Release 24. http://www.ars.usda.gov/Services/docs.htm?docid=22113.

Yang, R.-Y., Hanson, P. M., & Lumpkin, T. A. (2007). Better health through horticulture—AVRDC's approach to improved nutrition of the poor. Acta Horticulturae, 744, 71–77.

Mulching: a water saving approach for summer cultivation

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The availability of water becomes restricted especially during summer season all over the country. The efficient and judicial use of water during crop growth periods is important which can significantly improve summer cropyields. Therefore, mulching may be used as efficient water saving option for farming during summer season as it conserves soil moisture and cause rise in production.

Mulching is the system of covering the surface of soilin the cropped land with organic or inorganic mulch materialsin order to create a microclimate suitable forcrop growth and yield.The mulch protects the soil surface from direct sunlight, hence reduces evaporation by conserving soil moisture and modifyingthe soil temperature. This technique is beneficial during the summer season for optimizing the water use.

Mainly there are two types of mulches; organic (leaves, straw, dead leaves, coir pith, compost,bark chipsetc) and inorganic (gravel,plastic, etc.). Organic mulch materials decompose over time, thereby incorporate nutrients to the soil and improve its water holding capacity.The decay of organic materials adds organic acids to the soil resulting in the low soil pH and thusincreases the availability of micronutrients like Mn, Zn, Cu, and Fe to the growing crops.Plastic mulches are the main inorganic type mulch used in the commercial crop production. The use of plastics in agricultureas mulching material is called plasticulture. Poly vinyl chloride or polyethylene films of varying thickness are used as per crop requirement.The plastic mulches are completely impermeable to water as compared to other mulching materials; therefore it restricts the direct evaporation of moisture from the soil and limits the soil erosion over thesurface. Thus, it plays a positive role in retention of soil moisture, control of temperature fluctuations, improvingthe properties of soil, and eventuallyimproves the growth and yield of fresh vegetables or row crops. Plastic mulching was found most suitable for crops like bhindi, cucumber, brinjal, chilli, etc. It is possible to increase the yield of crops from 25 to 70% through plastic mulching as compared to normal crop cultivation.

Benefits of mulching:The mulching technique in cropped field have a wide range of benefits during summer season.Mulching improves soil aeration andsoil health,insulates the soil and acts as a buffer from extreme temperature, conserve soil moisture by reducing direct evaporation, control soil erosion,pest control,helps in

effective utilization of nutrients, reduces fertilizer leaching, etc.Plastic mulcheshelp in early seed germination andtherefore increased biomass production at early stages of growth itself.Mulching blocks thesunlight to the weeds and hinders their growth. Crop growth and yield are positively influenced by application of mulch due to soil microclimatemodification.

Mulch laying: The seed bed or ridges are prepared after thorough ploughing of the soil. All the clods, rocks or stones and other trashes should be removed from the field as it hinders proper application of mulch. Basal dose of fertilizers may be broadcasted in to the field and the beds are kept with appropriate moisture.Drip irrigation is the most efficient system to be used with plastic mulches. The drip laterals should be laid on the ridges or beds prior to plastic mulch application. The plastic mulch should belaid in continuous contact with the soil as the gap between the soil surface and the mulch affectsthe heat transfer phenomena.The edges of the mulch should be buried within the soil for making it secure. Mulch films can be laid manually or by using tractor mounted mulch laying machines.

Small holes of suitable diameter are made at predetermined crop spacing on the plastic sheet and the crops are planted in the middle of bed. Seeds or Transplants can be planted into the mulched bed.Planters can also be used for planting seedlings.Recommended doses of fertilizers should be supplied to the crops at appropriate intervals through drip fertigation. Care should be taken to avoid loosening of the laid mulch film. Integrated pest management program as per the crops can also be adopted for healthy crop growth. The plastic mulch films must be removed from the field after the growing season of crop and should be disposed in landfills. These films can be used until two or three growing seasons according to its thickness.

Wide varieties of mulch materials in various thicknesses and colours are available commercially. They are available in widths of 90cm and 120 cm in common. For annual short durationcrops and perennial long duration crops, mulch films of 20-25 micron and 50-100 micron thickness are recommended.

The adoption of mulching technique can conserve the water resources in the field of agriculture and thereby improve the crop production in summer cultivation.

Managing the Menance of Melon Fruit Flies, *Bactroceracucurbitae* (*Tephritidae, Diptera*)

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ABSTRACT:

The melon fruit fly, *Bactroceracucurbitae* (Coquillett) (Diptera: Tephritidae) is widely distributed and has been reported to damage 81 host plants. Among different species of host plants, plants belong to Cucurbitaceae are most preferred .The extent of losses vary between 30 to 100% in diverse agroecologies. It prefers to infest young, green, soft-skinned fruits by inserting the eggs 2 to 4 mm deep in the fruit tissues. The maggots feeding lead to fruit decay. Pupation occurs in the soil at 0.5 to 15 cm below the soil surface. Keeping in view the importance of the pest and crop, melon fruit fly management could be done by using different integrated approaches. Out of which, bagging fruits, field sanitation, protein baits, cue-lure traps, growing fruit fly-resistant genotypes, augmentation of biocontrol agents are important non-chemical methods for suppression of the fruit fly. The fruit fly escapes the chemical treatment due to its feeding habit. Apartfrom this, the problematic identification makes it difficult to control. Some times the pseudo-punctures by the fruitflies also goes unnoticed by the growers that lead to post harvest decay. Considering above menances caused by the tiny fly, it becomes necessary to control it by using eco-friendly approaches.

Key words: *Bactroceracucurbitae*, Cucurbitaceae, Fruit decay, Non chemical methods, Eco-friendly approaches**.**

INTRODUCTION

Melon fruit fly (Tephritidae :Diptera), are of great economic importance in Indian subcontinent. At present, 4352 species in 483 genera known all around the world. But in India, only 200 species in 71 genera and 5 subfamilies are known till today (Kapoor, 2002). Out of which, only 35-40 species with known host association has been reported. Fruit flies causing huge economic losses to the tune of 35 – 80% in different areas causing annual losses of around Rs. 6000 crores.

HOST RANGE

Melon fruit fly damages over 81 plant species among which, plants belonging to the family Cucurbitaceae are preferred most (Hollingsworth **and Allwood,2002**)

Nature of damage

Maggots feed mostly inside the fruits, but sometimes, also prefer flowers, and stems. Generally, the females prefer to lay the eggs in soft tender fruit tissues by piercing them with the ovipositor. The true punctures alongwith pseudo-punctures (punctures without eggs) have reduces the market value of the produce (Miyatake *et al*., 1993). The extent of losses vary between 30 to 100%, depending on the cucurbit species and the season (Jaiswal*et al.,* 1997).

Life Cycle

The melon fruit fly remains active throughout the year on one or the other host (Khan et al. 1992).The fruit fly attack fruits at different stages off maturity. The damage normally starts when fruit fly punctures the fruit with its long and sharp ovipositor. The maggots hatches from eggs feed on the fruits thus render them unmarketable. Fruit fly carry bacteria which decay the fruit and making it more nutritious for the maggots (Srinivasan,1994). Fruits finally drops down and the larva hops out and pupate in soil upto a depth of 1.5- 15 cm.

Fig. 1: Life cycle of melon fruit fly

MANAGEMENT OF FRUIT FLY

SL NO.	CONTROL MEASURES	
1.	CULTURAL CONTROL	**Montitoring**(Using sexual traps eg. Cuelure without insecticides)
		Summer ploughing to expose the pupae of the fruit fly and crop rotation with non-cucurbits crops
		Sanitation (A special sanitation technique was first developed in Hawaii, using a tool called an **augmentorium**. This is a closed tentlike structure with a roof consisting of mesh, constructed next to the crop. The structure is used by the farmers who place infested fruit inside. Adult flies

		emerging from the fruits are locked inside and eventually die. On the other hand, the mesh allows the smaller parasitoids to escape, especially the two braconid species *Fopiusarisanus* (Sonan) and P*. fletcheri* (Silvestri), parasitoids of, espectively, *B. zonata* and *B. cucurbitae*) **Collecting the damaged fruit** and destroying it to practice clean cultivation
		Assisted push pull strategy 1. Habitat manipulation by planting trap plants eg. Maize against *Bacteroceracucurbitae* 2. Attract and kill (by spraying on trap plants) **Growing Tulsi as a trap crop** and application of Carborandum / Malathion/ Dichlorvos on tulsi)
		Clean cultivation
		Physical exclusion **Whole trees or fruits** can be protected by excluding Medfly with mosquito netting, shade-cloth or nylon flyscreen. Large nets will need to be supported by a frame **Individual fruits or branches** can be protected by making bags or sleeves out of cloth such as gauze curtain material, muslin or mosquito netting
	PHYSICAL CONTROL	A higher temperature than 45 °C kills fly eggs and larvae, So irradiation, Vapour Heat Treatment (VHT), hot water treatment ,**Microwave treatments** (increase the temperaturein the fruit heart), **Irradiation can be used**
2.	MECHANICAL CONTROL	1. **Bait trap** can be installed using synthetic pheromorecuelure that mimics female sex pheromone, will attract male fruit fly 2. **Bottle trap** using combination of fruit fly parapheromone (1 trap/ 400 m^2) **3. Poison baited Mashed Sweet Gourd (MSG) trap** 100gm smashed ripe sweet gourd+0.25gm insecticide+ 100ml water 4. Application of **insecticide trap** (99.98% protein attractant+ 0.02% Spinosad) 5. Installation of **mineral water bottle trap or Mc Phail trap** with cuelure (as MAT) saturated with wood blocks (Ehonol: cuelure: Carbaryl in a ratio of 8:1:2 @ @25-30 traps per ha prior to flower initiation
3	BIOLOGICAL CONTROL	***Opiusfletcheri*Silv.** *Steinernemacarpocapsae* (*Neoaplectanacarpocapsae*),

		fungus, *Rhizoctoniasolani*and*GliocladiumvirensB.cucurbitae*larvae
4.	GENETIC CONTROL	• Male-sterile technique: In this technique, sterile males are released in the fields for mating with the wild females (Odani*et al.,* 1991) • Sterilization is done through irradiation, chemo-sterilization, or by genetic manipulation (Nakamori*et al.,* 1993)
5.	CHEMICAL CONTROL	Deltamethrin (DeCis 2.8 EC) Flubendiamide (Fame 48 SC) Acephate (Asataf 75 SP.) Triazophos (Tarzan40 EC) Cartap (Kritap 50 SP) Neemazal (NeemAzal 10,000 ppm) Neem oil @3% as foliar spray Karanja oil, citronella oil Spinosad (Tracer 45 WC) Chlorfenapyr (Intreprid 10 SC) and Emamectin benzoate (Proclaim 5 SG) (Bhowmik*et al.,* 2014)

TRAPS USED FOR FRUIT FLY

Fig.2: Mashed Sweet Gourd trap; Fig. 3: Pheromone trap; Fig.4: Bottle trap

CONCLUSION:

Realizing the importance of the pest and crop, the melon fruit fly can be managed or suppressed either locally or over a wide area basis by using any of the option(s) available including, bagging of fruits, field sanitation, cue-lure traps, construction of augmentorium, spray of protein baits with toxicants, growing fruit fly-resistant genotypes, augmentative releases of biological control agents. These approaches are eco-friendly and economically feasible by farmer individually or in groups. Contrary to this, On the other hand, the incorporation of a number of different techniques including the sterile insect technique, transgene lethality system, and quarantine, can also be exploited for intesifying the outcome. Thus, the coordinated control measures can be

more useful in managing the pest area wide rather than eradicating it locally. Furthermore, reinvasion of the pest can be done by adopting quarantine controls.

REFERENCES

Bhowmik, P., Mandal, D., and Chatterjee, M. L. 2014. Chemical Management of Melon Fruit Fly, *Bactroceracucurbitae*Conquillett (Diptera: Tephritidae) on Bitter Gourd (*Momordicacharantia* Linn.). Pesticide Research Journal, 26(1), 68-73.

Hollingsworth, R. and Allwood, A.J. 2002. Melon fly. In: SPC Pest Advisory Leaflets, pp.1-2.

Jaiswal, J.P., Gurung, T.B. and Pandey, R.R. 1997. Findings of melon fruit fly control survey and its integrated management 1996/97, Kashi, Nepal. Lumle Agriculture Research Centre Working Paper, 97/53, pp 1-12.

Kapoor, V. C. 2002. Fruit fly pests and their present status in India. In Proceedings of the 6th International Symposium on Fruit Flies of Economic Importance, Stellenbosch, South Africa. Isteg Scientific Publications, pp. 23-33.

Khan, L., Inayatullah, C. and Manzoor, U.H. 1992. Control of melon fly, *Dacuscucurbitae* (Diptera: Tephritidae) on melon in Pakistan. Tropical Pest Management, 38: 261-264.

Miyatake, T., Irabu, T. and Higa, R. 1993. Oviposition punctures in cucurbit fruits and their economic damage caused by the sterile female melon fly, *Bactroceracucurbitae*Coquillett. Proceedings of the Association of Plant Protection, Kyushu, 39: 102-105.

Nakamori, H., Shiga, M. and Kinjo, K. 1993. Characteristics of hot spots of melon fly, *Bactrocera (Dacus) cucurbitae*Coquillett (Diptera: Tephritidae) in sterile fly release areas in Okinawa Island. Japanese Journal of Applied Entomology and Zoology, 37: 123-128.

Odani, Y., Sakurai, H., Teruya, T., Ito, Y. and Takeda, S. 1991. Sterilizing mechanism of gamma-radiation in the melon fly, *Dacuscucurbitae*. Research Bulletin of Faculty of Agriculture Gifu University, 56: 51-57.

Srinivasan, K. 1994. Recent trends in insect pest management in vegetable crops. In: Dhaliwal GS, Arora R editors. Trends in Agricultural Insect Pest Management, pp. 345-372. Commonwealth Publishers, New Delhi, India.ss

Agricultural Residue Burning Impact and Its Management

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ABSTRACT

Crop residue burning has become a major environmental problem causing health issues as well as contributing to global warming. It also causes the loss of the nutrients present in the soil and affects the soil properties. Composting, biochar production and mechanization are a few effective sustainable techniques that can help to curtail the issue while retaining the nutrients present in the crop residue in the soil. The government of India has attempted to curtail this problem, through numerous measures and campaigns designed to promote sustainable management methods such as converting crop residue into energy. The solution to crop residue burning lies in the effective implementation of sustainable management practices with Government interventions and policies. Capacity building and awareness about ill effects of crop residue burning and its effective utilization and management; Formulation and implementation of suitable law and legislative/policy measures are needed to curb crop residue burning.

