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Sr. No.	Full length Articles	Page
1	Scientific Management of Pest and Disease in Carrot Cultivation Selvakumar, R., Singh DB, Sajad Un Nabi, Geetika Malik, Anil Sharma and Gangadhara K	296-301
2	Protected Cultivation of Temperate Vegetables for Doubling Farmer's Income Selvakumar, R., Geetika Malik, Singh D.B., Javid Iqbal Mir, Sa-jad Un Nabi and Gangadhara K	302-309
3	Green Manuring-A scientific tool for sustainable crop production Bishal Mukherjee, Biplab Biswas and Saju Adhikary	310-314
4	Prevention of Milk Fever in Dairy Animals R.B. Vishnurahav	315-317
5	Ailanthus Excelsa : The Tree of Heaven S. Umesh Kanna and N. Krishnakumar	318-321
6	Recent Breed Improvement Projects on Buffaloes in India Jyotimala Sahu, Aayush Yadav, Prasanna Pal, Rohit Kumar, Sanjay Chaudhary, Suresh Kumar1 and Roshan Kumar Sahu	322-328
7	Recommendations for Euthanasia of Laboratory Animals Aayush Yadav, Jyotimala Sahu, Rajkumar Gadpayle, Ashutosh Dubey, Mithilesh Uppal and Roshan Kumar Sahu	329-334
8	Pericarp browning in litchi: A major bane to the blessed fruit Nusrat Perveen and Hidayatullah Mir	335-339
9	Use of Sewage Water in Agriculture Vimal N. Patel, R. D. Shinde and Rajal Patel	340-350
10	Importance 0f Management Education in Agriculture B.Krishnakumare, Saurabh Singh and S.Niranjan	351-353

Scientific Management of Pest and Disease in Carrot Cultivation

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Carrots (*Daucus carota,* 2n=2x=18) is grown all over india.It is taken by raw as well as cooked form.It is made into pickles and sweetmeat. A sweet preparation called *Gajar halwa* is very famous dish in north India. Carrot juice is a rich source of β-carotene and is sometimes used for colouring butter and other foods. Black carrot rich source of anthocyanins, is used for the preparation of a beverage called *Kanji* considered to be a good appetizer. The carrot containing about 87% water, rich in minerals and vitamins (B, C, D, E). Raw carrots are an excellent source of vitamin A, Potassium, vitamin C, vitamin B6, thiamine, folic acid, and magnesium. The carrot is a cool season crops though some of the tropical types tolerate quite high temperatures. The colour development and growth of the roots are affected by temperature. The optimum temperature for root formation is 18-20° C while germination of seed can take place with a wide range of temperature, viz. 7.2° - 23.9° C. The tropical Asiatic types can tolerate and can productive to form roots even at a higher mean temperature of 25-30°C, but also tend to bolt earlier. Carrots are grown in the north Indian plains with a cool night temperature around 7-10°C. At mean temperature of 12-13°C roots tend to grow relatively long and slender where as constant 24° roots are shorter and thicker.Carrots belong to the moderately hardy group of plants that are not particularly sensitive to winter cold and frost. Heavy frost just before harvesting can scorch leaves. Sandy loam or loam soils are most suitable for fresh market and early cropping. Heavy, stony, compacted or poorly-drained soils interfere with good root development and are less suitable. In fairly heavy, humus-rich soils, carrots tend to develop excessive leaf growth, and to form forked, hairy roots; they also tend to be rougher and coarser on the outside. The pH of 6.5 is ideal.Yields are extremely low at PH below this. The important

varieties of carrot grown in different parts of India are Pusa Kesar, Pusa Kulfi, Pusa Asita, Pusa Yamdagni, Pusa Meghali, Pusa Nayanjyothi, Pusa Rudira, Zeno, Early Nantes, Nantes, Nantes Half Long, Imperator, Chantenay (Selvakumar, 2016).

Pests

Carrot fly *(Psila rosae*)

Larva mines into the roots and causes holes, which rots and leads to secondary infection.Dropping and discolouration of foliage from green to rusty brown are the symptoms.

Management

Carrot rust fly adults can be monitored with orange/yellow sticky traps placed in the carrot field or in nearby trees where the adults rest. Summer ploughing, crop rotation, destruction of wild hosts are the cultural methods that can be used to reduce the pest population. Application of Carbofuran at 1 kg a.i./ha at a depth of 10-15 cm during land preparation is effective.

Carrot Weevil (*Listronotus oregonensis*)

The adult weevil is brown with a hard shell and a snout.The larvae looks like a white grub. This pest overwinters as an adult in the garden litter and hedgerows. Larvae feed for two to four weeks and tunnel extensively throughout the upper third of the roots, damaging 80% or more of the carrots. They destroy plant tissue. Zigzag tunnels can be found in the tops and roots of infested plants. Carrot weevils can damage up to 80% of the carrots in a field.

Management

Crop rotation is effective if a carrot field is set remotely from fields previously in carrots. However, it is almost impossible to isolate carrot fields from a source of carrot weevil in areas of intense carrot cultivation. No resistance or tolerance of carrot varieties to carrot weevils has been documented.

Aster Leafhopper (*Macrosteles quadrilineatus*)

Leafhoppers pierce leaf tissue of plants and remove the sap. The feeding punctures cause death and discoloration of individual plant cells, resulting in a yellow, speckled appearance in affected plants. This feeding damage, while unsightly, is minor in comparison to the damage caused to numerous vegetable crops by transmission of aster yellows by leafhoppers.Aster yellows is a plant disease caused by a Phyto-plasma, and is transmitted almost exclusively by aster leafhopper. Such crops as carrot, celery, cucumber, lettuce, potato, pumpkin, and squash are affected. Losses of 50-100% are reported due to this disease. Phytoplasma-infected plants are discoloured, stunted, and deformed. On carrots, for example, the symptoms are red or yellow foliage and excessively hairy, bitter- tasting roots. On lettuce, symptoms are chlorosis, stunting, and lack of head formation.

Management

Leafhoppers are easily collected with sweep nets, especially from grasses and grain fields. Sequential sampling protocols have been developed for sweep net sampling in carrot.Yellow-sticky traps is also useful and easy to use. Light traps equipped with fans for suction also have been used effectively to capture leafhoppers. Row covers, where economically feasible, should provide good protection against leafhoppers and disease transmission

Nematodes (Meloidogyne incognita)

The nematode larvae feed on roots causing the swellings or knots that are characteristic of root-knot infection. Roots are often stunted and deformed. Carrots are very susceptible to root-knot and should never be planted in infested soils.The symptoms are nodular thickenings on the taproot and particularly on the finer lateral roots. Splitting and forking of roots can occur. The attacks are generally more severe with carrots grown over the summer months, when higher soil temperatures favour development of the pest. Nematodes are often more prevalent on lighter soils.

Management

Deep summer ploughings of nematode infested fields 2-3 times at an interval of 10-15 days during the hot summer months. Use of non-host crops like mustard, garlic, onion and cereals at least for 2-3 years in a suitable cropping system helps in controlling the nematodes. The oil cakes (Neemcake, Groundnut) were effective in reducing parasitic nematode population using tolerant varieties cv. Arka Suraj

Diseases

Alternaria Leaf Blight (*Alternaria dauci*)

Alternaria leaf spots first appear at the margin of the leaflets and are dark brown to black and irregular in shape. Lesions produced on the petioles and stems are dark brown and often coalesce and girdle the stems. As the disease progresses entire leaflets may shrivel and die, appearing scorched. Alternaria leaf lesions are generally more prevalent on older foliage and plants than on young foliage. The disease spreads rapidly on the older leaves of a maturing crop after the rows have closed. This is due in part to poor air circulation among the older lower leaves in the canopy and to the moisture-holding capacity of the dense foliage.

Management

The disease can be kept under check if a well-drained soil is selected and suitable crop rotation is adopted. Since the fungus can survive in the seed, hot water treatment at 50°C for 15 minutes is recommended. Seed treatment with Thiram (3g/kg of seed) before sowing is effective to control the disease. Crop rotation and destruction of infected plant material in the field will minimize the disease infection, Fungicidal

applications with Foltaf (0.2%), Copper Oxychloride (0.3%) satisfactorily controls the disease.

Cercospora Leaf Blight (*Cercospora carotae*)

The disease produce severe blighting on carrot leaves and petioles if wet weather is prolonged during the growing season. Entire leaves and petioles may die on severely infected plants. The symptoms first appear along the margins of the leaves, often causing the leaves to curl. Spots inside the leaf edges are small, roughly circular, and tan or gray to brown with a dead center. As the lesions increase in number and size, the entire leaflet withers and dies. The fungus attacks younger leaves and plants in preference to older ones. In heavily infested fields, however, both older and younger leaves are subject to attack. The pathogen also produces lesions on the petioles and stems. The lesions may merge and girdle the stems, causing the leaves to die.

Management

The leaf blight pathogens can survive from one year to the next in infected plant debris. Therefore, a two-to three-year rotation is recommended to allow for natural decline in the pathogen population. The use of disease-free seed is strongly recommended because the fungus can survive on or in the seed. Early applications of Foltaf (0.2%), Copper Oxychloride (0.3%), starting at the first sign of infection, effectively control leaf blights on carrots. Best control is achieved when fungicides are applied at high pressure and in sufficient water to reach the lower leaves in a dense canopy.

Powdery mildew (*Erysiphe cichoracearum*)

The symptoms appear as white powdery growth on the leaves and petioles causing the leaves to turn brown and wilt.

Management

Spraying Bavistin (0.1%) or Benlate (0.1%) at an interval of 8-10 days effectively controls the disease.

Watery soft Rot (*Sclerotinia sclerotiorum*)

Carrots are susceptible to this disease, especially late in the season and during storage. The disease is present in soil or storage areas and often shows up after the crop has been harvested. Symptoms can be identified in the field as characteristic white mold with black sclerotia present on the crown of infected carrots. In storage, a soft, watery rot with white mold and black sclerotia characterizes the disease.

Management

Crop rotation, weed control (to improve air circulation), planting on raised beds, winter flooding, rapid cooling prior to storage and meticulous sanitation of all storage components are all necessary to reduce losses from this disease.

Black Rot (*Alternaria radicina*)

This disease can be seed and soil-borne and is characterized by a shiny black decay at the crown area and a greenish-black mold on the taproot. The infected tissue is

greenish black to jet black due presence of masses of black spores. This disease affects the roots in the field well as in storage.

Management

Proper field sanitation and practicing rotation helps to keep the disease under control. The root surface should kept dry and stored at 0°C with 95 % relative humidity

Bacterial soft Rot (*Erwinia carotovora p.v. carotovora* and *Erwinia carotovora p.v.atroseptica*)

Bacterial soft rots of carrots occur only when soil conditions are wet or storage conditions are poor. Soft water-soaked, irregular lesions appear on the roots. Initially these lesions are superficial but soon spread to cover the inner tissues. The foliage may remain green until the disease on the tuber advances considerably. The entire plant wilts when complete rotting of the tuber takes place. A foul odour is given out from the decayed roots. Abundant moisture on the root surface favours disease incidence.

Management

Planting on raised beds in poorly drained areas may also reduce bacterial infections. Careful harvest handling, grading and sanitation are the only ways to reduce the problem. The diseased roots should not be stored along with the healthy tubers. The root surface should kept dry and stored at 0ºC with 95 % relative humidity.

Carrot Aster yellows

Aster yellows is caused by a mycoplasma-like organism and is disseminated by the aster leafhopper, *Macrosteles phytoplasm.*The affected leaves become yellow accompanied by vein clearing. Dormant buds in the crown grow out into chlorotic shoots, which give a withers broom appearance on the top. Size and quality of roots are reduced and malformed. The internal texture of roots show marked changes causing reduction in value carrots for fresh market as well as for processing. Roots of infected plants have a bitter taste with astringent flavour. The disease is transmitted by the six-spotted leaf hopper

Management

Weed control especially of those acting as alternate host eliminates the disease. Spraying insecticides to control the leaf hopper population helps to reduce the disease attack.Spray with Carbaryl 0.025% or Endosulfan 0.05% when hoppers population is high.

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Protected Cultivation of Temperate Vegetables for Doubling Farmer's Income

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Protected cultivation of horticultural crops encompasses manipulation of micro climate of crop to make it able to grow and develop out of its normal season. Depending on requirement and resources, this manipulation can be partial or complete. Protected cultivation is practiced at all levels of vegetable production throughout the world be it household, community or commercial level. It helps the grower to produce crops slightly and in some cases considerably ahead or late with respect to the natural time of their production. This shift in the period of production increases the chances of fetching greater premiums in the market because the produce escapes the glut period and in some cases catches the slack period. In addition, protected cultivation helps to extend the production window. The crops that yield for a particular period under natural conditions keep giving the produce for longer durations under protection. The third important advantage is enhanced quality of the produce due to more congenial environment inside protected structure with respect to quality and intensity of sunlight, temperature regime, gaseous composition and barrier to diseases and insect pests. In India, the states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and some NE regions are most suitable for protection from low temperatures while horticulture in other parts of the country needs protection from high temperature. It is relatively easier and cheaper to achieve protection from low temperature, which is less dependent on electric power and machinery. That is probably the most important reason for adoption of polyhouses in temperate regions of the country.

IMPORTANT CONSIDERATIONS IN ADOPTING PROTECTED CULTIVATION

Need and suitability for the region

In order to take maximum advantage of protected cultivation technology, it is crucial to estimate the degree to which it is needed or suitable to the region in question. In India, passive form of protected cultivation, that is, the polyhouses or structures that have no mechanization arrangements to control microclimate, is more preferable than the mechanized or computerized one. The reasons are inability of the farmers to afford high expenditures and no real need for such sophistication in general because of predominantly sub-tropical and mild tropical/temperate climates prevailing in the country. Therefore, it is important to weigh the pros and cons of introducing protected cultivation in any region.

Optimization of space

The second important consideration is optimization of area to be included under protection. Most of the temperate area of India is hilly or at the bases of mountains, which are difficult to cultivate owing to local problems of limited accessibility, electric power supply, irrigation and hindrances in use of farm machinery due to undulating topography and limited road access. Economization of space will help maximize the economic returns per unit area in these difficult to cultivate regions. From a broader perspective, the economization of space and maximization of energy output in the form of yield/biomass also helps nations to increase greenhouse productivity per unit expenditure. This is relevant especially to countries like India that have large populations to feed and house and where agriculture's contribution to GDP is already low compared with industry and services and needs to be improved.

TYPES OF PROTECTED CULTIVATION

Fully mechanized

Fully mechanized protected cultivation technology involves use of greenhouses that are fully computerized and in advanced cases robotics enabled. Most of the operations from sowing to harvesting are mechanized along with the intercultural operations, fertilizer/ pesticide application etc. Mechanization of planting, nutrient preparation and application, intercultural operations and postharvest activities has been done but advances in mechanization of crop maintenance and harvesting has been slow due to the need for visual and tactile sensors and artificial intelligence required to do crucial operations like de-leafing, pruning and identifying the fruit that has reached desired stage of maturity. With further refinements and optimizations, many robotic products are already being used in urban agriculture at advanced production facilities round the world. These robots mainly include strawberry harvesters, rose harvesters, capsicum and tomato harvesters, leaf clippers and pollinators.

Partially mechanized

These may or may not be computerized and are generally equipped with basic facilities like power operated ventilators, drippers, foggers, misters, cooling pads, heating systems etc.

Passive

These protected structures are made of polythene, fiberglass or glass and are naturally ventilated with the help of windows or exhaust fan or none of them, for example, low tunnels, shade-nets, walk-in tunnels and mulches for in-situ moisture conservation.

Suitability of protected cultivation to Jammu & Kashmir and climatically similar states

Suitability of protected cultivation to a region depends on its climate/weather, requirements of the crop, worth of the commodity (popular and regularly consumed), technological status of the region (industry and logistics), purchasing capacity of end users of the technology (rich and progressive farmers), adaptability of the species to micro-climate control (multiple cut or indeterminate species) and need for adoption (micro-climate really needs to be altered). Considering the current averages of temperatures in different divisions of the state of J&K, passive form of protected cultivation seems to be of considerable utility in enhancing farmers' income, especially in Kashmir, followed by Jammu division. However, passive technology is ineffective in Ladakh division, especially the Leh district. Fully or partially automated greenhouses will be effective for this region provided there is sufficient power supply.