Keywords: Crop residue burning, impact, residue management

INTRODUCTION

Waste materials derived from various agricultural operations are defined as agricultural wastes. As per the United Nations, agricultural waste usually includes manure and other wastes from farms, poultry houses and slaughterhouses; harvest waste; fertilizer run-off from fields; pesticides that enter water, air or soils; salt and silt drained from fields. The harvest waste, which is more popularly termed as crop residue can contain both the field residues that are left in an agricultural field or orchard after the crop has been harvested and the process residues that are left after the crop is processed into a usable resource. Stalks and stubble (stems), leaves, and seed pods are some common examples for field residues. Sugarcane bagasse and molasses are some good examples for process residue

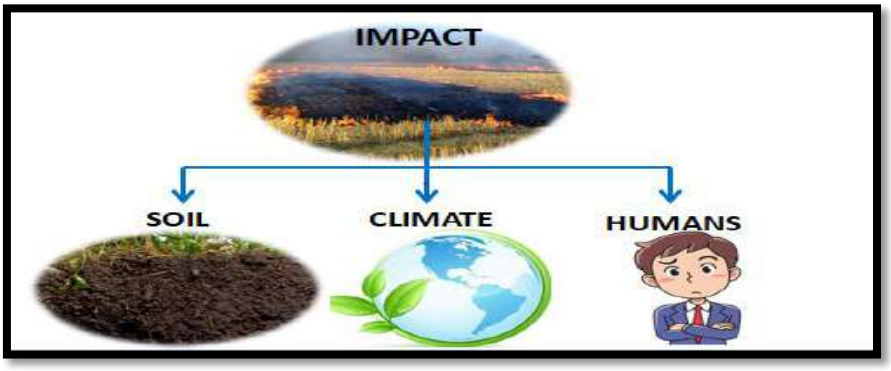
Harvesting of various crops generates large volume of residues both on and off farm. Ministry of New and Renewable Energy estimated that about 500 Mt of crop residues are generated annually. The generation of crop residues is highest in Uttar Pradesh (60 Mt), followed by Punjab (51 Mt) and Maharashtra (46 Mt). Among different

crops, cereals generate maximum residues (352 Mt), followed by fibres (66 Mt), oilseeds (29 Mt), pulses (13 Mt) and sugarcane (12 Mt). Cereal crops (rice, wheat, maize, millets) contribute 70%, while rice crop alone contributes 34% to the crop residues. Sugarcane residues consisting of top and leaves generate 12 Mt, i.e., 2% of the crop residues in India. Agriculture is one of the important production activities and crop residue burning generates a significant amount of air pollution. Atmospheric environment can absorb this pollution in a particular geographic region given its assimilative capacity. If the burning activities remain confined within the assimilative capacity, the pollution does not create harmful effects. Therefore, in the initial stages when the production and burning activities are limited, pollution caused through these activities is not considered a problem. However, due to technological advancements in the agricultural sector, waste concentration has gone beyond the assimilative capacity of the environmental limit, thereby distorting the balance.

HOW RESIDUE BURNING BECAME A MAJOR CONCERN

- Changing trend of manual to mechanical harvesting
- Use of combine harvesters
- Lack of time to prepare the field for the next crop
- Concept of burning of weeds/pests with crop residues
- Huge transportation cost of the residue
- Bulk transportation- loading /unloading require labour
- Unavailability of alternative economically viable solution
- High cost of removing crop residue by conventional method
- Long period required for composting

IMPACT OF CROP RESIDUE BURNING:



Impact of crop residue burning on soil

According to Singh et al. (2008), nutrient loss due to burning of rice residues in Punjab in 2001–2002 was 2,400 kg of carbon, 35 kg of nitrogen, 3.2 kg of phosphorus, 21 kg of potassium and 2.7 kg of sulphur in 1 ha. While loss of carbon and nitrogen was almost total, the loss of phosphorus, potassium and sulphur was partial (around 20–60 %). The residue burning increases the subsoil temperatures to nearly 33.8–42.2°C at 10 mm depth [Gupta *et al.* 2004], and long-term effects can even reach up to 15 cm of the top soil. Frequent burning reduces nitrogen and carbon potential of the soil and kills the microflora and fauna beneficial to the soil, and further removes the large portion of the organic matter.

Impact of crop residue burning on climate

Crop residue burning degrades the air quality due to emission of various gases, including gases responsible for global warming (Ramanathan and Carmichael 2008; Ioannidou and Zabaniotou 2007). It is estimated that upon burning, Carbon (C) present in rice straw is emitted as CO_2(70% of Carbon present), CO (7%) and CH_4(0.66%) while 2.09% of Nitrogen (N) in straw is emitted as N_2O. Besides, burning of crop residue also emits large amount of particulates that are composed of wide variety of organic and inorganic species. Crop burning increases the particulate matter in the atmosphere and contributes significantly to climate change.

Impact of crop residue burning on human health

Many of the pollutants found in large quantities in biomass smoke are known or suspected carcinogens and could lead to various air borne/lung diseases. The deaths of 66,200 were attributed to exposure to $PM_{2.5}$ (PM2.5 or fine, particulate matter with aerodynamic diameter <2.5 m from open burning in 2015, of which 50,500 were in rural areas and remaining 15,700 in the urban areas The emission from burning of crop residues also causes severe impacts on human health. It may cause the people suffering from chronic disease related to respiratory system, heart problems, blood, eye, and skin irritation (Singh et al., 2011)

Sustainable residues management practices:

1) Removal & Use
2) Incorporation
3) Retention

1. Removal and its use :

a. **Initiative towards Biogas Plants:** Biogas plants are a progressive step taken by the Government of India to curb crop burning and to prevent pollution. Recent developments in technology have opened the possibility of using paddy straw and other crop residue other than dung and vegetable waste for biogas generation in an integrated approach.

b. Composting:

Composting is the natural process of rotting or decomposition of organic matter by micro-organisms under controlled condition.The high organic content in crop residue makes it an ideal raw material for compost similar to animal manure and food waste.

c. Production of Biochar

Biochar is a fine-grained carbon rich porous product obtained from the thermo-chemical conversion called the pyrolysis at low temperatures in an oxygen free environment .This technique is viewed as a viable option to mitigate the GHG emissions while considerably reducing the volume of agricultural waste.

d. **Mushroom cultivation**

Paddy straw is a key ingredient for the cultivation of mushroom in Punjab (Choudhary et al. 2009) Use of crop residue for cultivation of mushroom particularly *Agaricus bisporus* (white button mushroom) and *Volvriella volvacea* (straw mushroom)

e. Rice straw mulching

Mulching of Rice straw is a process to conserve the moisture of the soil. It may be used for the crops like wheat, maize, sugarcane, sunflower, soybean, potato, and chilli production since these crops require wetland (Arora et al. 2011).

f. Fuel for power plants

The paddy straw may be used in the form of bales directly in the furnace or in the form of shredded straw with pulverized coal. The handling and storage of straw in the form bales become easy.

g. Making pellets

The crop residue may be used as a fuel in the pellet form. The pellet mill is used to crush, press, compact and form the straw, peanut shell, cob, cotton bar, soybean rod, weeds branches, leaves, sawdust, bark, and other solid wastes to prepare the pellets. This kind of fuel has high efficiency and is easy to store. It can also be used as main fuel for the industrial boiler (Verma 2014).

h. **Crop stubble as animal fodder/cattle shed and bed preparation**

One of the substitutes for the paddy straw burning may be fodder, bed, and preparation of shed of the cattle. The paddy straw is normally not used as fodder for cattle due to the presence of high silica and lingo-cellulosic content which is not easily digestible except straw of Basmati rice and wheat straw (Jain 2016; Kumar et al. 2015). Wheat straw is frequently used as cattle fodder. Basmati rice straw is mostly used as cattle fodder throughout the country.

i. Raw materials for paper and pulp industry

A pulping technology could eliminate waste by turning rice straw into the paper. Thus, the major portion of the burning paddy straw can be utilized as pulp for
paper and cardboard.

j. Mixing with plastics: The paddy straw can also be used as reinforcing the material in plastics.

2. Residue incorporation

Incorporation of crop residue into soils through adoption of conservation agriculture practices to prevent soil erosion from wind & water and to augment the soil moisture. It

Increases soil organic matter and N, P and K contents in soil. Recycles the beneficial nutrients. But leads to temporary immobilization of nutrients (e.g., Nitrogen). Extra nitrogenous fertilizer needs to be added to correct the high C:N ratio at the time of residue incorporation .

3. Residue retention

Residue retention on the surface of soil seems to be a better option for conservation of soil and avoiding water losses by evaporation. It also reduces the weed seed germination and helps in building of soil microbial populations results in increasing soil organic carbon-a direct indicator of soil health

Smart mechanization: Promoting in-situ management of crop residue by retention and

incorporation into the soil through the use of appropriate mechanization inputs. Incentivize purchase of happy seeder/ turbo seeder / shredder/ baling machines and zero- seed-cum-fertilizer drill to facilitate in-situ management of crop residue and retaining the straw as surface mulching; Extending subsidy to the farmers for hiring resource conservation machineries from Custom Hiring Center/Agriculture Service Center and promotion of establishment of new CHS/ASC to ensure availability of such machines to the farmers at the time of crop harvesting.

Straw baler

Straw reaper/combine

Happy seeder

Rotary disc no till drill

Laws and legislation

1. Developing a crop residues management policy for each state defining clearly various competing uses.
2. Developing and implementing appropriate legislation on prevention and monitoring of on-farm crop residues burnings through incentives and punishment.

3. Supplying machineries for conservation agriculture on subsidized rates, promoting custom hiring systems and providing soft loans for purchase of implements.
4. Introducing C-credit schemes to benefit the farmers who follow conservation agriculture for carbon sequestration and greenhouse gas emissions mitigation.

Government Direct Intervention (Need Proper & Timely Enforcement of Rules and Laws)

Some of the laws are in operation to regulate the pollution

1. The Air Prevention and Control of Pollution Act, 1981;
2. The Environment Protection Act, 1986;
3. The National Tribunal Act, 1995;
4. The National Environmental Tribunal Act, 1995
5. The National Environment Appellate Authority Act, 1997, (Particularly, in the states of Rajasthan, Uttar Pradesh, Haryana and Punjab; stringent measures have been taken by the National Green Tribunal (NGT) to limit the crop residue burning)

Policy Interventions for Residue Management and to curtail burning

1. Implementation Existing Policies to Control Air Pollution through State Pollution Control Board (Laws & Enforcement)
2. Agriculture Councils, State Council for Science & Technology for- Crop diversification, Residue incorporation or Retention through ZT drill or Happy/Turbo Seeder
3. Use for power generation- State Energy Development Agency
4. Paddy straw as source of protein enriched fodder for livestock after fermentation and bio-methanization
5. State Agricultural Universities to design, multiply and demonstrate/scale farmers friendly residue management equipment's like; Happy Seeder for planting in standing paddy stubbles; Tractor Operated Paddy Straw Chopper; Straw Collector and Balers; Residue Incorporation in Soil; Compositing Techniques using Paddy Straw

National Schemes and Policies Already in Place Need to Make Awareness in Public

1. To encourage optimum utilization and in-situ management of crop residue, to prevent loss of valuable soil nutrients, and diversify uses of crop residue in industrial applications.
2. Develop and promote appropriate crop machinery in mechanized farming practices with ample discounts and incentives for purchase.
3. Use satellite-based remote sensing technologies to monitor crop residue management with the National Remote Sensing Agency (NRSA), State Remote Sensing Agency (like HARSAC) and Central Pollution Control Board (CPCB).

4. Provide financial support through multi-disciplinary approach and fund mobilization in various ministries for innovative ideas and project proposals to accomplish above.

CONCLUSIONS

- Crop residue burning is emerging as a major problem in agriculture and a cause for environmental pollution and global warming.
- The residue ablaze can be decreased by adoption of conservation agriculture practices- residue retention, incorporation, mulching, composting etc.
- Innovative mechanization (super SMS, happy seeder) can ease in situ crop residue management and is widely adopted as it is economical, feasible and sustainable.
- There are many effective sustainable uses of crop residues- bioethanol production, biomass energy, urea treated straw etc.
- Crop residue can also be formulated into value added products- providing income and employment to the youth and profitable returns to the farmers.

REFERENCES

Arora, V.K., Singh, C.B., Sidhu, A.S. and Thind, S.S., 2011. Irrigation, tillage and mulching effects on soybean yield and water productivity in relation to soil texture. *Agricultural Water Management*, *98*(4), pp.563-568.

Choudhary, M., Dhanda, S., Kapoor, S. and Soni, G., 2009. Lignocellulolytic enzyme activities and substrate degradation by Volvariella volvacea, the paddy straw mushroom/Chinese mushroom. *Indian Journal of Agricultural Research*, *43*(3), pp.223-226.

Gupta, P.K., Sahai, S., Singh, N., Dixit, C.K., Singh, D.P., Sharma, C., Tiwari, M.K., Gupta, R.K. and Garg, S.C., 2004. Residue burning in rice–wheat cropping system: Causes and implications. *Current science*, pp.1713-1717.

Ioannidou, O. and Zabaniotou, A., 2007. Agricultural residues as precursors for activated carbon production—a review. *Renewable and sustainable energy reviews*, *11*(9), pp.1966-2005.

Jain, A.K., 2016, March. Residue crop (paddy straw) burning shrouds NCR. In *Proceedings of the 2nd international seminar on utilization of non-conventional energy sources for sustainable development of rural areas, ISNCESR. Parthivi College of Engineering & Management, CSVT University, Bhilai, Chhattisgarh, India* (Vol. 16).

Kumar, K., & Goh, K. M. 2015. Crop residues and management practices: Effects on soil quality, soil nitrogen dynamics, crop yield, and nitrogen recovery. *Advances in Agronomy,* 68, 197–319.

Ramanathan, V. and Carmichael, G., 2008. Global and regional climate changes due to black carbon. *Nature geoscience*, 1(4), pp.221-227.

Singh, M., Sidhu, H.S., Singh, Y. and Blackwell, J., 2011. Effect of rice straw management on crop yields and soil health in rice-wheat system. *Conserv Agric Newsl PACA*, *18*, p.2011.

Tabatabai, M. A. (1994). Soil enzymes. In A. L. Page, R. H. Miller, & D. R. Keeney (Eds.), Methods of soil analysis Madison: American Society of Agronomy. 775–833.

Verma, S. S. (2014). Technologies for stubble use. *Journal of Agriculture and Life Sciences,* 1(1), 106–110.

Direct Seeded Rice: What, Why and How?

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Rice (*Oryza sativa* L.) is the principal food crop for around 3.5 billon people throughout the world, most proportion of which is produced by the Asian continent (FAO, 2009). It is cultivated 2700 ft. above mean sea level. At present, about 114 countries grow rice and more than 50 countries have an annual production of 0.1 million tons or more (FAO, 2010). Currently, it is the staple food of almost 3 billion people, which accounts forabout 50% of the World's population.India is the leading country in the world in terms of area under rice crop,covering total area 43.79 mha with production 116.42 Million Ttonnes during 2018-19.Globally, its cultivation is achieved by multifold techniques but in India, conventional method i.e. puddled transplanted rice (PTR) is prevalent.Currently, transplanted puddled rice (TPR) system is widely established due to advantages like more nutrient availability (e.g. iron, zinc, phosphorus) by providing anaerobic conditions (Sanchez 1973), less weed flora (Surendra et al., 2001).