The tables presented below give a quick view of the weather observed in J&K during the current year (2018) and the temperature requirements of commercial vegetables for seed germination, growth and development.

	Av. max. temp.	Av. min. temp.	Av. max. precip.	Av. min. precip.
Jammu	38.7 °C (June)	7.8 °C (January)	371.5 mm (July)	10.1 mm (November)
Srinagar	30.1 °C (July)	-2.0 °C (January)	121.0 mm (March)	31.0 mm (September)
Leh	25.3 °C (August)	-14.4 °C (January)	15.4 mm (August)	3.5 mm (June)

Table 1: Temperature and precipitation averages of J&K (2018) (source: www.weather-ind.com)

Crop	Min. Temp. (°C)	Opt. Temp. (°C)
Celery	4	21-23
Bean	15	23-29
Beet	4	23
Carrot	4	23-26
Cole Crops	4	18-29
Cucumber	15	21-29
Eggplant	15	21-29
Lettuce	0	18-21
Melon	15	26-30
Onion	0	21-23
Pea	4	18-21
Pepper	15	23-29
Radish	4	18-21
Spinach	0	21
Tomato	10	23-26

Table 2: Temperature requirements for seed germination (source: Government of Alberta, Canada)

Crop	Min. Temp. (°C)	Opt. Temp. (°C)
Celery	7	15-18
Bean	10	15-21
Beet	5	15-18
Carrot	7	15-18
Cole Crops	7	15-18
Cucumber	15	18-24
Eggplant	18	21-29
Lettuce	7	15-18
Melon	15	18-24
Onion	7	12-24
Pea	7	15-18
Pepper	18	21-24
Radish	5	15-18
Spinach	5	15-18
Tomato	18	21-24

Table 3: Temperature requirements for growth and development (source: Government of Alberta, Canada)

The following tables depict the suitability of passive protection technology (polyhouse, walk-in, low tunnel) in J&K based on research activities at ICAR-CITH, Srinagar and weather information presented above.

Objective	Crop	Jammu	Kashmir	Ladakh
Late nursery of winter vegetables	Onion, cole crops, celery, parsley, spinach, lettuce, pea	Least beneficial	Very beneficial	Not beneficial
	Beans	Very beneficial	Not beneficial	Not beneficial
Early nursery of summer vegetables	Tomato	Very beneficial	Beneficial	Not beneficial
	Chilli, capsicum, brinjal, cucumber, melons	Very beneficial	Less beneficial	Not beneficial

Table 4: Suitability for nursery production

Objective	Crop	Jammu	Kashmir	Ladakh
Extended cropping duration and better quality	Tomato, capsicum, brinjal	Least beneficial	Very beneficial	Not beneficial
	Cucumber	Very beneficial	Not beneficial	Not beneficial
	Swiss chard, spinach, lettuce, Chinese cabbage	Very beneficial	Beneficial	Not beneficial

Table 5: Suitability for vegetable production

Most crops discussed here require small manipulation of micro-climate, are regularly demanded in the market and fetch higher prices when supplied in slack period. The varieties recommended for protection are multiple harvest/ cut,

indeterminate and high value. The passive technology of micro climate control is relatively cheaper involving use of minimal to moderate use of raw material like bamboo, wood, polythene and exhaust fan apparatus, which is easily affordable to majority of the vegetable growers. Since all the criteria for adoption of protected technology are met, it may safely be advised that passive technology will be very effective in enhancing vegetable growers' income, especially in Kashmir region. At ICAR-CITH, Srinagar standardization of protected cultivation technology in tomato (Cv. Himsona) and capsicum (hybrid SH-SPH-1) resulted in stretching the production window from May to November against July-August under open cultivation conditions.

SPACE OPTIMIZATION

This essentially involves achieving maximum permissible plant population per unit area under protection structure. This is in direct relation with increasing floor area devoted to cultivation by reducing the area under paths, margins and bunds, by using movable benches, trays, racks, hanging baskets and pots. The second important factor is row-row and plant-plant spacing as well as number of tiers in which crop is grown. The plant spacing is directly influenced by plant architecture, which can ultimately be manipulated by training and pruning techniques. The idea of cultivating indeterminate types of vegetables in greenhouses emanates from the concept of best utilizing the limited space inside a greenhouse. The indeterminate type of growth habit mimics the multiple tier system of cropping, as the vegetable is obtained on multiple points in vertical direction from the same plant for a considerably longer duration. For growers who are resource-poor, growing indeterminate species and varieties like tomato, cucumber and sweet bell peppers is more economical option than installing racks to form multiple tiers.

ENERGY HARVEST

Since a greenhouse (glasshouse or poly-house or net-house) is a limited area of cultivation, it is necessary to reap maximum possible benefits in the form of crop yield. This yield is usually manifold of what is obtained in open cultivation conditions. The increase in yield is obtained not only with one time higher harvest but also because of stretched production window (including offseason) caused by continuation of congenial temperature, humidity and other environmental conditions. The premium of the produce is also enhanced because of the higher quality owing to protection from disease and insect pests because of physical barrier and integrated pest management (Bradley and Punja, 2010; Reddy and Kumar, 2006; Sabir *et al*, 2010; Sabir *et al*, 2011). However, it is very important to choose a species and then its variety which is well adapted to the protected cultivation conditions (Tuzel and Leonardi, 2009). Not all species of vegetables can be grown under protection. Typically indeterminate tomato, bell pepper and cucumbers are grown under greenhouses all over the world. To some extent vegetables with multiple pickings like lettuce, chillies, brinjal and cherry tomatoes are also grown. The yield increases have also been observed with the application of organic and biofertilizers or following integrated nutrient management strategies, using drip

irrigation facility, mulching and shade nets to control mild temperature rise in cool regions (Cakmacki *et al*, 2006;. Berecha *et al*, 2010; Maruo *et al*, 2002, Mahajan and Singh, 2006). All the above mentioned strategies when used according to the climate, market preferability, availability of inputs and experience of the grower increases the energy harvest from greenhouses.

Polyhouse cultivation at ICAR-Central Institute of Temperate Horticulture, Srinagar

In order to standardize greenhouse cultivation techniques in polyhouse adapted vegetables in the temperate agroclimate of Jammu and Kashmir divisions, some work has been done in tomato, cherry tomato, sweet pepper and cucumber at the ICAR-CITH, Srinagar keeping in mind the space economy, optimum energy harvest, promotion of organic/INM cultivation and evolution of new varieties for protected cultivation. Various approaches including selection of cultivar, training, pruning, plant spacing and INM strategies were optimized.

Space economy and optimum energy harvest

In tomato, it was found that hybrid CITH-TH-1 pruned to double stem and planted at 75 cm x 50 cm spacing gave highest yield (93.42 t/ha). In cucumber, the highest yield (96.06 t/ha) was recorded in hybrid SH-CH-1 pruned to double stem and spaced at 120 cm x 60 cm. Similarly, in sweet pepper, hybrid SH-SPH-1 yielded the highest (109.56 t/ha) among all tested genotypes when pruned to double stem and planted at 50 cm x 20 cm.

Integrated nutrient management

In all these crops, INM treatment under protected cultivation was also standardized for Kashmir region. Treatment with 50% vermicompost + 50% recommended dose of fertilizers + biofertilizer (azotobacter) gave fruit yields *at par* with the yield obtained from sole application of chemical fertilizers after two years of application. In each crop, INM treatments have statistically been *at par* with the recommended dose of fertilizers. In tomato (hybrid SH-TH-1), different INM treatments yielded 62.09 t/ha to 68.16 t/ha against 67.82 t/ha with recommended dose of chemical fertilizers. In capsicum (hybrid SH-SPH-1), it was 95.39 t/ha to 101.74 t/ha against 96.20 t/ha with chemical RDF. In case of cucumber (hybrid SH-CH-1), the production from INM treatments was 63.11 t/ha to 80.01 t/ha against 86.33 t/ha with chemical RDF. This is a clear indication that the integrated nutrient management with the use of organic sources of nutrients like vermicompost and biofertilizers of the above mentioned genotypes in these crops can efficiently replace sole use of chemical fertilizers under Kashmir valley and Jammu's temperate region conditions. Use of organic sources of nutrients may also help conserve the organic status of many regions of this state. However, further studies, which involve sole use of organic fertilizers in protected cultivation of these crops and genotypes in Jammu and Kashmir, are required to meet this objective.

Breeding for protected cultivation

Hybridization work was performed in tomato involving slicing tomato variety Himsona and cherry tomato varieties (CITH-CT-1 and CITH-Mukteshwar Yellow CT). The hybrids obtained from these two crosses had highly uniform fruit size and shape in attractive bunches. The fruit size is intermediate between parents with dark red skin, more juiciness, better flavor, early ripening and lack of pithiness in pericarp usually observed in parent Himsona. Both the hybrids performed well in polyhouse conditions and yielded earlier, more uniform fruits and uniform bunch ripening compared with all the parents. The data collection on yield and related parameters of hybrids are underway for comprehensive comparison with parents for estimation of heterosis.

CONCLUSION

Protected cultivation of both winter and summer crops under passive and partially controlled microclimatic regime is an attractive alternative to open cultivation for the vegetable growers of Jammu & Kashmir. While Ladakh needs more specialized arrangements like trenches, customized shapes and designs of polyhouses and cover material especially suited to extreme temperature conditions, most of the Kashmir region and temperate Jammu can benefit from late and early nurseries of most of the winter and summer vegetables and protected cultivation of tomato, cherry tomato, capsicum and cucumber. This will help the vegetabe growers to extra crops of short duration between two crops of major commercial value, catch the slack period and avoid glut period. Exploiting the technologies developed by ICAR-CITH, Srinagar for space economy, optimum energy harvest, INM and innovating with the new varieties adaptable to protected cultivation the vegetable growers can earn additional income and diversify the utility of their produce.

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Green Manuring-A scientific tool for sustainable crop production

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ABSTRACT

The agriculture of the modern chemical era concentrates on maximum output but overlooks input efficiency as a result of which it has not been sustainable. Under high input production systems where productivity cannot be further increased with incremental use of mineral fertilizers alone, addition of organic sources could increase yields through increased soil productivity and higher fertilizer use efficiency. Green manuring is a practice of ploughing or burying the undecomposed green plant tissues into the soil for improving soil structure and fertility. Leguminous Green manure crops can meet a substantial portion of N requirement of rice and provide organic matter to the soil to maintain soil fertility. In addition, green manures provide N and other mineral nutrients for the immediate need of the growing rice crop and improve soil physical and chemical properties. Combined application of fertilizer and green manure increased the efficiency of each other. Thus green manuring is the ray of hope for the production of quality food in sufficient quantity and also for maintaining soil health.

INTRODUCTION

India is one of the largest democracy of the world. But as a developing country, we are facing a lot of challenges still now to meet up the hunger and malnutrition problems. Population explosion is now a days a major factor that affects the food production in our country and thus quality food grain production in sufficient quantity without damaging the soil quality, productivity and fertility is one of the biggest challenges in the present agriculture scenario. The agriculture of the modern chemical era concentrates on maximum output but overlooks input efficiency as a result of which it has not been sustainable. Stagnation in maximum yield potential during the recent years in cereal crops like rice, wheat on which most of the people are dependent is a real concern for agricultural scientists and professional technocrats.

Among the cereals, rice (*Oryza sativa L.*) is the major source of calories for 40 % of the world population. Cultivation of high yielding dwarf varieties responsive to fertilizer and excess use of inorganic fertilizers has depleted the inherent soil fertility. The decline or stagnation in yield has been attributed to nutrient mining and reduced use of organics (John *et al.* 2001). Under high input production systems

where productivity cannot be further increased with incremental use of mineral fertilizers alone, addition of organic sources could increase yields through increased soil productivity and higher fertilizer use efficiency. In this context, practice of green manuring is the spark in dark to a great extent. Green manuring can be the one of the feasible option for sustainable crop production.

NEEDS FOR INTEGRATED NUTRIENT MANAGEMENT

Several long-term experiments conducted all over India indicated a decrease in rice productivity due to continuous use of chemical fertilizers. Integrated nutrient management (INM) aims to improve soil health and sustain high level of productivity and production (Prasad *et al*, 1995). The combined use of organic and inorganic fertilizers has been reported not only to meet the nutrients need of the crop but also has been found to sustain large scale productivity goals (Yadav and Meena 2014). Integrated Nutrient Management (INM) promotes the use of balanced and judicious use of chemical fertilizers in conjunction with manures like compost, far m yard manure, vermicomposting, green manures and use of fertilizers fortified with micro-nutrients, use of bio-fertilizers (e.g. phosphate solubilizing bacteria, Azospirillum, Azotobacter, Rhizobium, and Potash mobilizing bio-fertilizers) that can supplement a part of NPK fertilizers (Herbert 1998). Now a days, inorganic fertilizers are becoming more expensive; therefore, sustainability of soil productivity has become a question. Hence, green manures can be a good alternative solution to improve the soil health without causing any environmental hazards.

Green Manuring

Every farmer knows how hard work is essential for production of a basket of compost and utilizing it for crop production as well as for maintaining soil productivity. Green manuring is a method of replacing that basket of compost with a handful of seed. In this method, the plants that grow from the handful of seed are ploughed back into the soil. After a while in the soil, the plants rot down to become compost. Particularly, green manuring is a practice of ploughing or burying the undecomposed green plant tissues into the soil for improving soil structure and fertility. The plants used in this method are called as green manures. Green manure crops are primarily used in the environmental friendly agricultural practices to reduce application of chemical fertilizers.

Fig: Green Manuring in soil

Types of green manuring:

The practice of green manuring is performed in different ways according to suitable soil and climatic conditions of a particular area. Broadly the practice of green manuring in India can be divided into two types:

1. Green manuring in- situ: In this system, green manure crops are grown and buried in the same field, which is to be green manured, either as pure crop or an intercrop with the main crop. This system is followed in the northern India. An ideal in-situ green manure crop should possess the following desirable characteristics:

1. It should be a legume with good nodular growth habit indicative of rapid N fixation under even unfavorable soil conditions.
2. It should have little water requirements for its own growth and should be capable of making a good stand on poor and exhausted soils.
3. It should have a deep root system, which can be open the sub-soil and tap lower regions for plant nutrients.

4. The plant should be of a leafy habit capable of producing heavy tender growth early in its lifecycle.
5. It should contain large quantities of non-fibrous tissues of rapid decomposability containing fair percent of moisture and nitrogen.

Suitable green manure crops: Sunn-hemp (*Crotalaria juncea*), Dhaincha (*Sesbania aculeata* and *S. rostrata*), Wild indigo or kolingi (*Tephrosia purpurea*). Among the green manures, *S. aculeata* and S. speciosa exhibited higher organic carbon content with wider C-N ratio than *S. rostrata* (Ndoye and Dreyfus, 1988).

2. Green leaf manuring: Green leaf manuring refers to turning into the soil green leaves and tender green twigs collected from shrubs and trees grown on bunds, wastelands and nearby forest areas. This system is generally followed in the central and eastern India. For *e.g.*-