Water requirement to produce 1 kg of rice is considerably more than any other cereal crop (Bhuiyan 1992) due to loss of water through processes like seepage, evapotranspiration and percolation (Bouman and Tuong 2001). In addition, with the rise of water paucity, dropping water table and exploding labor wages, an absolute alternative is demanded. It is ceaselessly posing menace in the Indo-Gangetic plains of northwestern India which is the major belt of rice and wheat production, to meet the sustainable rice production (Humphreys *et al.,* 2010). Due to ongoing pandemic, laborers shortage occurs throughout the nation, makes the situation worsen. Consequently, DSR (Direct seeded rice) is a possible solution and farmers have evinced keen interest in the technology. In the traditional transplanting system (TPR), puddling creates a hard pan below the plough-zone and reduces soil permeability. It leads to high losses of water through puddling, surface evaporation and percolation. Water resources, both surface and underground, are shrinking and water has become a limiting factor in rice production (Farooq *et al*., 2009a). As a result, it is the one of the possible choices to cope up with above glitches which encompasses rice cultivation by directly sowing the seed in the main field, instead of transplanting the seedling from nursery.

What is DSR?

Before green revolution landed, most of the area under rice employed direct seeding technique (Pandey and Velasco 2005; Rao et al., 2007) that involved raising of rice crop by directly sowing the seeds in the main field rather than transplanting one-month old saplings (Farooq et al., 2011). Generally, it avoids some tedious operations such as a) Puddling- The practice of mechanized seed-bed preparation under conditions of water stagnation or constant flooding usually carried to alleviate water percolation (downward movement) and seepage (lateral movement) by churning the clay particles and to increase the soil porosity. Transplanting- It is a process of uprooting the rice seedling grown in nursery area(via close placement of seeds) to finally grow in the main fieldafter about 30-35 DAS. Relying upon resources availability, DSR system can be primarily achieved by three methods viz. 1) wet seeding, 2) dry seeding and 3) water seeding. Wet seeding includes sowing of pre-germinated seed in standing water/puddled soil. Dry seeding is drilling or broadcasting of seeds on well prepared seedbed over un-puddled soil whereas water seeding refers to drilling of seeds in the stagnated water.

Wet seeding/Wet-DSR is commonly practiced in cases of labor paucity and can be predominately seen in Malaysia, Thailand, Vietnam, Philippines and Sri Lanka (Pandey and Velasco 2002; Weerakoon et al., 2011) while Dry seeding or Dry-DSR is most suitable for regions with less availability of water such as rainfed upland ecosystems in many Asian countries. Water seeding is chiefly adopted to avoid heavy damage by objectionable weeds such as weedy rice and is extensively followed in the US (Joshi et al 2013). Presently, in Asia, DSR occupies around 29 Mha area (Pandey and Velasco, 2002) covering rainfed uplands, lowlands, and flood-prone areas, whereas wet seeding is commonly practiced in irrigated areas (Azmi et al., 2005; De Dios et al., 2005). Direct seeding in saturated soil has been largely accomplished in S. Brazil,Venezuela, Chile,few Caribbean countries, Cuba and certain areas of Colombia (Fischer and Antigua 1996).Various modulations in tillage/land preparation and crop establishment (CE) according to site-specific requirements, exist in DSR, but has gained littleacceptance, besides its' recommendations over TPR by numerous research studies (Farooq *et al*., 2008; Singh *et al*., 2005b). Farmer can adopt the below mentioned DSR methods (Table1), suitable for farm and climate conditions.

Table 1: Various systems of DSR (Source: Joshi *et al* 2013)

DSR system	Land condition	Soil ecology	Method of sowing	Suitable areas
Dry seeding	Dry seeds are used for sowing in dry soil	Commonly aerobic	Drilling or Broadcasting	Rainfed, irrigated areas with water conservation practices
Wet	Pre germinated	Aerobic or	Several	Rainfed

seeding	seeds are used for sowing in puddled soil	anaerobic		lowlands, irrigated areas with good drainage system
In standing water	Dry or pre germinated seeds are used for direct seeding in standing water	Commonly anaerobic	Broadcasting of seeds in standing with depth of 5 to 10 cm	Areas with heavy infestation of weedy rice, irrigated lowlands with proper land leveling system

Why DSR?

No doubt, the puddling process aids to suppress the harmful weeds by sustaining anaerobic conditions (Singh *et al*.,1995). But unfortunately, the PTR technique has turned into peril for parched areas because of its labor, energy and water intensive nature confronting less profit and overutilization of natural resources. The higher water requirement, continuous water stagnation and methane emissions from puddled rice adversely engenders soil physical problems in soil like poor aggregation, reduced permeability, hardpan formation, surface compaction and crusting, which in combination, down regulate the succeeding crops' performance. Since the water resources are constantly dwindling (Farooq *et al*., 2009), the revenue under PTR is declining due to more labor cost and water constraints (Chan *et al.,* 1993; Pandey *et al* 1999), therefore, switching to DSR is important for saving irrigation water, labor and production costs and to maximize net economic returns. Some of the key drivers are as follows:

1. **Less water requirement:**

Under irrigated conditions, transplantation of rice seedling in the puddled soil is followed (Pandey and Velasco 1999) where, the field is subjected to constant water stagnation at pre-harvesting stage that require relatively higher water inputs than other technologies. Rice crop consume 50 percent of the total irrigation water in Asia (Barker *et al.* 1998), 24-30% of total freshwater and 34-43% of irrigation water, globally (Bouman *et al.* 2007) leads to overutilization of natural resources. Therefore, large water demand for rice cultivation is expected to cut back the available supply of water in the very near future. Many districts under rice-wheat area of Haryana, India, have shown 3–10 m decline in the ground water table over the last twenty years. DSR rice on the other side, can establish well with 150 mm irrigation water or rain as compared to 450 mm water needed for transplanting. Further, since deeper root system of DSR is

more proficient at using soil moisture, thus, less frequent irrigation is needed throughout the growing season. Direct seeding, therefore, declines water consumption by about 30- 55% (0.9 million liters per acre) with the soil kept near field capacity and by avoiding the practices of raising seedlings in the nursery, puddling, transplanting and water stagnation for 4-5 inches of water at the base of the transplanted seedlings (Joshi *et al* 2013, Lav Bhushan *et al.,* 2007).

2. Less labor requirement:

The conventional tillage (CT-TPR) requires intensive labor in the critical operations like nursery raising, puddling, uprooting seedlings or transplanting which can be evaded by practicing direct seeding (both wet and dry) (Pepsico International, 2011) that helps in making thorough use of family members than hired manual or machine labor.

Table 2: Comparison of TPR and DSR in Jalandhar, Punjab

Parameter (ha-1)	DSR	Transplanted
Crop duration (day)	130-140	140-150
Tractor (hours)	5-6	10-12
Human labour (man days)	35-40	55-60
Global warming potential (Mg CO2 eq.)	1.3-3.0	2.0-4.5
Number of irrigation	14-17	20-25
Benefit (`)	17000-20000	14000-17000

3. More annual income of farmers:

The huge water inputs, labor requirements and cost for TPR tremendously narrow the profit margins (Pandey and Velasco, 1999). In previous years, there have been several concerns regarding labor shortage, which uplifted the transplanting costs that subsequently swapped the TPR with DSR. Generally, direct seeding seems to benefit the large farmers in saving the expenses on manual and machine labor, fuel and maintenance cost of machines. It has been examined through research that adopting DSR for lowland regions would considerably decrease the costs of production (Flinn and Mandac, 1986) and will possibly meet the timely sowing of succeeding crop due to 7 – 10 days early maturing of rice crop than PTR. In addition, the recent shift to DSR in some countries of South East Asia (Pandey and Velasco, 2002) was principally due to early maturation of DSR that permits growth of short duration wheat cultivars followed by other supplementary short duration crop can be taken for maximizing profit. For instance, in India, rice-wheat system is most common which allows the farmers to grow only two crops per annum, but DSR can increase the crop intensity. In this way, DSR

being a rapid and easy technology fits well in the various cropping systems as compared to PTR (Gill and Dhingra 2002).

4. Superior soil health:

In the post green revolution era, concerns associated to soil health and long-term sustainability are emerging throughout the tropical rice ecosystems due to depletion of soil fertility. Experimental patterns observed in yield decline/stagnation in S. Asia were almost related to soil problems in rice-rice or rice-wheat systems viz. reduction in soil carbon (C) as well as other macro- and micronutrients, heavy accumulation of Fe2+, phenolic compounds and sulfides. Intensive use of poor-quality irrigation water in rice has led to buildup of high salinity which in the short term, reduces the crop yield and, in the long term, can abandon the crop lands. Moreover, the puddling process give rise to poor soil health through antagonistic effects on physical properties of soil like compaction, reduced permeability, poor aggregate stability etc. (Gathala *et al*. 2011). Better soil structure which is otherwise destroyed by puddling can be achieved via DSR that will not only improve yield of succeeding crop but also vanishes the methanic emissions.

5. More time to manage residue:

The manner of disposing rice straw through burning is exclusively against the environment. Rice straw burned in NW states of Punjab and Haryana as estimated is 80 % and 60 %, respectively. (Pathak *et al.,*2006). Out of which the former alone, burns approximately 12 MT of rice residues annually. The straw burning is considered environmentally unacceptable due to reasons like (1) substantial release of black particles of soot and smoke that cause human health associated risks of asthma and other respiratory problems, (2) discharge of greenhouse gases including carbon dioxide, nitrous oxide methane leading to global warming and (3) erosion of essential plant nutrients viz. N, P, S and K because25% of P, 20% of K, 50% of S and almost the entire C and N in straw are lost after burning. Contrary to which, DSR being a short duration crop allows early harvesting and management of residues becomes an easy task. Direct seeding into residue retained fields, using Happy Seeder machine (developed by PAU, Punjab) can reduce the problem of straw burning.

6. Less green-house gas emission:

The methanic and nitrous oxide emission by rice production is increasingly contributing to the global climate change. The metabolic activities of specific methane producing bacterial strains proportionally upgrades in submerged or anaerobic conditions commonly developed in wetland paddy fields, which consequently qualifies the oxygen transport into the soil to render such water-saturated soils pragmatically devoid of oxygen. It has been asserted that the mean global warming potential (GWP) due to three greenhouse gases viz. CO2, NO2 and CH4 in PTR was 2.91 Mg ha-1 as compared to 1.9 Mg ha-1 in DSR (Pathak *et al.* 2011, unpublished).Therefore, DSR is counted as an environmentally feasible alternative to conventional PTR for ameliorating the climate

change. The trend of reduction in methanic emissions in various methods is - PTR (Transplanted rice) > WDS (wet direct seeding >DDS (dry direct seeding)

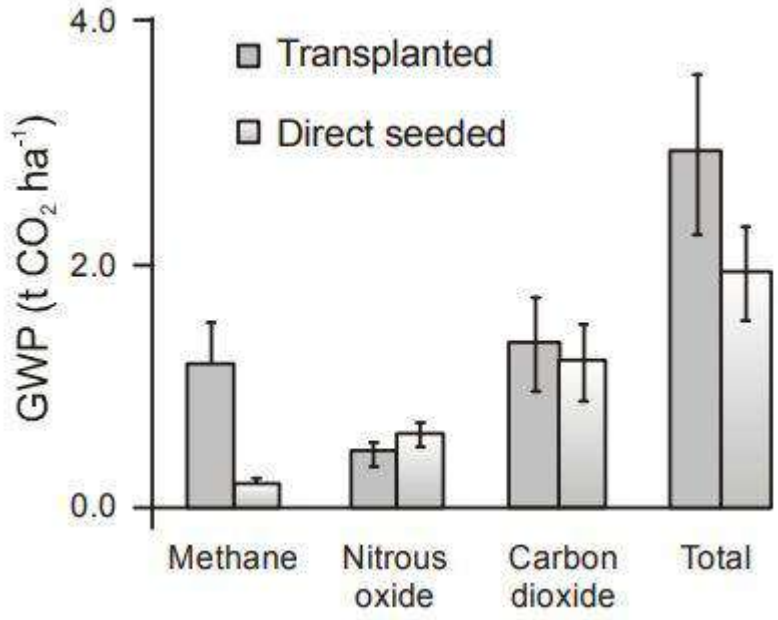

Figure 1. DSR and TPR under global warming potential (Source: Pathak *et al. 2011*, unpublished)

How DSR?

1. **Land preparation-** Land/ seedbed preparation by ploughing the fields during summer season is a pre-requisite for better crop husbandry. Under DSR, precision land leveling is advantageous for better germination, weed control, uniform irrigation that increases water use efficiency (WUE)along with improved grain yield.
2. **Time of sowing -**Success of DSR thoroughly relies upon the optimum time of sowing rice during the kharif season which should be completed 10-15 days before the onset of monsoon for facilitating the early root establishment and to avoid the emerging weeds along with timely sowing of next crop. Since the monsoon arrival time varies from West Bengal to Punjab therefore, the best time of sowing extends from end May up to third week of June.
3. **Selection of varieties-** Selection of cultivars according to the soil type and irrigation availability plays an efficient role to procuring the desired yield. Early to medium maturing varieties (100 –135 days) are most suitable for light textured sandy-loam soils, while the late maturing varieties (135-165 days) adapt to heavy textured clay.Various cultivars established so far befitting to different regions, states, and planting time (Table 3) finely possess the following traits:

- Early emergence under rainfed conditions through breaking up the hard crust.
- High vigor index for suppressing the competing weeds (Jannink et al., 2000; Zhao et al., 2006).

- Proficient root system to facilitate water and nutrient uptake (Clark *et al*., 2000; Pantuwan *et al*., 2002).
- Moderate to high yield.

Table 3: Suitable varieties for different areas (Source: Joshi *et al.* 2013)

Region	Recommend cultivars for DSR
Cambodia	Koshihikari, W42 (Tuong 2008)
Nepal	SonaMasuli, Hardinath, Radha–4, Radha–11, Chaite 2 (Shah and Bhurer 2005)
Thailand	IR57514-PMI-5-B-1-2, IR20 (Naklang et al., 1996)
Japan	RS-15, RS-20 (Tanno et al., 2007)
Eastern Uttar Pradesh (India)	Aditya, NDR–359, Sarjoo–52, Mahsoori, Swarna,, Moti, Pusa–44, KRH-2
Punjab, Western U.P and Haryana (India)	Pusa–1121, Pusa Sugandh-5, PRH–10, Pusa Basmati–1, Pant Dhan–12, Sharbati, PHB–71, Kanchan, Kalinga-3, Heera, Pathra, Sneha, Sahbhagi, Birsa dhan –101, 104,105, 201 and 202, Saket-4, VLK dhan, Kranti, Satya , PR-126
Bihar (India)	Satyam, RajendraMahsuri–I, NDR–359, Prabhat, Birsa dhan-101, Birsa dhan -104
Tarai of Uttaranchal(India)	Nidhi, Narendra–359, Sarvati, PR–113, Sarjoo–52

4. Seed priming- Water soaking of seeds for overnight and then drying in shade prior to sowing is particularly carried out to enhance the seed germination. After drying the seeds are treated with Bavistin @ 2.5 g per kg seed as a preventive measure against seed-borne diseases.

5. Seed rate, spacing and depth-The optimum seed rate using zero till drill, for fine and coarse basmati rice is 15-20 kg per ha and 20-25 kg per ha respectively, whereas for hybrids it is 8-10 kg per ha. However, for proper spacing (20cm) and reduced seed rate, cupped metering system or plate devices has proved to be is very useful. But, a higher seed rate of 25-30 kg ha-1 is required in broadcasting. Seeding depth positively influences germination and should not exceed 3 cm deep for achieving desired crop stand as seed placement below 3 cm badly affects the seed emergence due to drying of the upper soil layer.