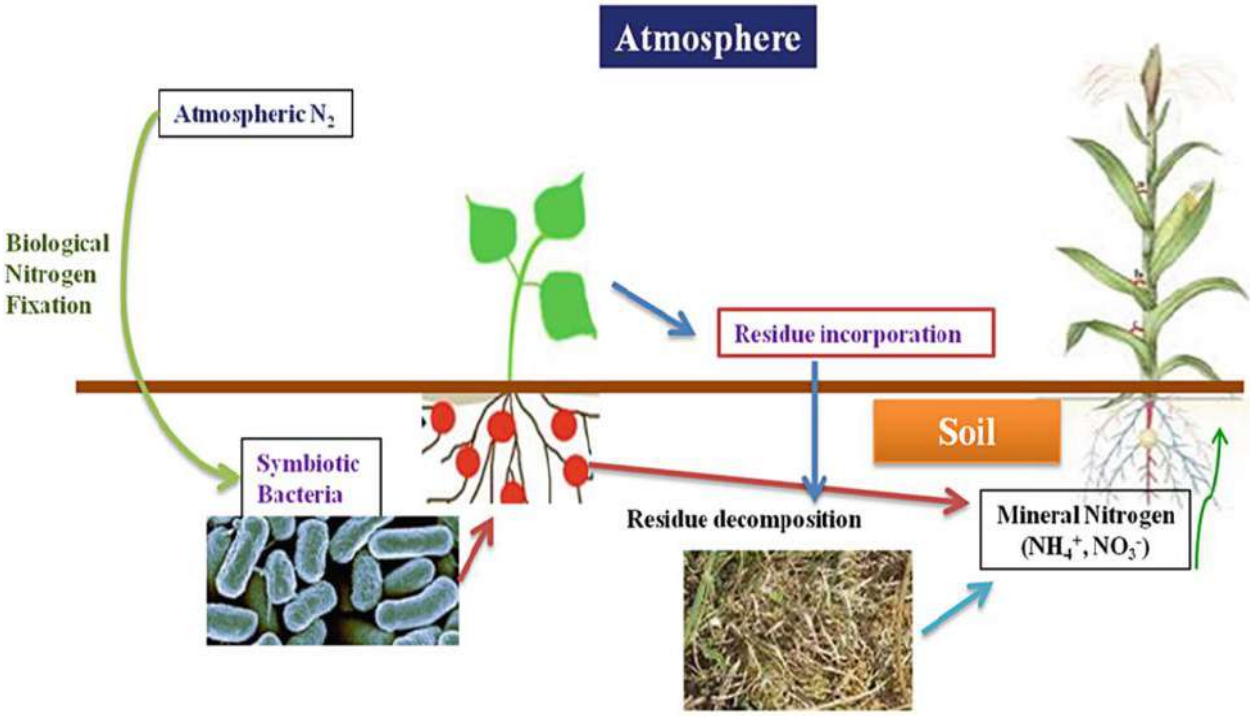
Gliricidia (*Gliricidia maculata*), Subabul (*Leucaena leucocephala*), Cassia (*Cassia auriculata*).

Advantages of Green Manuring

There are various advantages of green manuring which are as follows: –

- Green manure crops modify soil physical chemical and biological environments. Green manures not only supply N to rice by biological N fixation but also improve physical and chemical properties of soils (Buresh and De Datta, 1991, Becker *et. al*., 1995). In fact, this stimulates the activity of soil micro-organisms.

- The green manure crops help for returning the different plant nutrients to the surface soil layer from the sub-surface soil layer.
- It can add organic matter in soil and thus improves soil microbial activity.
- Due to green manuring the nutrient regimes can be improved and restored otherwise be lost by leaching. In waterlogged soils, green manures increased the availability of P through the mechanism of reduction, chelation and favourable changes in soil pH (Hundal *et al*, 1987).
- Better utilization of P and K to an extent of 10 to 12 per cent was observed due to green manure incorporation (Lekha and Palaniappan, 1990).
- Green manure crops can act as a cover crop, facilitates penetration of rain water and decreases erosion and runoff.



- Green manuring with *Sesbania aculeata* increased the growth, yield parameters, nutrient uptake and yield of rice (Padmavathy, 1992). Prickly sesban (*Sesbania cannabina*) green manuring significantly increased the grain yield of rice (Hiremath and Patel., 1998).

Desirable characteristics in legume green manure crops

For lowland ecosystem Dhaincha is a premier green manure crop since it fulfils the traits of an ideal green manure which is further supported by FAO (1977); IRRI (1988); Ladha *et al.* (1988) as described below.

- Early establishment and high seedling vigour
- Tolerance to flooding and drying
- Early onset of N fixation and efficient sustenance over varied climatic and edaphic conditions.

- Fast growth with an ability to accumulate large biomass and N within four to six weeks of growth.
- Quick decomposability.

CONCLUSION

Green manuring is an inexpensive; eco-friendly alternative to mounting prices of fertilizer nitrogen and has become an effective technology in economizing the agricultural production system ensuring productive capacity of soil without causing environmental problems. The average N loss in flooded soils from applied green manures was considerably lower thus resulting in less pollution to the environment. Thus practice of green manuring in the rice field is an indication of sustainable production system in an ecologically sound environment. Improving rice production with such an environment friendly approach can always bring monetary improvisation as well as sustainability in agriculture.

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Prevention of Milk Fever in Dairy Animals

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Milk fever is an important metabolic disease of cow caused by deficiency of calcium around the time of parturition in high producing animals and characterised by general weakness, recumbence, shock and death. A transient deficit of ionized calcium occurs at the onset of lactation caused by an imbalance between calcium outputs in the colostrum. Matured dairy cows in the age group of five to six years are most commonly affected. Incidence of milk fever increases with age and maximum incidence is noticed in cows in third to seventh lactation. Most of the cases occurs within the first 48 hours after parturition and the critical period extends up to the tenth postpartum day.

Dietary management and other miscellaneous practices were discussed here will aide in the prevention of milk fever.

DIETARY MANAGEMENT

Dietary calcium and phosphorous restriction in prepartum

Calcium and phosphorus are very important minerals in the body involved in many metabolic activities. Calcium homeostasis controlled by parathyroid hormone, calcitonin, vitamin D and its metabolites.

Low level of calcium in the diet (20g/day) during the last two to three weeks of calving reduces the incidence of milk fever. Feeding of calcium more than 100 g/day during the dry period increase the predisposition of milk fever. Excess phosphorous more than 80g/day during the dry period increase the incidence of milk fever. Although the ratio of Ca to phosphorus in the diet is of relevance in monogastric species, it is now recognized that this ratio is of little importance in ruminants. Calcium and phosphorous ratio should be 1:3.3.

Dietary cation-anion difference (DCAD)

Legumes and grasses are rich in potassium and are alkaline. Alkaline diet will increase the incidence of milk fever. Sodium and potassium are considered as cationic salts. Diets rich in anionic salts like sulphur and chloride which increases the level of 1, 25 $(OH)_2$ D –increases the intestinal absorption and bone resorption of calcium.

Commonly used anionic salts were ammonium chloride and magnesium sulfate. Magnesium sulfate is the most palatable of the anionic salts commonly supplemented. Ammonium chloride is more effective than most other salts as an acidifier. Ammonium chloride (100g/cow/day) can be used from 21 days prior to parturition and it decreases the incidence of milk fever. Feeding anionic salts not only controls milk fever but also increases the lactation and efficiency of reproduction.

Vitamin D3 supplementation during dry period

A single parenteral dose of 10 million IU per cow of intramuscular (IM) vitamin D3 given 2 to 8 days before parturition is ideal. Oral dosing with 20 million IU of vitamin D2/d for 5 days to cows immediately before calving can markedly reduce the expected incidence of milk fever.

Level of potassium and magnesium in the diets

Reduce the dietary potassium content as much as in late gestation (Below 2% dry matter). It is important to restrict potassium (K) intake for dry cows to prevent milk fever.

Magnesium supplementation

Magnesium is another important body element and 70% of body magnesium is found in bones. Magnesium is responsible for membrane stability and thus related with cardiac and skeletal muscle functions and nervous tissue function. It is also related with several enzymes required for body metabolism and most importantly plays very important role in calcium metabolism. Magnesium is essential for maintaining blood calcium level in animals thus indirectly responsible for occurrence of milk fever. Magnesium supplementation at the rate of 15 to 20 g/day along with a source of easily digestible carbohydrate helps in preventing milk fever in dairy animals. During pregnancy magnesium should be supplemented at the rate of 0.4% of dry matter of ration

Other suggestions

Just after calving, cow should not be milked completely for about 2-3 days. However, to avoid associated complication like mastitis, the calf should be allowed to suck milk for about 36 hours during this period. Oral administration of calcium gel at calving and one day after calving is effective in preventing milk fever.

Partial Milking

Partial milking after calving has been proposed for decades as a strategy to decrease Ca losses through the mammary gland in early lactation. Although this practice evidently reduces the amount of calcium excreted through the mammary gland.

Forages rich in calcium should not be fed before calving particularly during the last trimester of pregnancy period.

The following formulation can be suggested as a lick on feed: 1 cup molasses + 4 tablespoons linseed oil or meal + 2 tablespoons salt + 2 tablespoons causmag or dolomite.

Avoid over fattening in the pre-partum period

Avoid stresses in at the time of parturition

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Ailanthus Excelsa : The Tree of Heaven

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ABSTRACT

Tree of heaven is fast growing extensively cultivated in many parts of India towards the vicinity of villages. The tree is indigenous to Southern and Central India and distributed in Western Peninsula, Rajasthan, Bihar, Orissa, Bundelkhand, throught Madhya Pradesh, Broach and Panchamal district of Gujarat, in dry deciduous forests of Maharastra, scrace in Deccan and Karnataka, N. Circars, forest of Tamilnadu. It is often planted along the roads. It is exotically found in Sudan. The plant is known for its high economical and commercial importance. Ailanthus excelsa Roxb. is a tree belonging to family Simaroubaceae and commonly it is known as a plant of Heaven. The traditional claims, phytochemical investigations and pharmacological evaluation and some ayurvedic formulations provide the backbone to make this tree as a plant of Heaven.

INTRODUCTION

Ailanthus is a fast-growing deciduous trees growing to 25-45 m tall, with spreading branches and large pinnate leaves, the terminal leaflet normally present and the basal pairs of leaflets often lobed at their bases. The small yellow to greenish flowers are borne on branched panicles they turn reddish later in the year and eventually brown they stay on the tree for a long time; the male flowers have a strong odour. The odour tends to resemble the smell of strong cat urine or the spray of a male cat. In addition, touching the leaves, leaves an unpleasant smell on the hands. The fruit is a samara drawn out into a long wing with the seed in the middle. The wood is fine grained and satiny.

Distribution and Habitat

Ailanthus excelsa is a lofty deciduous tree, though it is widely distributed in the country, it grows in the semi-arid and semi moist regions. In its natural habitat the absolute maximum shade temperature varies from 45^0C to 47.5^0C and the absolute minimum from 0^0 to 12.5^0C. The mean maximum temperature in the month of May is generally the highest. The temperature varies from 30^0 to 42.5^0C. The mean daily minimum

temperature in January, the coldest month of the year varies from 4^0 to 21^0C.The mean annual rainfall ranges from 500 – 1900 mm, sometimes even up to 2500 mm. It has been found to be a suitable species for planting in dry areas of Rajasthan with annual rainfall of about 400 mm. It avoids moist areas having high monsoon rainfall.It can grow on a variety of soils but thrives best on porous sandy loams. It avoids clayey soils with poor drainage and waterlogged areas. It can grow even on shallow dry soils but the growth is poor. *A. excelsa* has given better performance as compared to other species in lateritic soils. The tree can be seen growing upto an elevation of 900 metres.

Phenology

It has large branches starting right from trunk and perpendicular to the trunk which tend to curve upwards.The leaves are shed during the cold season and the new leaves appear in March-April, 3-9 dm long, pinnate; leaflets 8-14 pairs, 10-15 cm long alternate or sub opposite, coarsely and irregularly serrate, oblique at base; petioles 5-8 cm long.The flowers are small in size yellow in colour and arranged in panicles, appear in February – March in Central India and in the month of April in north India. The flowers appear in the large open clusters among the leaves; the male, female and bisexual flowers being intermingled on the same tree. The fruits are formed soon after flowering. The fruits ripen in May-June, just before the onset of monsoon.

Silvicultural Characters

A. excelsa is a strong light demander. The seedlings get easily suppressed by weeds as a result of shading. It is sensitive to drought and is moderately frost tender, being killed by frost in exposed situations. The prolonged droughts kill the seedlings, though the poles and trees are drought resistant. In places, where winters are damp as well as cold, seedlings do not easily grow. The tree coppices well and produces root suckers freely. The tree is very susceptible to waterlogging or excess of moisture in the soil. It is easily broken by wind due to the brittleness of the stem and branches. It can attain a height of 18 to 25 m and girth of 2.5 m and has a cylindrical bole.

Natural Regeneration

Its natural regeneration in the forest is usually not satisfactory. The seeds are very light and winged and are dispersed far wide by the wind. If the seeds fall on bare ground germination takes place early in the first rainy season after the fall of the seed, but the seedlings rarely survive due to the sensitiveness of the seedlings and their intolerance of heavy weed growth. A large proportion of seeds does not germinate and are destroyed. The seeds that are buried deep into the soil failed to germinate and seedlings in depression die due to poor drainage, weed competition and attack of pests etc. Natural regeneration through coppice and root suckers is adequate. Coppice shoots are thinned for better development. The practice of coppicing can be practiced for 3 to 4 generations depending on the vigour of age and health of plant cut, season, time of cutting, height of stump and edaphic and biotic conditions.

Artificial Regeneration

The species is best raised by planting out nursery raised seedlings with ball of earth.The seeds are light and winged and are easily blown away by wind. Therefore, the fruit bunches at the end of the branches should be cut with long handled tools as soon as they show signs of ripening. The seeds are dried on a clean floor so as to prevent seeds to be blown away by winds. The seeds are then separated and stored in sealed airtight tins after being thoroughly dried. The seeds should be used in the same year as they cannot stand storage till the second year. Sowing of seeds in beds is carried out in the month of December-January. The seeds are sown in light soils in drills and lightly covered with soils. The seeds may also be sown directly in the polybags. After sowing, watering is done regularly but sparingly. The germination is epigeous. Germination starts in 8-10 days and is completed in about 40-45 days. No pretreatment is required for germination.

Ailanthus excelsa prefers sandy and porous soils. After selecting the site, the area is cleared and 30 cm^3 or 45 cm^3 pits are dug out in the month of February -March and the soil is allowed to weather. The planting in pits is carried out in the month of July.For block planting nursery raised seedlings of 6 to 10 months old are used for planting in pits at a spacing of 3m x 3m or 5m x 5m. *Ailanthus excelsa* can also be raised in the mixed plantations. A suitable mixture of tree species used in planting includes; *Acacia catechu*, *Albizialebbeck*, *Prosopisjuliflora*, *Prosopis cineraria*, *Acacia leucophloea*, *Azadirachtaindica, Dolichandronefalcata, Shorearobusta, Acacia nilotica, Pongamiapinnata, Ziziphusmauritiana* etc. some fodder grasses can also be planted with *Ailanthus excelsa*.

Silvicultural Treatments

This species is fast growing and normally does not require organic or inorganic fertilizers in plantations. In the arid regions of the country and in sandy soils, nitrogenous fertilizer application has given good response in the first year of growth. In arid and semi-arid areas watering should be done if the rains are not received within one week of planting. Timely and regular weeding for the first two years and soil working stimulates growth. The first silvicultural thinning may be carried out in the seventh or eighth year when the tree attains a height of 10-12 m.

Pest and Diseases

The seedlings or saplings may be affected by webworm *Atteva fabriciella*. They can be controlled by application of 0.1 per cent of Endosulphan and Malathion. Severe defoliation due to *Batoceraru fomaculata* causes the branches to fall off, leaving prominent scars with cracks on the main stem. There are suitable places for oviposition by the beetles. Spraying of kerosene or fuel oil is done in the larvae tunnels or the tunnels are plugged with cotton saturated with kerosene oil. *Eligma narcissus* is another defoliator recorded on this species particularly in South India and whose control is suggested through biological and mechanical means.

Utilization

1. **Splints:** Wood of the tree is extensively used for making matchwood boxes and match splints. The wood is extensively used in cottage industries for making wooden toys and cheap quality cricket bats.
2. **Plywood:** It is used as Grade III and Grade IV plywood.
3. **Fodder:** The leaves are rated as highly palatable and protein rich nutritious fodder. The mature leaves are lopped for their excellent cattle fodder.
4. **Fuel:** Wood makes good firewood. The stem and branches are used for fuel wood but it gives poor quality fuel as it burns quickly and does not sustain heat for long.
5. **Timber:** The wood is easily worked but is perishable and subject to insect attack and stain. It is used in boxes, crates,poles, fishing floats, tool handles and drums.
6. **Gum or resin:** The bark yields a gum of inferior quality.
7. **Medicine:** Bark, gum and the bitter aromatic leaves are used medicinally in home remedies.