6. Water management-In natural conditions, an adequate pre-monsoon rain between mid-May to mid-June occurs which can be effectively utilized to kill the first flush of emerging weeds using non-selective herbicides like glyphosate and paraquat for sowing DSR crop via zero till drill. But in case of no rain during mid-May to mid-June, a pre-sowing irrigation is very important. Indeed, no irrigation is needed following seedling to crop emergence and soil should be kept moist after sowing till emergence. During crop emergence, one or two irrigations are required. After the onset of rains, no further irrigation is required unless period of dry spell occurs, under which life-saving

irrigations are given during the critical growth stages of crop including tillering, panicle formation, flowering, milking and grain filling. Moreover, irrigation at alternate wetting and drying is the most economical for reducing crop lodging and improving the root system.

7. Nutrient management-Nutritional requirement can be meet through soil analysis of the field or fertilizer scheduling. Blanket application of N @ 120-150 kg ha-1, P2O5 @ 60 kg ha-1 and K2O @ 40 kg ha-1 may be applied in addition toZnSO4 @ 25 kg ha-1. In light soil, one fourth N and whole of P2O5 and K2O is applied as a basal dose. The remaining N should be top dressed in two splits first at maximum tillering and second at panicle initiation stage. In clay loam soil, full P2O5 and K2O and half N along with S and Zn should be applied as basal dose and remaining N same as applied in light soils. Iron deficiency causing leave chlorosis is a major problem in DSR sown in light textured sandy loam soils leaves which can be ameliorated through the spray of FeSO4. DAP and NPK are applied in the form of basal dose with the help of zero till ferti-drill machine.

8. Weed management -The DSR, conditions are the most conducive for weed emergence during rainy season, which competes with the rice crop for moisture, light, nutrients and lead to severe grain yield losses, which makes the task of weed free environment throughout crop period, a difficult rather uneconomical task in DSR. Spray of 0.5% glyphosate, two days before sowing or preparation of stale seed bed can knock down the pre-germinated weeds while the second flush can be uprooted manually. It has been experimentally demonstrated that providing weed free conditions during 2-6 weeks after sowing led to attainment of optimum grain yield in DSR.

Based on trials conducted by different SAUs in collaboration with IRRI, the following herbicides are found effective against annual and perennial species of weed in DSR (Tewari et al., 2009, unpublished).

Table 4: Dose and time of application of selective herbicides against target weeds

Herbicide	Dose kg/ha	Target weed	Time of application
Glyphosate	1.2-1.6	All types of weeds	7-15
Pretilachlor	1.5	All types of weeds	1-2
Pendimethalin	1.0	Grasses, broad leaves	1-2
Paraquat	0.5	All types of weeds	1-2
2,4-D	0.5	Sedges and broadleaved	20-25
Ethoxysulfuron	15	Sedges and broadleaved	10-15

Table 5: Objectional weeds of DSR system in Indo-Gangetic plains

Category	Species
Broad leaf weeds	*Echinochloa colona, E.Crusgalli, Digitaria sanguinalis, Dactyloctenium aegyptium, Leptochloa chinensis, Elusine indica, Cynodon dactylon, Paspalum distinchum, Ischaemum rugosum*
Grassy weeds	*Trianthema monogyna, Commelina benghalensis, Caesulia axillaris, Sphenoclea zeylaica, Marsila minuta, Ludwigia spp., Monochoria vaginalis*
Sedges	*Cyperus rotundus, Cyperus iria, Fimbristylis littoralis, Cyperus difformis, Scirpus juncoides*

CONCLUSION

The energy-, water-, and labor-intensive nature of conventional puddled transplanted rice has uplifted the problem of environmental pollution and groundwater depletion. So, in alternative to this, direct seeded rice needs to be adopted because it is economically and technically feasible and is environmentally safe. The seed priming technique functions as a catalyst in speeding up the germination rate. Moreover, the practices including stale seed bed, low herbicide application along with the better understanding of disease and pest dynamics have not only increased the farmer's income but also the quality of the grain yield.

REFERENCES

Azmi M, Chin DV, Vongsaroj P, Johnson DE (2005) Emerging issues in weed management of direct-seeded rice in Malaysia, Vietnam, and Thailand. In: Rice is life: scientific perspectives for the 21st century. In: Proceedings of the world rice research conference, Tsukuba, Japan, 4–7Nov 2004, pp 196–198

Barker, R., Dawe, D., Tuong, T. P., Bhuiyan, S. I., and Guerra, L. C. (1998). The outlook for water resources in the year 2020: Challenges for research on water management in rice production. In "Assessment and Orientation Towards the 21st Century". 7–9 September 1998. Proceedings of 19th Session of the International Rice Commission, Cairo, Egypt, FAO, pp. 96–109.

Bhuiyan SI (1992) Water management in relation to crop production: case study on rice. Outlook Agric 21(4):293–299

Bouman BAM, Lampayan RM, Tuong TP (2007) Water management in irrigated rice: coping with water scarcity. International Rice Research Institute, Los Baños, 54 p

Bouman BAM, Tuong TP (2001) Field water management to save water and increase its productivity in irrigated rice. Agric Water Manag 49:11–30. doi: 10.1016/S0378-3774(00)00128-1

Bouman, B. A. M., Lampayan, R. M., and Tuong, T. P. (2007). Water Management in Irrigated Rice: Coping with Water Scarcity. International Rice Research Institute, Los Ban˜ os, Philippines, 54p.

Chan, C.C. and Nor, M.A.M. *Impacts and implications of direct seeding on irrigation requirement and systems management.* In: Paper Presented at the Workshop on Water and Direct Seeding for Rice, 14–16 June 1993, Muda Agricultural Development Authority, Ampang Jajar, Alor Setar, Malaysia (1993).

Clark LJ, Aphale SL, Barraclough PB (2000) Screening the ability of rice roots to overcome the mechanical impedance of wax layers: Importance of test conditions and measurement criteria. Plant Soil 219:187–196.Connor DJ, Timsina J, Humphreys E (2002) Prospectsfor permanent beds in the rice-wheat system. In "Improving the Productivity and Sustainability of Rice-Wheat Systems: Issues and impacts" (ladha JK , Hill JE, Duxbury JM, Gupta RK, Buresh RJ (eds.) 65:197–210. ASA Special Publication, ASA Inc., CSA Inc., SSSA Inc., Madison, WI.

De Dios JL, Javier EF, Malabayabas MD, Casimero MC, Espiritu AJ et al (2005) An overview on direct seeding for rice crop establishment in the Philippines. In: Rice is life: scientifi c perspec tives for the 21st century. International Rice Research Institute/Japan International Research Centre for Agricultural Sciences, Los Baños/Tsukuba, pp 189–193

Farooq M, Basra SMA, Asad SA (2008) Comparison of conventional puddling and dry tillage in rice–wheat system. Paddy Water Environ 6:397–404 Fischer AJ, Antigua G (1996).

Farooq M, Siddique KHM, Rehman H, Aziz T, Dong-Jin Lee, Wahid A (2011) Rice direct seeding: Experiences, challenges and opportunities. Soil Tillage Res. 111: 87–98.

Farooq, M., Basra, S. M. A., and Asad, S. A. (2008). Comparison of conventional puddling and dry tillage in rice–wheat system. Paddy Water Environ. 6, 397–404.

Farooq, M., Wahid, A., Lee, D.-J., Ito, O. and Siddique, K.H.M. Advances in drought resistance of rice. *Critical Review Plant Science* **28**: 199–217(2009)

Fischer AJ, Antigua G (1996) Weed management for rice in Latin America and the Caribbean. In: Auld BA, Kim KU (eds) Weed management in rice, vol 139, Plant production and protection paper. FAO, Rome, pp 159–179

Flinn JC, Mandac AM (1986) Wet Seeding of Rice in Less Favored Rainfed Environments Working Paper. Agricultural Economics Department, International Rice Research Institute, Los Ban˜os, Philippines.

Gathala, M. K., Ladha, J. K., Kumar, V., Saharawat, Y. S., Kumar V., Sharma, P. K., Sharma, S., and Pathak, H. (2011). Tillage and crop establishment affects sustainability of South Asian rice-wheat system. Agron. J. (In press).

Gill, M. S. and Dhingra, K. K. Growing of basmati rice by direct seeding method in Punjab.*Indian Farmer's Digest* **13**: 141(2002). 37. Gill, M. S., K

Humphreys, E., Kukal, S. S., Christen, E. W., Hira, G. S., Balwinder-Singh, Sudhir-Yadav, and Sharma, R. K. (2010). Halting the groundwater decline in north-west India—Which crop technologies will be winners? Adv. Agron. 109, 155–217.

Jannink, J. L., Orf, J. H., Jordan, N. R., and Shaw, R. G. (2000). Index selection for weed-suppressive ability in soybean. Crop Sci. 40, 1087–1094.

Joshi, E., Kumar, D., Lal, B., Nepalia, V., Gautam, P., & Vyas, A. K. (2013). Management of direct seeded rice for enhanced resource-use efficiency. *Plant Knowledge Journal*, *2*(3), 119.

Lav Bhushan, Ladha JK, Gupta RK, Singh S, Tirole-Padre A, Saharawat YS, Gathala M and Pathak H, 2007. Saving of water and labor in rice-wheat system with no-tillage and direct seeding technologies. Agronomy Journal 99: 1288-1296.

Pandey, S., and Velasco, L. (2002). Economics of direct seeding in Asia: Patterns of adoption and research priorities. In "Direct Seeding: Research Strategies and Opportunities" (S. Pandey, M. Mortimer, L. Wade, T. P. Tuong, K. Lopez, and B. Hardy, Eds.), pp. 3–14. International Rice Research Institute, Los Ban˜ os, Philippines.

Pandey, S., and Velasco, L. (2002). Economics of direct seeding in Asia: Patterns of adoption and research priorities. In "Direct Seeding: Research Strategies and Opportunities" (S. Pandey, M. Mortimer, L. Wade, T. P. Tuong, K. Lopez, and B. Hardy, Eds.), pp. 3–14. International Rice Research Institute, Los Ban˜ os, Philippines.

Pandey, S., and Velasco, L. (2005). Trends in crop establishment methods in Asia and research issues. In "Rice Is Life: Scientific Perspectives for the 21st Century" (K. Toriyama, K. L. Heong, and B. Hardy, Eds.), pp. 178–181. International Rice Research Institute, Los Ban˜ os, Philippines and Japan International Research Center for Agricultural Sciences, Tsukuba, Japan.

Pandey, S., Velasco, L. E., and Suphanchalmat, N. (2002). Economics of direct seeding in northern Thailand. In "Direct Seeding: Research Strategies and Opportunities" (S. Pandey, M. Mortimer, L. Wade, T. P. Tuong, K. Lopez, and B. Hardy, Eds.), pp. 139–150. International Rice Research Institute, Los Ban˜ os, Philippines.

Pantuwan G, Fukai S, Cooper M, Rajatasereekul S, and O'Toole JC (2002) Yield response of rice (*Oryza sativa* L.) genotypes to different types of drought under rainfed lowlands. Plant factors contributing to drought resistance. Field Crops Res. 73:181–200.

Pathak H, Singh R, Bhatia A and Jain N, 2006. Recycling of rice straw to improve crop yield and soil fertility and reduce atmospheric pollution. Paddy Water Environment 4: 111-117.

Health Beneficial Properties and Uses of Kitchen Herbs

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Herbs are leafy or soft flowering parts of plants used to add flavour or aroma to food and beverage. These are normally known as culinary or kitchen herbs, in contrast to other herbs which are used for different purposes, such as medicinal herbs, cosmetic herbs, sweet herbs, salad herbs, etc. Kitchen herbs are used in flavouring or seasoning wide variety of food products. Herbs contain low amounts of protein and carbohydrate, and are rich in water, vitamins and minerals. Their fat content is low, but their taste is good because of aromatic compounds. Herbs are used in cooking to improve flavor. Coriander leaves, mint, thyme, parsley, basil and dill are used in cookery. They also give health advantages.

Health benefits of kitchen herbs : (Opara and Chohan, 2014)

- Because of the low glycemic index of kitchen herbs, they are highly useful for diabetic and obese people.
- Due to the presence of dietary polyphenols, they are known to posses a number of properties associated with reducing the risk of developing chronic non-communicable diseases.
- Many herbs are used as blood purifiers to alter or change a long-standing condition by eliminating the metabolic toxins. These are also known as blood cleansers.
- Herbs improve the immunity of the person, thereby reducing conditions such as fever.
- It exhibits anti-oxidative as well as anti-inflammatory properties.
- They play an important role in providing protection against cardio-vascular diseases, neuro-degenerative diseases, cancer and type 2 diabetes.
- Herbs contain powerful bioactive components that might be effective for preventing cancer.

FORM OF HERBS

The flavor and aroma of herbs are due to the presence of essential oils that are complex organic compounds produced by the plants. These essential oils are the volatile

compounds that get evaporated with heat. They also evaporated during storage, although quite slowly, especially if kept in cool place. For the full release of flavours and aromas, different kinds of herbs behave differently depending on their condition and inherent characteristics. This difference is referred to as the aggregate form of herbs that can be divided as follows:

Fresh Herbs

These are best used in their fresh state since their flavors are easily lost soon after picking them from plants. So, it is best to pick these herbs when they are needed for use. If brought herbs are used, they should be kept as fresh as possible. The best method is to store these fresh herbs in the refrigerator in sealed plastic bags so that the leaves do not become dry out.

Dried Herbs

Herbs dried before use are most suitable for both industrial processing as well as for direct use, especially in food industry. They have a more pronounced flavor as compared to fresh state. However, not all the herbs can be dried; some herbs are simply unsuitable for drying. Examples for such type of herbs include dill, parley, and fennel. Commercially available dried herbs are either ground or chopped into small pieces. They are packed into small bottles equipped with numerous holes for sprinkling.

Freeze-dried Herbs

There are herbs that can be freeze-dried. Although, the freeze-dried herbs considerably more expensive than conventionally dried herbs, but, they retain both flavour and colour much better and resemble fresh herbs since they have absorbed some of the cooking liquid.

Health Benefits and Common Uses of Kitchen Herbs

Herbs	Characteristics	Common uses	Health Benefits
Basil	Sharp, refreshing green leaf with hints of mint, anise and pepper	Sauces, vegetables, salads, herb vinegars, pasta dishes	Anti-oxidant, inhibits lipid peroxidaion, decreases inflammation.
Chives	Tender green shoots with faint onion and scallion flavor	Soups, chowders, egg dishes for garnishing	Anti-oxidant, anti-microbial.
Coriander leaves	Pungent flavor	Salsa, poultry, sausages, vegetables, sambar, curries, chutneys	Anti-oxidant, digestive aid.
Dill	Refined feathery green strands with distinctive lemony	Sauces, salads, yogurt, dips	Anti-oxidant, anti-microbial.

	caraway flavor		
Lemon grass	Sturdy, pale green, mild lemony flavor	Stir fries, soups, chicken and fish dishes	Anti-oxidant, anti-cancer properties, anti-inflammatory.
Mint	Dark green leaves with refreshing palate-cleansing taste	Pulao, chutneys, raitha, vada and for flavouring confectionary	Improve irritable bowel diseases, improves digestion and also improves brain function.
Parsley	Refreshing flavor with grassy undertones	Soups, dressings, sauces, dips, marinades	Anti-oxidant, anti-microbial.
Rosemary	Narrow needle like leaves with a fragrant evergreen scent	Lamb, pork, poultry dishes	Anti-oxidant, inhibits bone resorption, anti-carcinogen, anti-inflammatory.
Sage	Pale green leaves with earthy musky flavor	Poultry stuffing, vegetable and legume dishes	Anti-septic, Anti-biotic, Stimulate central nervous system and digestive tract.
Thyme	Tiny greenish gray petals with a pungent earthy flavor	Potato and fish chowders, vegetable dishes	Anti-oxidant, inhibits bone resorption.
Curry leaves	Small shrub whose leaves resemble with bay leaves.	Chutneys, curry, sambar, pickles, meat and fish dishes, fried foods and buttermilk preparations	Anti-lipidemic effect and have low glycemic effect.

Herb Products

There are various herb products that can be derived from natural kitchen herbs. These products includes**:**

Ground Herbs : The herbs can be dried and ground into various-sized products, from coarse to fine and powder forms depending on the nature of herbs and the purpose. Further, they can be packed in a small bottle, whose inner cap should be perforated by holes that can allow the ground spices to come through by shaking.

Herb Teas: Herbs can also be processed into a product ready to be used, such as to make tea. There are two methods to make herbal teas:

1. **Tea Bag**: This can be made by packing small amount of ground herbs in special paper bags. They can be made from one type of herb or also from blending two or more herbs. These bags can be made into a drink by infusion, i.e. by placing the bag into hot water, or by decoction, i.e. by boiling the bag in water.

2. **Spray Drying**: This can be done by using the modern equipment named spray-drier, reliable on the same method used in making spray-dried coffee. In this method, the herbs are boiled and concentrated, and finally placed in the spray drier equipment to make powder form. The end product is in the powder form, which can be easily dissolved in hot water.

Herb Juices: Juices made from herbs provides good colour and aroma and these herb juices can be further used to add flavor and colour in sauces.

Herb Vinegars: Vinegars flavored with herbs can also be prepared to give extra taste to salad dressings and sauces, e.g. basil vinegar, dill vinegar.

Herbal Drinks: Drinks flavored with herbs made by pounding fresh herbs and other ingredients such as sugar, salt, etc. are often added to give specific taste.

CONCLUSION

As herbs are natural products, so they are free from side effects, they are comparatively safe, eco-friendly and locally available. There are lot of herbs that can be used for the ailments related to different seasons. So, there is a need to promote them to save the human lives. Kitchen herbs can be used to prepare various herbal products that can be typically used in an effort to maintain or improve human health. These herbal products are today the symbol of safety due to their medicinal properties.

REFERENCES

Chomchalow, N. 2002. Production of Herbs in Asia: An Overview. *Journal of Herbal Medicine*, **6** (2): 95-108.

Esiyok, D., Otles, S. and Akcicek, E. 2004. Herbs as a food Source in Turkey**.** *Asian Pacific Journal of Cancer Prevention*, **5**: 334-339.

Opara, E. I. and Chohan, M. 2014. Culinary herbs and spices: their bioactive properties, the contribution of polyphenols and the challenges in deducing their true health benefits. *International Journal of Molecular Sciences*, **15**: 19183-19202.

Srilakshmi, B. 2010. Spices and Herbs. Food Science (5thed). New Age International Limited Publishers, pp_258-260.

Zheng, W. and Wang, S. Y. 2001. Antioxidant activity and phenolic compounds in selected herbs. *Journal of Food Chemistry*, **49:** 5165-5170.

Role of Trap Cropping in Insect Pest Management

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ABSTRACT

The concept of trap cropping fits into the ecological framework of habitat manipulation of an agro-ecosystem for the purpose of pest management. Various methods alter the habitat as a part of an integrated pest management (IPM) strategy, and such manipulation can occur either within a crop, a farm, or at a landscape level. Prior to the introduction of modern synthetic insecticides, trap cropping was a common method of pest control for several cropping systems. The recent resurgence of interest in trap cropping as an IPM tool is the result of concerns about potential negative effects of pesticides on human health and the environment, pesticide resistance, and general economic considerations of agricultural production.

Keywords: Chemical pesticides, integrated pest management, trap crop, push-pull strategy

INTRODUCTION

Trap crops have been defined as "plant stands grown to attract insects or other organisms like nematodes to protect target crops from pest attack, preventing the pests from reaching the crop or concentrating them in a certain part of the field where they can be economically destroyed" (Hokkanen,1989).

MODALITIES OF TRAP CROPPING:

A. **Modalities Based on the Trap Crop Plant Characteristics:**

1. **Conventional Trap Cropping:**

A trap crop planted next to a higher value crop is naturally more attractive to a pest as either a food source or oviposition site than the main crop. Thus preventing or making less likely the arrival of the pest to the main crop and or concentrating it in the trap crop where it can be economically destroyed.

Shivayogeshwara *et al*. (2001) Reported marigold as trap crop for management of *H. armigera* in tobacco showing lowest foliage loss. They also found that single-whorled orange flower trapped higher number of eggs of *H. armigera* than multi-whorled flowers.

2. Dead-End Trap Cropping:

Plants are highly attractive to insects but on which they or their offspring cannot survive. Such crops serve as a sink for pests, preventing their movement from the trap crop to the main crop. Lu *et al.* (2004) found that the potential of wild crucifer *Barbarea vulgaris* serve as a dead-end trap crop for the diamondback moth *Plutella xylostella*.

3. Genetically Engineered Trap Cropping:

'Use of Genetically modified plants with improved quality to serve as trap crop'. This modality of trap cropping may not be considered unique and itself because it can produce plant characteristics that fit other modality we describe. However, because of it present importance and growing potential, we believe it bear special consideration. There are already examples of genetic engineering in trap cropping and its importance in the development and improvement of trap crop is likely to increase in the future.

Mitchell *et al*. (2000) reported that planting genetically modified collards along field peripheries as a trap crop may be a promising tactic to manage the diamondback moth in commercial cabbage.

B. Modalities Based on the Deployment of the Trap Crop

1. Perimeter Trap Cropping:

The use of a trap crop planted around the border of the main crop. The use of field margin manipulation for insect control is becoming common in IPM programs and is similar in practice to the early use of traditional trap cropping using borders of more attractive plant.

Rao *et al*. (1994) reported that raising two rows of *N. rustica* around flue-cured tobacco was effective against *H. armigera*.

2. Sequential Trap Cropping:

Trap crops that are planted earlier and / or later than the main crop to attract the targeted insect pest. This modality involves trap crop that are planted earlier and or later than the main crop to enhance the attractiveness of the trap to the targeted insect pest. Hoy *et al*. (2000) reported use of an early-season trap crop of potatoes to manage Colorado potato beetles.

3. Multiple Trap Cropping:

It involves planting several plant species simultaneously as trap crops with the purpose of either managing several insect pests at the same time or enhancing the control of one insect pest by combining plants whose growth stages enhance attractiveness to the pest at different times. Muthiah (2003) reported the use of a

mixture of castor, millet, and soybean to control groundnut leafminer, *Aproarema medicella*.

4. Push-Pull Trap Cropping:

The push-pull or stimulo-deterrent diversion strategy is based on a combination of pull and push components. The trap crop (Pull component) attracts the insect pest and combined with the repellant intercrop (Push component), diverts the insect pest away from the main crop.

A push pull strategy based on using either Napier or Sudan grass as a trap crop planted around the main crop, and either desmodium or molasses grass planted within the field as a repellent intercrop, has greatly increased the effectiveness of trap cropping for stem borers in maize (Khan *et al*., 2001).

C. Additional Trap Cropping Modalities:

1. Biological Control-Assisted Trap Cropping:

A part from diverting the insect pests away from the main crop, trap crops can also reduce insect pest populations by enhancing populations of natural enemies. Patel (1991) reported that marigold when planted with tomato gave higher egg parasitism in *H. armigera* by *T. chilonis* as compared to tomato alone. Khan *et al*. (1997) also reported higher parasitism of stem borers by *Cotesia seasamea* in maize when intercropped with molasses grass. Purcell *et al*. (1992) reported the potential of *Steinernema carpocapsae* for minimizing damage to corn ears by controlling *H. zea.*

2. Semiochemically Assisted Trap Cropping:

They are either trap crops whose attractiveness is enhanced by the application of semiochemicals or regular crops that can act as trap crops after the application of semio-chemicals. Nesnerova *et. al*. (2004) demonstrated that semi synthetic pheromone formulation attracted males of *M. brassicae* even at low population densities.

APPLICATIONS OF TRAP CROPPING IN PEST MANAGEMENT:

- Use trap cropping in insect pest management has been common in entomological research.
- It includes the level of implementation of the trap crop and interpretation of whether it was successful.
- Success in preliminary laboratory, greenhouses, screen houses, or field studies may not necessarily result in a successful use at the commercial level, where additional
- Variables and different environmental condition may affect insect behavior.
- Adoption of trap cropping is also dependant on the potential economic return to the grower in a particular situation (Shelton and Badenes-Perez, 2006).

INCREASING THE EFFECTIVENESS OF TRAP CROPS

- In general, combining biological and / or insecticidal control to supplemental the effects of the trap crop can increase the effectiveness of a trap crop (Muthiah, 2003 and Patel, 2005).
- By exploiting specific characteristics of the plants which are used as a trap crop, and host preference of the target insect can be changed with reference to time (season) and space (cropping pattern).
- Enhancing the effectiveness of the trap crop is vital to minimize the land sacrificed to production when using trap cropping.
- About 10% of the total crop area is planted with trap crop, although the percentage of trap crop needed for each particular system has to be determined for each case.
- Cultural control methods can also be used to increase the effectiveness of trap crops.
- Host utilization by most insect herbivores, particularly specialists, is consistent with the resource concentration hypothesis in that they are more likely to find and remain in hosts that are concentrated (Manguire, 1983).
- Plant breeding can be used to develop trap crop cultivars with enhanced attractiveness to the insect pest and / or low larval survival, such as glossy wax trait.

FACTORS DETERMINING THE SUCCESS OF TRAP CROPPING SYSTEMS:

1) The potential success of trap cropping system depends on the interaction of the Characteristics of the trap crop and its deployment with the ecology and behavior of the targeted insect pest.
2) The combination of insect and trap crop characteristics and practical considerations determines the success of trap cropping system.
3) The most important characteristics of insects to be managed by trap crops are the insect stage targeted by the trap crop, insect's ability to direct its movement, its migratory behavior and its host-finding behavior.
4) Low proportion of trap crop in a field may not be sufficient to reduce pest populations significantly, even if the trap crop is highly attractive and results in insect arrestment.

ADVANTAGES OF TRAP CROPPING:

- Reduces the use of pesticide.
- Lower cultivation cost.
- Conservation of indigenous natural enemies.
- Improvement of the crop's quality and quantity.
- Conservation of soil and environment.

LIMITATIONS OF TRAP CROPPING:

- A limited number of cases of trap crops are implemented at the commercial level vary with the crop system and insect pest.
- In many cases, crops are attacked by a complex of insect pest and because trap crops tend to be relatively species specific makes them less practiced compared with other alternatives IPM strategies.
- Agronomic and logistical considerations associated with implementing trap crops.
- The success of trap cropping systems is highly variable often increasing the risk of economic loss of the grower.
- Trap cropping is knowledge-intensive and demands information on the temporal and spatial attractiveness of potential trap crops to maximize their effectiveness.

CONCLUSION:

Successful implementation of trap cropping has provided sustainable and long term management solutions to control difficult pests. Successes have been achieved in both developed and developing countries. With the advent of biotechnology, new opportunities for trap cropping have arisen. Traditional trap cropping methods, such as the use of mustard to manage the DBM in cabbage and the use of marigold to manage *H. armigera* in tomato are likely to be implemented at the commercial level. To develop trap cropping to its full potential, however requires a multifaceted approach involving research and extension.

REFERENCES

Chari, M. S., Bharpoda, T. M. and Patel, S. N. (1985). *Tobacco Res.*, **11**(2): 93-98.

Hokkanen, H. M. T. (1989). *Acta Entomol.*, **53**: 25-30.

Hoy, C. W., Vaughn, T. T. and East, D. A. (2000). *Entomol. Exp. Appl.*, **96**: 193-204.

Khan, Z. R., Wadhams, L. J. and Woodcock, C. M. (1997). *Nature*, **38**: 631-632.

Khan, Z. R., Pickett, J. A., Wadhams, L. and Muyekho, F. (2001). *Insect Sci. Appl.*, **21**: 375-380.

Landis, D. A., Wratten, S. D., and Gurr, G. M. (2000). *Annu. Rev. Entomol.*, **45**: 175-201.

Lu, J., Liu, Y. B., and Shelton, A. M. (2004). *Bull. Entomol. Res.*, **94**: 509-516.

Manguire, L. (1983). *Environ Entomol.*, **12** : 1415-1419.

Mitchell, E. R., Hu, G., and Johanowicz, D. (2000). *Hortscience*, **35**: 875-879.

Muthiah, C. (2003). *Indian J. Agri. Sci.*, **73**: 466-468.

Nesnerova, P., Sebek, P., Macek, T., and Svates, A., (2004). *Green Chem.*, **6**: 305-306.

Patel, R. K. (1991). M. Sc. (Agri.) thesis submitted to G. A. U., Anand.

Patel, Y. C. (2005). M. Sc. (Agri.) thesis submitted to G. A. U., Anand.

Purcell, M., Johnson, M. W., Lebeck, L. M., and Hara, A. H., (1992). *Environ. Entomol*, **21**: 1441-1447.

Rao, R. S. N., Sreedhar, U., Rao, S.G. and Satyavani, J. V. R. (1994). *Tobacco Res.*, **20** (1): 36-39.

Shelton, A. M. and Badenes-Perez, F. R. (2006). *Annu. Rev. Entomol.*, **51**: 285-308.

Shivayogeshwara, B., Gowda, B. L. V., Shankar and Patil, N. M. (2001). *Tobacco Res*., **27** (1): 181-183.
Srinivasan, K. and Krishna, M. (1991). *Trop. Pest Manag*., **37**: 26-32.
Talekar, N. S. and Shelton, A. M. (1993). *Annu.Rev. Entomol*., **38**: 275-301.
Virk, J. S., Brar, K.S. and Sohi, A. S. (2004). *J. Bio. Control*., **18**: 61-64.

Major Insect Pests of Jute: Identification and Management

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ABSTRACT

Jute is the cheapest, most widely grown and extensively used natural bastfibre in the world known as golden fibre.Intensive cultivation of high yielding, fertilizer responsive cultivars and changing climatic condition during the crop establishment and active growth phase of the crop have compounded the problem of insect pests. More than 30 species of pests including insects, mites and nematodes attack jute from seedling to harvesting stage.Integrated management of the insect pests depends on use of the resistant jute varieties, optimal date of sowing, line sowing and selective use of insecticides.