SIGNIFICANT ECONOMIC IMPORTANCE AND UTILILIZATION

Ailanthus is extensively used for making matchwood boxes and match splints. The wood is used in cottage industries for making wooden toys and cheap quality cricket bats. The debarked wood is also used for making packing cases and wooden boxes. The wood is used for packing cases, fishing floats and sword sheaths. It is used as Grade III and Grade IV plywood. The pulp obtained from debarked wood and is used in paper industry. The leaves are rated as highly palatable and protein rich nutritious fodder for sheep and goats and are said to augment milk production. The stem and branches are used for fuel wood but it gives poor quality fuel as it burns quickly and does not sustain heat for long. The tree is the most adaptable and pollution tolerant. It is suitable for sloppy, degraded and denuded areas and wasteland. It is also yields gum of inferior quality. The bitter and aromatic leaves of the plant show medicinal properties. The leaves are used for the preparation of lotions for scabies. Quassinoids and ailantic acid are isolated from bark. The dried bark is aromatic and burnt as incense.

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Recent Breed Improvement Projects on Buffaloes in India

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ABSTRACT:

The buffalo holds an important place and role in Indian rural economy. India has the world's best breeds of buffaloes which is a major contributor to India's total milk production. To maintain and further increase the production there is a need of conservation and improvement in existing buffalo breeds by executing policies and programmes. This article summarizes various programmes implemented by government till date, results of which are unsatisfactory. These programmes therefore need several breeding strategies/policies to be adopted for their proper implementation.

Key words: Buffalo, programme, economy, improvement

INTRODUCTION

Buffaloes are preferred over cattle in India because of their distinctive qualities such as better feed conversion efficiency, more resistance to diseases and higher milk fat percentage than in cows. India is positioned first in milk production contributing 20% of the world milk production. Buffaloes contribute about 13% to the world milk production with an annual growth rate of 3.5%, compared with over 2.1% for the cow milk production. Milk production in India is 163.7 million tonnes with the growth rate of 6.6 %. 49 % of milk production is contributed by buffalo out of which of 35% is contributed by indigenous buffaloes and 14% is contributed by non-descript buffaloes. As per BAHS (2018) world buffalo milk production is 111 million tonnes. Buffalo holds great hope for food security and poverty alleviation in India, because of the largest population buffalo comprising diverse and the best buffalo germplasm of the world.

India has 108.7 million and they comprise approximately 56.7 % of the total world buffalo population. Buffaloes in India are spread over almost all parts of the country with varying density of population in different states and union territories. The majority of the population (72%) is concentrated in the north and western states where most of the milch breeds of buffaloes are found. Buffalo meat production accounts for about 19.80% of the total 7.4 million tons meat production in the country (19th Livestock census). Dry matter intake of such animals is generally more than 3% of body weight and dressing percentage as high as 55 to 60% can be achieve. At present there are 16 recognized breeds of buffalo in India. India's buffalo germplasm treasures include the world renowned breeds viz. Murrah, Surti, Mehsana, Jaffarabadi, Bhadawari, Nili Ravi, Pandharpuri, Banni, Marathwadi, Nagpuri, Kalahandi, Toda and Chilika. Luit, Bargur and Chhattisgarhi are new breeds registered by NBAGR. These breed types constitute only about 40% of the population while the remaining 60% represent an admixture of different breeds and are commonly referred to as Desi or non-descript types. According to breed survey (2013) the distribution of indigenous buffaloes are under three major categories i.e. Pure, graded and non-descript (table 1). Out of total buffaloes, 17.05 % are pure breeds, 39.58 % are graded and remaining 43.37 % are Non-Descript (approximate values).

Table 1: Breed-wise estimated number of Indigenous Buffaloes

S. No.	Name of the Breed	Pure (no.)	Graded (no.)	Total no. of Animals	Percentage share with respect to total (approximate values)
1	Murrah	1,16,86,198	3,65,68,676	4,82,54,874	44.39
2	Surti	18,86,280	20,06,614	38,92,894	3.58
3	Mehsana	26,76,699	9,48,426	36,25,125	3.33
4	Jaffarabadi	5,71,077	12,00,421	17,71,498	1.63
5	Bhadawari	5,83,599	11,70,188	17,53,787	1.61
6	Nili Ravi	1,29,411	5,47,834	6,77,245	0.62
7	Pandharpuri	2,87,751	1,95,987	4,83,738	0.45
8	Banni	2,39,572	1,42,550	3,82,122	0.35
9	Marathwadi	2,78,502	98,093	3,76,595	0.35
10	Nagpuri	73,584	1,17,410	1,90,994	0.18
11	Kalahandi	1,15,213	26,802	1,42,015	0.13
12	Toda	3,003	2,533	5,536	0.01
13	Chilika	2,599	787	3,386	0.00
Total Indigenous Breed		**1,85,33,488**	**4,30,26,321**	**6,15,59,809**	**56.63**
Non-descript		-	-	4,71,42,313	43.37
Total Buffaloes		**1,85,33,488**	**4,30,26,321**	**10,87,02,122**	-

Among the individual breed only 5 breeds namely Mehsana, Banni, Marathwadi, Kalahandi and Chilika are having their pure breeds more than 60% in number. In all other breeds major contributions is from graded breeds. The improvement of buffalo is focused to include the different economic traits such as:

1. Growth traits: It includes body weight, body weight at different ages, growth rate body weight at sexual maturity, body weight at calving interval.
2. Reproductive traits: It includes age at puberty, age at first calving, service period, gestation period, calving interval, number of services per conception.
3. Production traits: It includes milk yield (Lactation yield), Persistency of yield, lactation length, dry period, milk composition.

In majority of the cases, the true productive potential of individual breeds in their breeding tracts has not been adequately documented. This has affected the detailed description of the breeds and also their genetic potential. There is thus an urgent need for differentiating the real breed differences by conducting systemic scientific studies. There is an urgent requirement to uniformly describe all the Indian buffalo breeds by utilizing common breed descriptors, by studying their native environment, management practices, qualitative and quantitative aspects of morphological, physiological and functional traits, blood groups and biochemical polymorphisms, cytogenetic parameters, DNA analyses, utility and demographical and geographical distributions. This will lead to the identification of the types of genes and gene combinations available in different breeds and will also assist in formulating breeding policies and selection of animals for conservation, propagation and improvement programmes.

METHODS OF BREED IMPROVEMENT:

1. Grading up: Grading up is the method used for genetic improvement of the buffalos. The low producing, local non-descript buffaloes are generally reared under low to medium input production system in areas where feed and fodder resources and marketing facilities are moderately available. The production potential of low producing non-descript buffaloes can be increased rapidly through mating with superior sires of improved breeds like Murrah, Surti and Mehsana. Surti is recommended for Karnataka, Kerala, parts of Gujarat and Rajasthan, Nili Ravi for few pockets of Punjab, Murrah for Haryana, parts of western Uttar Pradesh and Punjab. In other parts of the country where sufficient feed and fodder resources are available, Murrah is recommended for grading up of medium body sized non- descript buffaloes. The low producing non-descript buffaloes can be replaced with relatively high producing buffaloes conforming to the characteristics of well-defined breeds through grading up with superior breeds in 5 to 6 generations. It may be explored to collect semen from 50 % graded breed bull and distribute for field insemination in the places with inadequate management and feed / fodder resources for sustaining the improvement achieved in the first generation of grading up programme.

2. Selective breeding: The relatively high yielding buffaloes of well-defined breeds are maintained under intensive production system at organized farms and under semi-

intensive management system in farmer's herds in the breeding tracts of different buffalo breeds. To exploit the large degree of genetic variability between and within the buffalo breeds, the genetic improvement of buffalo herds in the country can be brought through selective breeding within breeds by net-working approach of progeny-testing of bulls associating multiple organized herds as well as farmer's herds under field conditions. For effective implementation of such programmes particularly on large scale, existing organized farms of Murrah, Surti, Mehsana, Nili Ravi, Nagpuri, Bhadawari and Jaffarabadi buffalo breeds should be strengthened for production of breeding bulls. In certain pockets of states like Gujarat, Rajasthan and Karnataka, Surti is recommended to be the breed of choice; Murrah is generally the breed of choice in the states of Punjab, Haryana and Western U.P besides few pockets in Punjab where Nili Ravi has sizable population and it also needs to be improved through selective breeding. It is expected that genetic improvement of 1 to 1.5% per annum in milk production will be achieved at organized farms by selective breeding, through networking of multi-herds of a particular breed and 8-10% per annum in farmers' herds through introducing germplasm of high yielding buffalo bulls.