Key-words: Jute, Insect Pests, Identification, Management

INTRODUCTION

Jute (*Corchorusolitorius* and *C. capsularis*) grown as rainfed summer crop, is one of the important bastfibre crops cultivated in South East Asia especially in India. Like other crops, pest problem is considered to be one of the bottlenecks responsible for low productivity and declining quality. More than 30 species of pests including insects and mites infest jute crop from seedling stage to harvest which cause yield loss up to 31-34%. Severe infestation of these insect pests also affects the fibre quality causing loss in tensile strength, knotty fibre and reducing the length of fibre. Among different insect pests of jute,indigo caterpillar (*Spodopteralitura*) stem weevil (*Apioncorchori*), jute semilooper (*Anomis sabulifera*), yellow mite (*Polyphagotersonemuslatus*) and Bihar hairy caterpillar (*Spilosomaobliqua*) are the most important pests which occur regularly. Among the sucking pests, intensity of damage caused by yellow mite has been enhanced to great extent and cotton mealybug, *Phenacoccussolenopsis* has emerged as a new pest.Identification of insect pests of crop plants is an important pre-requisite for initiating decision making in IPM.

IDENTIFICATION AND MANAGEMENT OF MAJOR JUTE PESTS

INDIGO CATERPILLAR, *Spodopteralitura*Hubner (Noctuiidae: Lepidoptera)

IDENTIFICATION AND NATURE OF DAMAGE

Fig 1. Larvae of indigo caterpillar

The egg batches are covered with hair scales provided by the female, which gives off a golden brown color.The young larvae after hatching feed on tender leaves in groups.The feeding activity of grown up larva is generally confined to few morning hours and late evening. They are very voracious and quite large patches of foliage are quickly stripped and top plants are webbed together. In jute typical damage is noticed in young seedlings, which are cut on the ground surface by the larvae causing reduction in plant stand.

MANAGEMENT

Hand picking and destruction of larvae in the early hours when they are active on plant parts can reduce the damage to greater extent.Prior to infestation on the basis of monitoring chlorpyriphos 50 EC (2ml/ lit) may be sprayed in the base of the plant and also spraying of 5% neem seed kernel extract is effective for the management of early instar larvae.

STEM WEEVIL, *Apioncorchori*Marshall (Curculionidae: Coleoptera)

IDENTIFICATION AND NATURE OF DAMAGE

It is mainly a pest of capsularis jute.The small weevil is only 1.8 mm in length and 0.8 mm in breadth, brown or dull black and has small whitish setae on its body.

The adults make small holes in the lamina. One or more punctures by the female at the top nodes, where knot is formed and there are corresponding numbers of grubs inside the plant. The destruction of the tissues causes withering and drying of the crown leaves.The vertical growth is reduced the quality and yield. In older plants mucilaginous substances produced around the tissues damaged by the grub bind the fibres togetherand results in '*knotty fibre'*.

MANAGEMENT

Fig3. Yellow mite damaged jute plant

Removal and destruction of stubbles and self-sown plants avoid the carryover of pest and reduce the infestation.Sowing of the crop both *tossa* and *white* jute varieties in the late April had remarkably less incidence of stem weevil as compared to those sown in late March or early April.

Need based foliar spray of cypermethrin 25 EC (0.5 ml/ ha) can control the stem weevil.

YELLOW MITE, *Polyphagotarsonemuslatus*Banks (Tarsonemidae: Acarina)

IDENTIFICATION AND NATURE OF DAMAGE

Both nymphs and adults suck the sap from the ventral surface of young leaves even before they are unfolded. The mid rib curves downwards and the lamina roll inwards from two sides. The secondary veins wrinkle and give the leaf a rough and crumpled look and do not grow to their full size. The infested leaves turn deep green with coppery brown shades, typical inverted boat like shape and drop prematurely.The vertical vegetative growth of the crop is arrested, internodes become shortened and significant yield loss occurs regularly.

MANAGEMENT

Instead of March, the crop sown in April escapes the damage of mite to greater extent.Foliar spray of mineral oil @ 3 ml/litre + neem oil @ 3ml/ litre at 35 and 50 DAS may be applied for management of yellow mite. Need based spray of abamectin 1.8 EC @ 0.83 ml/lit.andfenazaquin 10 EC@ 1.5ml/ lit.is most effective.

MEALYBUG, *Phenacoccussolenopsis* Tinsley (Pseudococcidae: Homoptera)

Fig4.Mealybug damaged jute plant

IDENTIFICATION AND NATURE OF DAMAGE

Adult female of*P. solenopsis* generally has paired dark spots and/or stripes dorsally which are covered with a powdery, waxy secretion. Apical meristem is the most susceptible part of the plant. Plants infested during vegetative phase exhibit symptoms of distorted and bushy shoots, crinkled and/ or twisted bunchy leaves, and stunted plants that dry completely in severe cases. The damage is mostly caused by the immature stages of mealybug which suck the sap.

The vertical growth of plant is arrested and gives bushy appearance. Repeated attacks on the stem cause the development of crust due to which fibre bundles resist separation at the time of retting, resulting in the formation of '*barky fibre*".

MANAGEMENT

Preventive seed treatment with thiamethoxam (70 WS @ 5g/ kg seed) or clothianidin(50 WDG @ 3g/ kg seed) is effective. Foliar spray of profenophos 50 EC @ 2 ml/litre or chlorpyriphos 20 EC @ 2 ml/litre or imidacloprid 17.6 SL @ 0.4 ml/litre or thiamethoxam 25 SG @ 0.4 g/litre water is recommended for management of mealybug. The control of ants which help the mealybug colonies to grow and spread by soil application of chlorpyriphos 20 EC @ 2 ml/litre

Fig. 5.Semilooper on jute plant

SEMILOOPER, *Anomissabulifera* (Noctuidae: Lepidoptera)

IDENTIFICATION AND NATURE OF DAMAGE

The larvae are slender greenish with light yellow head, narrow dark green dorsal lines and a waxy, dark lateral strip.Damage starts in all cases from unopened leaves in upper

part of the plant which represent the most susceptible portion. Approximately 95% of the damage is restricted to 9 fully opened leaves of the crop. In seed crop, scooping of terminal stem causes drooping of the plants and damages seed capsules by larvae causes holes on the capsules.

MANAGEMENT

Balanced use of fertilizers is the key to reduce semilooper infestation. Plough the infested fields after harvest to kill the pupae. *Bacillus thuringiensis* effective against the jute semilooper. Whenever the damage by semilooper reaches 15% then any contact insecticide such as profenophos 50 EC (2 ml/lit) or cypermethrin, 25 EC (1.2 ml/lit) may be applied.

JUTE HAIRY CATERPILLAR, *Spilosomaobliqua*Walker, (Noctuidae: Lepidoptera)

IDENTIFICATION AND NATURE OF DAMAGE

The larva is orange colored with broad transverse bands with tuffs of yellowish to black hairs. Adults are crimson colored medium moths with red abdomen.

Young larvae feed gregariously and scrap the chlorophyll content of the leaves. Later they disperse to the entire field and prefer to defoliate the older leaves particularly the third and fourth stages feed voraciously on the jute leaves and may completely skeletonize the jute plant. The pest causes damage to jute during June and continued till mid-September coinciding with 60-100 day old crop.

Fig. 6. Hairy caterpillars on jute

MANAGEMENT

Regular monitoring to spot early oviposition and egg masses in the early stage, when the caterpillars remain gregarious on leaf, it is easy to destroy them after plucking such infested leaves and then dipping them in insecticidal solution. When caterpillars dispersed, their control is achieved by insecticidal spraying of lambda cyhalothrin 5% EC (0.6ml/lit.) or indoxacarb 14.5%SC (1.0 to 1.4 ml/lit.) may be sprayed to reduce the pest population to a greater extent.

CONCLUSION

In crop like jute in which the cost of cultivation is gradually increasing due to higher input cost, it is very important to adopt preventive pest control measure to reduce the damage and crop loss. In this context, low cost, biorational pesticides application based on pest monitoring conjugated with cultural control tactics are to be prioritized for effective and economic management of insect pests.

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Proper Artificial Insemination Technique in Cattle for Optimum Conception and Pregnancy

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The artificial insemination is one of the most important reproductive techniques which have been most popular in veterinary practice. The artificial insemination is universally accepted for genetic improvement of the animals especially cows and buffaloes. The recto-vaginal method is most common method to inseminate the cows/buffaloes. This technique brought tremendous improvement in milk production through selection of good quality bulls of high genetic merit for milk production. So, to increase the conception rate, there must be proper knowledge of proper insemination techniques. This chapter provides an idea about proper use of different equipments related to A.I. and proper techniques of insemination for successful conception and pregnancy.

EQUIPMENTS INVOLVED IN ARTIFICIAL INSEMINATION

I) *Semen Storage Tank*

- ✓ This is made of aluminum body and is a tank within a larger tank suspended over a narrow neck. The space in between the two tanks is a vacuum.
- ✓ Semen Storage tank should not be kept in cemented floor as acid from the floor may corrode the aluminum body and result in microscopic holes that destroys the vacuum and the insulating property of the tank is lost. This type of tank should ideally be kept on a wooden platform.
- ✓ If dew accumulates at the neck of a filled semen storage tank, then it indicates vacuum loss and such a tank should be rejected.
- ✓ Newly purchased semen storage tank should be evaluated for evaporation rate by daily measurement of liquid nitrogen level with a measuring stick.

Image: Liquid Nitrogen Semen Storage Tank

II) ***Canisters***

Canisters are cylindrical stainless steel containers with long handle that hangs from the mouth of the tank. Semen straws are placed in plastic goblets those are kept within the canisters. Generally, six canisters are provided for a semen storage tank. When the semen storage tank is filled with liquid nitrogen these canisters are completely dipped in liquid nitrogen.

III) ***Frozen Semen Straws***

These are plastic straws with a factory seal end with two cotton plugs and PVC in between them and a heat seal end that is sealed ultrasonically after the straws are being filled with semen. The straws are filled with extended bovine semen except at the heat seal end where there is an air gap.

IV) ***Artificial Insemination Gun***

This is a stainless steel tube with a piston and a barrel. The semen is inserted into the barrel of the gun. One 'O' ring is also provided with the gun so as to lock the sheath in it.

V) ***Artificial Insemination Sheath***

This is a sterile plastic cover that is put over the metal body of the gun. The sheath has a green or yellow plastic insert that holds the cut end of the straw preventing the semen from back flowing into the gun.

VI) ***Tweezer Forceps***

These are long forceps for taking a straw out of the tank.

STEPS IN ARTIFICIAL INSEMINATION

1. *Animal Preparation*

Manure should be removed completely from the rectum of the cow to be inseminated. The tail and the peri-vaginal area should be cleaned thoroughly with water and should be wiped dry.

2. *Taking a Frozen Semen Straw out from the Storage Tank*

The canister holding the straws should be lifted no farther up than the frost line at the neck of the tank and the semen straws should be taken out with the help of tweezer forceps. The frost line is an area at the neck of the tank below which is

covered by a layer of frost. This is the danger zone above which there is an abrupt increase in temperature that can result in significant damage to the straws.

3. *Thawing*

After taking a straw out of the tank, it should be dipped in a thermos containing water at 37º C for 30 seconds. After thawing the straw should be taken out of the water and wiped dry with a tissue paper towel. This is important as any contact of the semen with outside water, once the lab seal end of the straw is cut open, may lead to death of the spermatozoa.

4. *Loading the AI Gun*

- ✓ Before loading the semen straw into the barrel of the AI gun, the piston should be retracted out of the gun the length of the straw. Thawed semen straws should be inserted into the AI gun at the factory seal end (cotton-PVC-cotton).
- ✓ The lab seal end of the straws should be cut with a pair of scissors at right angle to the straw. Deviation from the right angle leads to mis-aligned fit in the sheath resulting in backflow of semen.
- ✓ The cut end of the straw should be fitted nicely into the green/yellow insert of the sheath and then the sheath should be glided gently over the gun, except at the upper end where the 'O' ring should pass over the sheath. The split upper end of the sheath should touch the head of the gun and then the 'O' ring should be tightened over the split end of the sheath.
- ✓ AI sheath with a plastic cover over them is ideal. These minimize the uterine contamination with vaginal pathogens.

5. *Artificial Insemination*

- ✓ Once a frozen semen straw is thawed, it should be inseminated within 5 minutes.
- ✓ The cow should be secured firmly in a trevis and one animal attendant should hold the tail away.
- ✓ Well lubricated gloved hand should be inserted into the rectum and the cervix should be held firmly.
- ✓ Then the loaded gun should be inserted through the vulva in an upward direction to prevent it from entering the urethral orifice.
- ✓ After the gun passes through the vestibule it should be held horizontally and the cervix should be pull forward with the rectal hand so as to straighten the vaginal folds should the gun lodge in these folds.
- ✓ Once the gun reaches the cervix, the protective thin plastic cover over the sheath should be pulled back and the posterior end of the cervix should be held firmly with the rectal hand so as to obliterate the blind pouch 'fornix vagina' thus ensuring that the gun enters the internal os cervix.
- ✓ The cervix is a cartilaginous structure at the neck of the uterus that contains three to five annular rings. As the gun enters the os cervix and passes through the first ring, a gritty sensation can be felt.

- ✓ At this stage the cervix should be moved in all directions so as to enable it to glide it over the gun. Too much force should not be applied on the gun as the idea is to glide the cervix over the gun and not to push the gun through the cervix.
- ✓ If too much forced is applied on the gun there is every possibility to slip through the cervical annular ring and forcefully tear the uterine wall, thus jeopardizing the life of the animal.
- ✓ Once the gun passes through the cervix, it should be advanced no farther than the body of the uterus and this can be checked by palpation with the index finger.
- ✓ Finally, the semen should be deposited at the body of uterus by pressing the piston of the AI gun.
- ✓ Once the insemination is completed it is good practice to massage the clitoris as it enhances the conception rate.

Image: Site of Deposition of Semen in the Female Reproductive Tract

Measurement of Liquid Nitrogen Level in the Semen Storage Tank

This is performed by a plastic or wooden meter scale. The scale is first dipped completely to the bottom of the storage tank and kept for two minutes. It is then taken out and gently swung in the air. This results in a white frost line to develop in the scale. The upper level of the frost line denotes the level of liquid nitrogen in the storage tank. Ideally frozen semen straws should be completely dipped in liquid nitrogen. Therefore, the liquid nitrogen level in the tank should be checked periodically.

In conclusion, the proper knowledge of instruments and their handling related to artificial insemination and A.I. technique is most important to optimize conception/ pregnancy in cows/buffaloes.

Water hyacinth- Benefits with their nutritive value

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Abstract
Water hyacinth (*Eichhoriniacrassipes*) is a weed which is found in rivers, lakes and other water bodies. It is difficult to remove because of their rapidly growing nature. But the features of water hyacinth considered as advantageous. There are many interesting and novel properties of water hyacinth. It is a good feed stock and can be used as a various renewable energy source. It is also valuable in traditional medicine, bioethanol production, textile industry, fodder and water purification.It is rich in protein, crude fibre and minerals with their good nutritive value. It also helps for better germination of plants and soil health improvement because we prepare compost, vermicompost and mulch from water hyacinth. Thus, it is profitable and source of income if it is used properly and in particular manner.

Keywords: Weed, Renewable Energy Source, Fodder, Bioethanol

INTRODUCTION

Water hyacinth (*Eichhoriniacrassipes*) belongs to family pickerelweed Pontederiaceae and its name Eichhorinia was derived from well-known 19th century Prussian politician J.A.F. Eichhorn (Aquatics, 2005). The weed is known as jalkhumbe in hindi, pisachithatamara in telugu, akasaoevengaya in tamil and kola vazha in malayalam. It is a native of northern neotropics of South America. This tropical plant spread throughout the world in late 19th and early 20th century (Wilson et al., 2005).

It is currently distributed through North America, South America, Eastern Africa and Asia. It was introduced through its native home in South America growing worldwide in regions between 40° north and sought latitude (Center*et al*., 2002) to the various countries by people as an ornamental plant to US in 1880. In Asia it became introduced in 1888 and to Australia around 1890. After that, In 1950 it spreads to Congo, the Nile and Lake Victoria. Till then water hyacinth spread to countless tropical and subtropical countries (Julien, 2001) usually with catastrophic socioeconomic and ecological consequences (Center*et al.,* 2005 and Ghbbour*et al*., 2004)
Till then water

hyacinth spread to countless tropical and subtropical countries (Julien, 2001) usually with catastrophic
socioeconomic and ecological consequences (Centeret al., 2005; Ghabbouret al., 2004)

It is free floating plant, which grow up to 3 feet height. It has waxy, rounded, thick and glossy leaves. The diameter of leaves is 4-8 inches with ovate to circular shape. Leaf stalks are spongy and bulbous. The flowers have 6 petals with purplish blue or lavender to pinkish, upper petals with yellow, blue border central splotches. Water hyacinth is vegetatively reproduces by the stolons. Roots are purplish black and feathery. Water hyacinth is a fast growing perennial aquatic macrophyte (Reddy and Sutton, 1984). Its population double in only twelve days (APIRIS, 2005). It is also known for its ability to grow in severe polluted water (So *et al*., 2003).

Water hyacinth is a heliphyte plant growing best in warm water which is rich in macronutrients (Center*et al*., 2002). Optimal water pH for growth of this aquatic plant is neutral but it also tolerate 4 to10 pH and optimum temperature for growth is 28-30°C (Center*et al*., 2002). Temperature above 33°C inhibits the further growth of plant. Optimum air temperature is 21-30°C. If the temperature remains -3°C continually 12 hours, it will destroy all leaves and temperature remains -5°Cfor 48 hours, it will destroy whole plant (U.S. EPA, 1988). It tolerates the drought because it survives under moist sediments up to several months.

➢ **Properties of Water hyacinth:**

▪ **Moisture (In fresh plant)**			**95.5%**	
▪ **N**			**0.04%**	
▪ **Ash**			**1.0%**	
▪ **P_2O_5**			**0.06%**	
▪ **K_2O**			**0.20%**	
▪ **Organic matter**			**3.5%**	
▪ **Organic matter (zero-moisture basis)**			**75.8%**	
▪ **N**			**1.5%**	
▪ **Ash**			**24.2%**	
▪ **Ash contains:**				
K_2O – 28.7%	**Na_2O– 1.8%**	**CaO – 12.8%**	**Cl – 21.0%**	**P_2O_5 – 7.0%**

(Source: Jafari, 2010)

➢ **Chemical Composition and Nutritional Value of Water Hyacinth:**

❖ Water hyacinth (*Eichhorniacrassipes*) fresh whole plant with roots

	Crude protein		**NDF**		**Ether extract**		**Ash**		**Other**

Main analysis	Unit	Avg	SD	Min	Max	Nb
Dry matter	% as feed	5.8	1.1	4.9	7.6	5
Crude protein	%DM	18.3	5.8	9.8	26.2	11
Crude fibre	%DM	22.6	6.4	17.1	31.8	7
NDF	%DM	57.3				1
ADF	%DM	33.4				1
Ether extract	%DM	2.0	0.5	1.1	2.5	8
Ash	%DM	21.1	8.0	11.1	34.1	9
Gross energy	MJ/kg DM	15.8				*
MINERALS						
Calcium	g/kg DM	9.5	5.2	5.6	17.2	4
Phosphorus	g/kg DM	6.3	2.9	3.1	8.9	4
Potassium	g/kg DM	26.3	7.5	16.4	34.5	4
Sodium	g/kg DM	17.9	1.8	16.3	20.2	4
Magnesium	g/kg DM	2.6	0.8	1.7	3.5	4
Manganese	mg/kg DM	164	89	86	291	4
Zinc	mg/kg DM	41	22	21	68	4
Copper	mg/kg DM	32	20	10	55	4
Iron	mg/kg DM	3028	2102	1581	6150	4
AMINO ACIDS						
Alanine	%protein	5.2	-	5.2	5.2	2
Arginine	%protein	4.5	-	4.4	4.7	2
Aspartic acid	%protein	10.5	-	10.1	11.0	2
Cystine	%protein	0.2	-	0.2	0.2	2
Glutamic acid	%protein	9.3	-	9.3	9.4	2
Glycine	%protein	4.5	-	4.4	4.6	2
Histidine	%protein	1.6	-	1.6	1.6	2
Isoleucine	%protein	3.9	-	3.8	3.9	2
Leucine	%protein	6.8	-	6.8	6.8	2
Lysine	%protein	4.7	-	4.4	5.0	2
Methionine	%protein	1.4	-	1.3	1.4	2
Phenylalanine	%protein	4.1	-	3.8	4.4	2
Proline	%protein	3.6	-	3.4	3.7	2

Serine	%protein	3.5	-	3.4	3.6	2
Threonine	%protein	3.7	-	3.7	3.7	2
Tyrosine	%protein	2.9	-	2.9	2.9	2
Valine	%protein	4.5	-	4.3	4.7	2

*indicates that the average value obtained by the equation

(Source: Boyd,1969; Gerard *et al.,* 1980, Jantrarotai, 1993; Klinaveet *al.,* 1990; `NguyenVan Thu *et al.,* 2009, Wolvertonet *al*., 1978)

❖ Water hyacinth (*Eichhorniacrassipes*) fresh whole plant with dried

Main analysis	Unit	Avg	SD	Min	Max	Nb
Dry matter	% as feed	88.8	5.9	81.4	95.7	4
Crude protein	%DM	13.7	2.8	10.7	17.8	6
Crude fibre	%DM	24.0	51	17.1	28.6	5
NDF	%DM	58.0				1
ADF	%DM	32.3				1
Lignin	%DM	8.6				1
Ether extract	%DM	2.3	1.7	0.9	4.8	5
Ash	%DM	18.1	5.2	14.5	27.2	5
Gross energy	MJ/kg DM	16.4				*
MINERALS						
Calcium	g/kg DM	12.9	9.1	2.5	18.8	3
Phosphorus	g/kg DM	2.3	1.5	0.5	3.2	3
Potassium	g/kg DM	8.7	5.5	2.7	13.5	3
Sodium	g/kg DM	3.6	4.3	0.3	8.4	3
Magnesium	g/kg DM	2.8	1.4	1.6	4.3	3
Manganese	mg/kg DM	269	211	70	490	3
Zinc	mg/kg DM	151		101	200	2
Copper	mg/kg DM	18		9	26	2
Iron	mg/kg DM	1221		112	2330	2
AMINO ACIDS						
Alanine	%protein	4.0	-	-	-	1
Arginine	%protein	1.3	-	-	-	1
Aspartic acid	%protein	10.1	-	-	-	1
Glutamic acid	%protein	9.1	-	-	-	1

Glycine	%protein	3.8	-	-	-	1
Histidine	%protein	1.2	-	-	-	1
Isoleucine	%protein	3.0	-	-	-	1
Leucine	%protein	5.5	-	-	-	1
Lysine	%protein	6.4	-	-	-	1
Phenylalanine	%protein	3.9	-	-	-	1
Proline	%protein	2.4	-	-	-	1
Serine	%protein	1.4	-	-	-	1
Threonine	%protein	1.9	-	-	-	1
Tyrosine	%protein	0.6	-	-	-	1
Valine	%protein	5.1	-	-	-	1

*indicates that the average value obtained by the equation

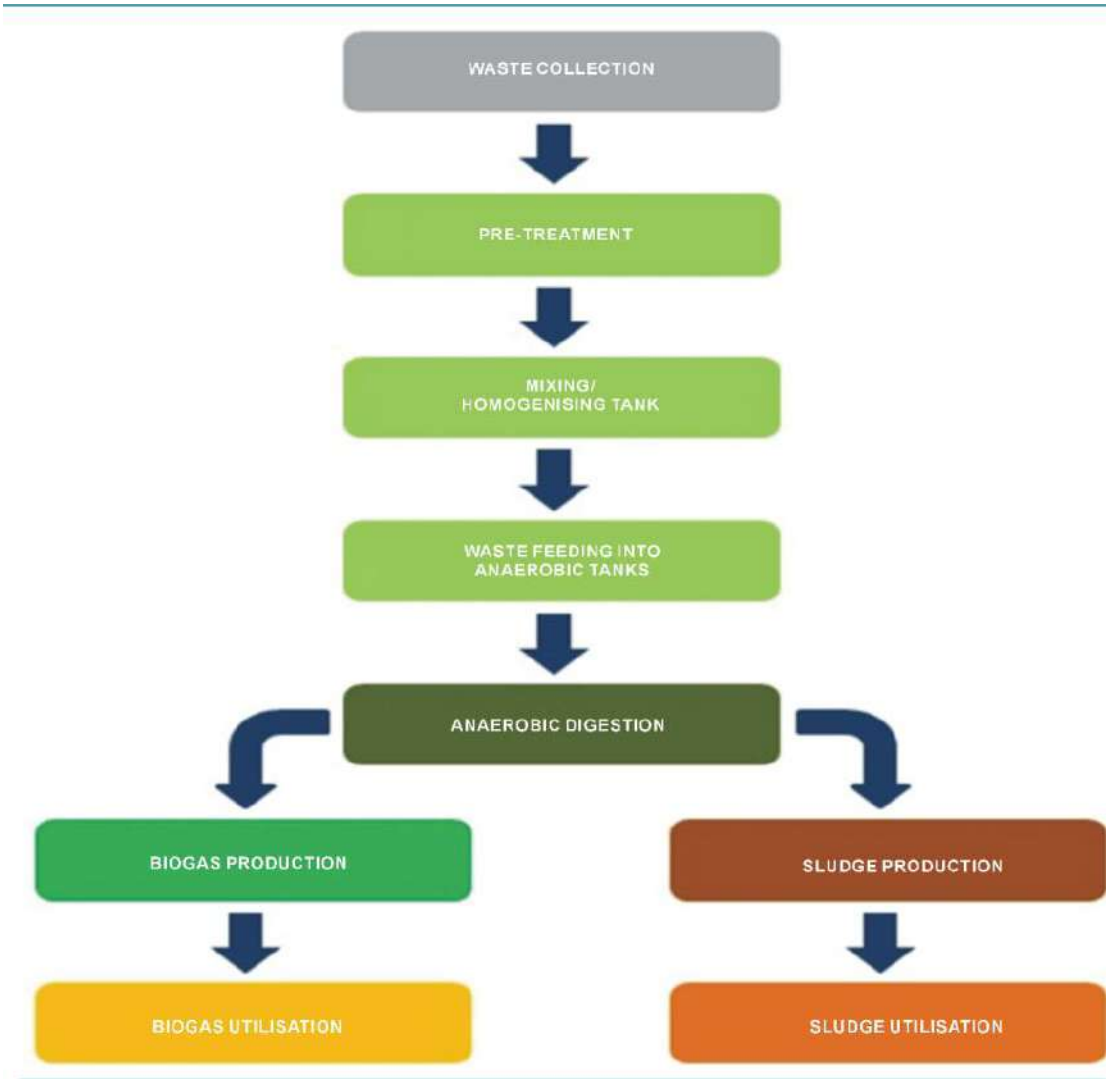
(Source: Biobaku*et al.,* 1991; Edwards *et al.,* 1985; Gerard *et al.,* 1980; Grandi*et al.,* 1983; Moreland *et al.,* 1991)

Avg: average or predicted value; **SD:** standard deviation; **Min:** minimum value; **Max:** maximum value; **Nb:** number of values (samples) used.

- **Value added products prepared from water hyacinth:**
  - **Biogas:** Water hyacinth is a possible supply for biogas production. Several reports were out that the water hyacinth used as a raw material in biogas production.Biogasis prepared by many anaerobic fermentation of organic materials by methanogenic microorganism. It consists of a mixture of CO2, methane, water, hydrogen sulphide and ammonia. Anaerobic co-digestion of water hyacinth with scarp and elephant grass used for biogas production was evaluated at a laboratory scale (Okewale*et al.,* 2016).

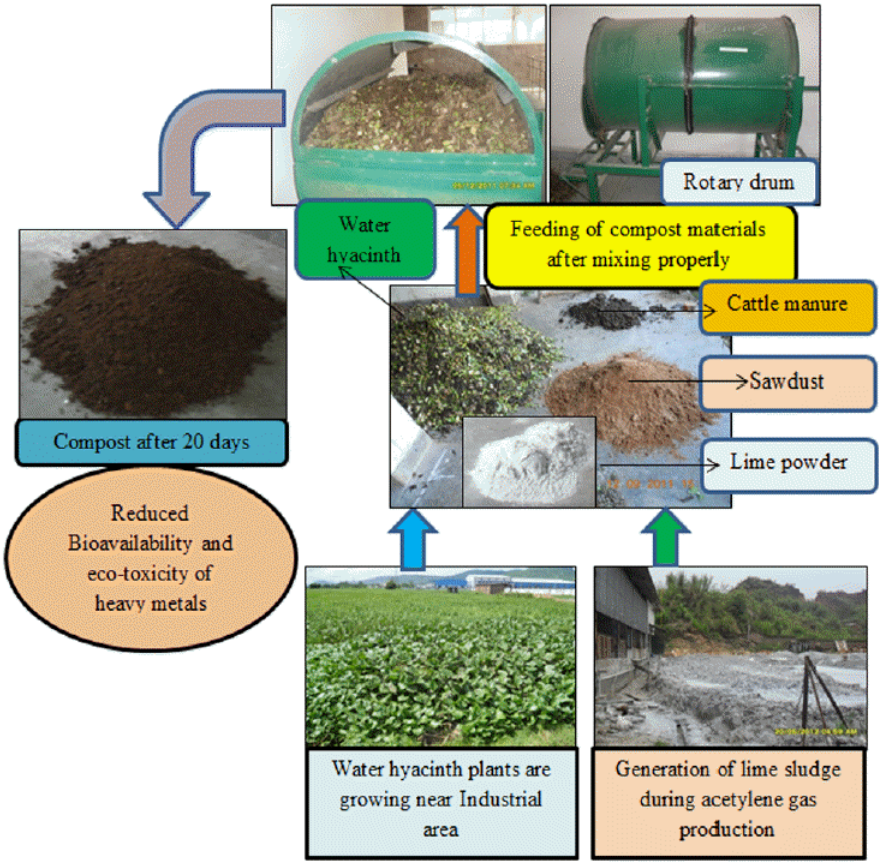
Theuprooted weeds were pulped and mixed with water 1:1 and 1:3 with junk to supplement decomposition microorganisms. This mixture loaded in the bioreactor for gas production (Njeru and Njeru, 2014).

  - **Use as biofertilizer:**water hyacinth used as organic manure and compost in the form of mulch or incorporated into the soil. In Sri Lanka it is mixed with organic municipal waste, ash and soil, composted and sold to the farmers and market gardeners. Water hyacinth used as biofertilizer once incorporated into the soil in the wheat field (Vidya and Girish, 2014). It may be sensible absorbent material of N, P and K from water and used as compost material. Thus, result indicates water hyacinth used as organic manure.



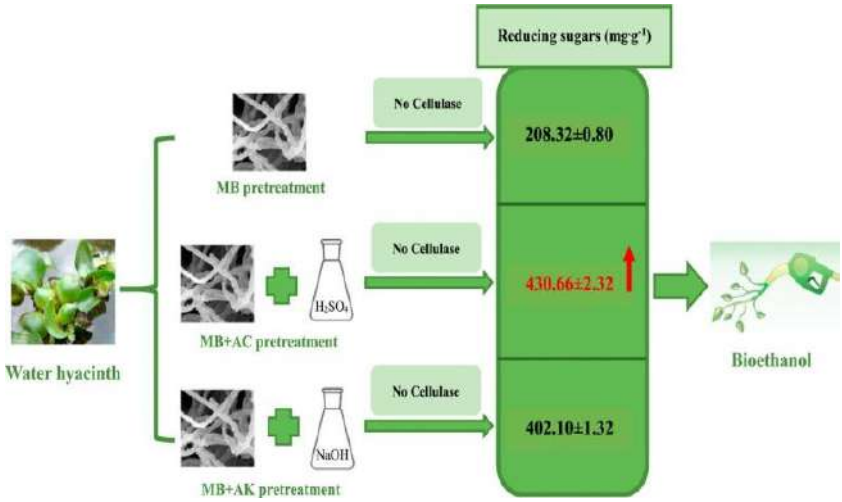
(Fig 1. Biogas Production; Source: Njogu*et al.*, 2015)

(Fig 2. Use a biofertilizer; Source: IUCN)



(Fig 3. Schematic view of the rotary drum composting process, preparation of compost materials and collection of raw material; Source: Environment engineering research)

- **Bioethanol production:** Water hyacinth waste biomass plays a very important role for the production of fuels. Bioethanol production from water hyacinth involves three steps i.e. pre-treatment, chemical reaction and fermentation. Bioethanol could be used as renewable fuel and its importance increase due to increase oil worth and depletion of fossil fuels.



(Fig 4. Bioethanol ProductionSource: Zhang *et al.*, 2018)

- **Animal feed and Fish feed:** It can be used for pigs, buffaloes. During 1950-1970, when fodder was scarce then it was widely used as an animal feed (Ding *et al.*,

2001). It is also used as fish feed. The Chinese grass carp is used for weed control and eat up to 18-40% of its own weight. Water hyacinth has directly or indirectly used for feeding the fish. Dehydrated water hyacinth has been value added to the diet of cat fish fingerlings to extend their growth (Gopal, 1987).

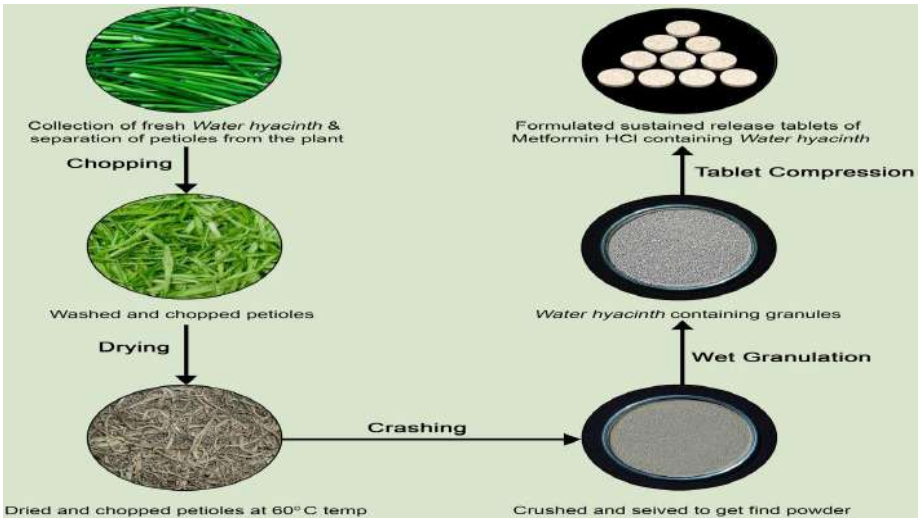
(Fig 5. Animal Feed; Source: Inriodulce.com)

(Fig 6. Fish Feed; Source: Pinterest.com)

- **Water purification:** Waterhyacinth is used for pollutant removal due to their rapid growth rate and extensive root system. It is a horizontal trickling filter where submerged roots provides physical support for the bio-film bacterial to growth. It soluble heavy metal ions and cyanide in polluted water. It also removes 2.4 tonnes ammonium sulphate in one hour and phosphorus just as efficiently. Thus, water hyacinth is very efficient in purify the sewage effluent.

(Fig 7. Water Purification; Source: Blogspot.com)

- **Beneficial for human health:**
  - Water hyacinthtreat diarrhea, nausea, distended stomach, intestinal worms and flatulence.
  - It controls cholesterol levels in the body.
  - The stem of the plant can be used to treat cholera.
  - Leaf extract of the plant can be mixed with rice flour and turmeric to treat skin problems like eczema.
  - It is used as antimicrobial, antifungal and antibacterial properties which help of treating the many skin orders.
  - Treat snake bite.
  - It promotes lactation in women and regular periods.



(Fig 8. Tablet Manufacturing; Source: Researchgate.net)

- **Source of natural textile fibre:**It is used as raw material for manufacturing of clothing and home fabrics. Processing the fibers with polyester staples initially produced blended yarn with 20-35% water hyacinth. In the stalks crimp property of wool is present which is helpful for better knitting and weaving. It is helpful for yarn count of 10-12 Ne ideal for home textile such as curtains, napkins, bed cover, pillow case and other items at home (Arlene and Obmerga, 2009).

(Fig 9. Natural Textile Fibre; Source: Technical textiles)

- **Useful for domestic purpose:** In Philippines water hyacinth is dried and used to make baskets and mattiing for domestic use. The stalks are properly dried before being used. Tourist industries also used these similar goods.

(Fig 10. Domestic Purpose; Source: Amazone.co.in)

as a plant that can double its population in only twelve days (APIRIS, 2005). Water hyacinth is also known for its ability to grow in severe polluted waters (So et al., 2003).
It is a member of pickerelweed family (Pontederiaceae) and its name Eichhornia was derived from well Optimal water pH for growth of this aquatic plant is neutral but it can tolerate pH values from 4 to 10 (Haller and Sutton, 1973; cit. Centeret al., 2002) Optimal water pH for growth of this aquatic plant is neutral but it can tolerate pH values from 4 to 10 (Haller and Sutton, 1973; cit. Centeret al., 2002).Optimal water pH for growth of this aquatic plant is neutral but it can tolerate pH values from 4 to 10 (Haller and Sutton, 1973; cit. Centeret al., 2002).

PREPARATION OF DIFFERENT FORMS OF WATER HYACINTH MULCHES

- **Green mulch:** Near the paddy fields water hyacinth harvested and initially rinsed very thoroughly with saline water and later with tap water in order to free from adhering microflora, fauna and other sediment debris. Then, the excess water drain and chopped after that air dried for 7-10 days and incorporate in the soil as mulch.
- **Vermicompost:** Fresh water hyacinth and paddy straw mixed with cow dung (8:2:1). This mixture allows for two week in bamboo made composting tanks. After that, this material transferred into the vermicomposting beds, where 1000-2000 earthworms introduced. Moisture content necessary to maintain. After 90 days vermicompost ready for application.
- **Compost:** For making compost, heaps consist with successive layers 10, 5 and 3 cm thick of water hyacinth, cow dung and paddy straw respectively which is made from bamboo. The layers of the compost repeated at 1m. For maintain moisture content water sprinkling is necessary. The heaps are continuously turned. The completion of compost indicates that all material mix well with each other.

CONCLUSION

It is concluded that water hyacinth is most noxious weed in the tropical as well as subtropical regions. But there are many benefits of water hyacinth. This weed used for many purposes. Water hyacinth used as fodder, green manure, compost, textile and mulch etc. It can be used fresh, dried, whole and chopped. The leaves of water hyacinth are rich in protein. The mineral content of water hyacinth is very high in all the plant

parts. Several by-products made from their roots as well as stems and other plant parts. Therefore, if proper practices adopted and used properly then it will be beneficial for humans, animals and others.

REFERENCES

APIRIS- Invasive nonindigenous plants in Florida.http://plants.ifas.ufl.edu/hyacin2.html (11/18/05).

Arlene, R. Obmerga, PTRI. September 01, 2009(Philippines).

Aquatics http://pss.uvm.edu/pss123/aquatics.html (11/18/05).

Biobaku, W.O and Ekpenyong, T.E. (1991). Effect of feeding graded levels of water lettuce and water hyacinth on the growth of rabbits. J. Appl. Rabbit Res. 14(2): 98-100.

Boyd, C. E. (1969). The nutritive value of three species of water weeds.Econ. Bot., 23(2): 123-127.

Center, T.D., Hill, M. P., Cordo, H. and Julien , M. H. (2002). Waterhyacinth. In: Van Driesche, R., *et al*:Biological control of invasive plants in the Eastern United States, USDA Forest Service Publication FHTET- 2002-04: 41-64.

Center, T. D., Van, T. K., Dray Jr., F. A., Franks, S J., Rebelo, M T., Pratt, P. D. and Rayamajhi, M. B. (2005).Herbivory alters competitive interactions between two invasive aquatic plants. Biological Control XXX, XXX- XXX (article in press).

Ding, Jianqing., Wang, Ren., Fu, W. and Zhang, G. (2001). Water hyacinth in China: its distribution, problems and control status. In: Julien MH, Hill MP, Center TD, Ding Jianqing eds. Biological and integrated control of water hyacinth, *Eichhorniacrassipes*. ACIAR Proceedings, No. 102. Canberra, Australia: ACIAR, 32-29.

Edwards, P., Kamal, M., Wee, K.L. (1985). Incorporation of composted and deied water hyacinth in pelleted feed for the tilapia *Oreochromisniloticus* (Peters).Aquacult. Res. 16(3): 233-248.

https://dailyasianage.com/news/220104/medicinal-benefits-of-water-hyacinth

http://eeer.org/journal/view.php?number=724

http://rk4design.blogspot.com/

Gerard, C., Troncoso, J. (1980). Utilization of water hyacinth (*Eichhorniacrassipes*) by the meat rabbit. Rev. Elev.Med.Vet. Pays Trop. 33(1): 91-96.

Ghabbour, E. A., Davies, D., Lam, Y. Y. and Vozzella, M. E. (2004). Metal binding by humic acids isolated from water hyacinth plants (*Eichhorniacrassipes* [Mart.] Solm-Laubach: Pontedericeae) in the Nile Delta Egypt. Environmental Pollution. 131: 445-451.

Gopal, B. (1987). Aquatic plant studies 1. Waterhyacinth.Elsevier Publishing, New York, USA.

Grandi, A., Marzetti, P. and Blasi, F. (1983). Water hyacinth (*Eichhorniacrassipes*) meal for feeding rabbits: digestibility, nutritive value and productive performances. Zootecnica e NutrizioneAnimale. 9(5): 297-309.

Jafari, N. (2010). Ecological and socio-economic utilization of water hyacinth.Journal of Applied Science, Environment and Management. 14: 43-49.

Jantrarotai, P. (1993). Nutritional composition and digestibility of water hyacinth and water pennywort.Kasetsart Journal Natural Science. 27(4): 532-535.

Julien, M. (2001). Biological controls of water hyacinth with arthropods: a review to 2000. In: Julien, M., Hill, M., Center, T., and Ding, J. (Eds.): Proceedings of the meeting of the global working group for the biological and integrated control of water hyacinth, Beijing, China, 9-12 December 2000. Australian Centre for International Agricultural Research, Canberra, pp. 8-20.

Klinavee, S., Tansakul, R., Promkuntong, W. (1990). Growth of Nile tilapia (*Oreochromisniloticus*) fed with aquatic plant mixtures. In: R. Hirano and I. Hanyu, eds. The Second Asian Fisheries Forum. Manila, Asian Fisheries Society, pp. 283-286.

Moreland, A. F., Collins, B. R., Hansen, C. A and O'Brien, R. (1991).Wastewater grown water hyacinth as an ingredient in rabbit food. J. Aquat. Plant Manage. 29: 32-39.

Njeru.,Muthoni, P. and Njogu, P. (2014). Conversion of water hyacinth derived biogas to biomethane for electricity generation in Kenya: a waste of energy (WtE) approach. Proceedings of Sustainable Research and Innovation Conference.

Njogu,P., Kinyua, R., Muthoni, P. and Nemoto, Y. (2015).Biogas production using water hyacinth (*Eicchorniacrassipes*) for electricity generation in Kenya. Energy and Power Engineering, 7: 209-2016.

Okewale, A. O., Omoruwou, F. and Ojaigho, R. O. (2016).Alternative energy production for environmental sustainability.British Journal of Renewable Energy. 1(02): 18-22.

Reddy, K. R. andSuttin, D. L. (1984).Water hyacinths for water quality improvement and biomass.Production. J. Environ. Quality.13: 1-8.

So, L.M., Chu, L.M. and Wong, P. K. (2003).Microbial enhancement of Cu^{2+} removal capacity of *Eichhorniacrassipes* (Mart.).Chemosphere. 52: 1499-1503.

Vidya, S. and Girish, L. (2014).Water hyacinth as a green manure for organic farming.International Journal of Research in Applied, Natural and Social Sciences. 2(6): 65-72.

U.S. EPA, 1988: Design manual- constructed wetlands and aquatic systems for municipal wastewater treatment. U.S. Environmental Protection Agency. Report no. EPA/625/1-88/022.Office of Research and Development, Cincinnati, OH, 83.

Wilson, J. R., Holst, N. and Rees, M. (2005).Determinants and patterns of population growth in water hyacinth.Aquatic Botany. 81:51-67.

Wolverton, B.C., McDonald, R. C. (1978). Nutritional composition of water hyacinths grown on domestic sewage.Econ. Bot. 32(4): 363-370.

Zhang, Q., Wei, Y., Han, H. and Weng C. (2018).Enhancing bioethanol production from water hyacinth by new combined pretreatment methods.Bioresource Technology. 251: 358-363.

Wilson, J.R., Holst, N., Rees, M., 2005: Determinants and patterns of population growth in water

eddy, K.R., Sutton, D.L., 1984: Water hyacinths for Water Quality Improvement and Biomass

Reddy, K.R., Sutton, D.L., 1984: Water hyacinths for Water Quality Improvement and Biomass