3. Newer Technologies:

3.1 Sexed semen production: Semen sexing technique can help to quickly address the requirement of superior germplasm through programmed birth of male calves to elite females so that these can be used extensively in AI programme to cover the vast population of low-producing indigenous and non-descript buffalo for faster upgrading. Progeny testing can also be accelerated through controlled births of required numbers of daughters within short period. Recent development of modern cellular methodologies has led to development of a flow cytometric system capable of differentiating and separating living X- and Y chromosome with about 90% accuracy.

3.2 Cloning: Cloning is the process of generating a genetically identical copy of a cell or an organism. The production of first buffalo clone in the world GARIMA, its normal pregnancy and the birth of its calf MAHIMA by the scientists of NDRI Karnal is a major land mark in developing such technologies for achieving higher success and a step forward for faster multiplication and production of superior germplasm.

3.3 Multiple ovulation and embryo transfer (MOET) and embryo manipulation: It offers possibilities for faster multiplication of superior germplasm from highly selected elite donors and may facilitate to achieve the target producing large number of superior bull calves/bulls and their adequate number of quality semen doses. Emerging developments in the area of molecular genetics has also opened the new possibility of identifying and using DNA level variation and major genes for genetic improvement of livestock.

3.4 Molecular marker systems: Molecular marker systems like RFLP and micro satellites, genome maps, methods of detecting marker-QTL linkages and marker-assisted selection are new tools used in breeding programme for enhancing the rate of genetic progress.

4. Network project for cattle and buffalo breeding (NPCBB): Initiated by Department of Animal Husbandry & Dairying, Government of India has played a vital role in evaluation, production and dissemination of adequate number of genetically superior bulls and their frozen semen doses through involving various research and development organizations. The project originated in the year 2000, October over a period of 10 years, in two phases each of five years, with an allocation of Rs. 402 crore for phase-I. In order to consolidate gains made during phase –I, phase-II has been initiated from December 2006 with an allocation of Rs. 775.87 crore. Under the Network Project on Buffalo Improvement, the wet average of Murrah herds at various centres increased from 5.29 at the start of the project to 7.15 during 2012-13 and further to 7.73 in the year under report. There is also an improvement in average standard lactation yield from 1,602 kg in 1992- 93 to 2,351 kg in 2013-14 across all Murrah centres.

5. Semen conservation and dissemination: A total of 110,844 frozen semen doses of Murrah bulls were produced, 18,805 doses were used for test matings and 75,500 doses were sold to farmers and other agencies. Pedigreed Murrah bulls were sold to livestock development boards and other developmental agencies of Haryana, Madhya Pradesh and Rajasthan for breeding and improvement of buffaloes. Increased interest in Nili Ravi breed is evident by sudden surge in frozen semen demand by farmers leading to sale of 27,875 doses of frozen semen of elite bulls. Institute's initiative to collect semen from champion Murrah bulls, available with Haryana's progressive farmers, was immensely popular; and 15,158 doses of semen were preserved from these bulls after stringent quality and disease tests, and made available to the farmers for breed improvement.

6. Field progeny testing programme: Artificial inseminations (16,394) with the semen of 10 test Murrah bulls of 14th set were performed and 6,934 pregnancies were confirmed. A total of 5,286 calvings were recorded and milk recording was completed in 363 daughters under various field unit centres.

7. AICRP: The project was launched in 1970 at four centers namely PAU, Ludhiana and NDRI, Karnal to improve the production potential of buffaloes through assessment of genetic merit of sires and to increase the production by breeding, feeding and management. AICRP comprising mainly Murrah breed and two centres for small/medium sized buffaloes comprising mainly Surti and Mehsana breed. Buffalo improvement programs through bull selection on the basis of progeny performance and distribution in the field were taken up at several state and central government farms.

8. Rashtriya Gokul Mission: The Rashtriya Gokul Mission has been launched in December 2014 with an outlay of Rs. 2025 crore for the improvement and conservation of indigenous breeds through selective breeding in the breeding tract and genetic upgradation of non-descript bovine population. The scheme comprises of two components namely National Programme for Bovine Breeding (NPBB) and National Mission on Bovine Productivity (NMBP). Recently, on 5th September, 2018 Chhattisgarhi breed of buffalo is registered under NBAGR and is distributed throughout the Chhattisgarh state. The coat colour is black. Animals are medium built with

proportionate body. Horns are medium to large in size and directed laterally backwards and then upwards with pointing tips. These buffaloes are reared under extensive system for providing draught power, milk and meat. Males have excellent ploughing ability and preferred over cow bullocks specifically in rice fields. Milk yield ranges from 3 to 6 kg/day.

9. National programme for bovine breeding and dairy development (NPBBDD): The scheme was launched in February, 2014 by merging four existing schemes i.e. Intensive Dairy Development Programme (IDDP), Strengthening Infrastructure for Quality & Clean Milk Production (SIQ&CMP), Assistant to Cooperatives and National Project for Cattle & Buffalo Breeding (NPCBB) with the budget provision of Rs.1800 crores for implementation during 12th Plan. The Scheme has two components namely (i) NPBB and (ii) NPDD. This has been done with a view to integrate milk production and dairying activities in a scientific and holistic manner, to attain higher levels of milk production and productivity and to meet the increasing demand for milk in the country. The mandate of this scheme is;

1) To arrange quality artificial insemination services at farmers' doorstep
2) To bring all breedable females under organised breeding through artificial insemination or natural service using germplasm of high genetic merits
3) To conserve, develop and proliferate selected indigenous bovine breeds of high socio-economic importance
4) To provide quality breeding inputs in breeding tracts of important indigenous breeds to prevent the breeds from deterioration and extinction.

CONCLUSION

It is concluded that buffalo has been and will remain an integral part of the economy especially for small holder farmers in India. As buffalo is the key animal of Indian economy, government has developed various policies and programmes for their improvement. However despite their good results, productivity still appears to be low. Therefore, there is a need to review the available information on the existing breeds and breeding policy and develop future strategies for buffalo development.

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Recommendations for Euthanasia of Laboratory Animals

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ABSTRACT

Euthanasia is the practice of intentionally ending a life to relieve pain and suffering. Millions of laboratory animals are sacrificed each year worldwide. However, there is lack of decision-making on humane methods of sacrificing laboratory animals at different stages of development. This article summarises the justifications and objectives of euthanasia, acceptable and unacceptable methods of euthanasia, recognition and confirmation of death of laboratory animals, and their appropriate disposal, to help inform good practices for humane sacrificing.

Keywords: Euthanasia, lab animals, humane methods, death, disposal

1. INTRODUCTION

The meaning for euthanasia is "easy death" and performed where an animal is required to be sacrificed on termination of an experiment or otherwise for ethical reasons. Whichever method for euthanasia is to be used, it must be carried out humanely, causing absolutely the minimum amount of anxiety and pain to the animal. The procedures must be performed only by the persons competent in the methods to be used, or under the direct supervision of a competent person. The appropriate means must be readily at hand. The animals should be killed in a quiet, clean environment, and normally away from other animals. There should be no disposal of the carcass until death is established. The dependent neonates of animals being killed must also be killed or provision should be made for their care, and when fertilized eggs are used, the method of disposal must ensure the death of the embryo. This article describes the "humane method of killing" as the killing of an animal with a minimum of physical and mental suffering, depending on the species.

2. Justifications of euthanasia: Animals are killed in laboratories or breeding establishments for various reasons which are listed below:

1. The animals are sacrificed at the end of an experiment for ethical reasons or when there might be continuing adverse effects.
2. The animals are sacrificed to supply blood and other tissues for a scientific purpose.
3. The animals are sacrificed when levels of pain, distress and suffering to animals exceed the designated level.
4. Where the health or welfare of the animals are grounds for concern.
5. To remove the animals which are no longer suitable for breeding, and feeding them would only increase the cost of rearing.
6. To remove unwanted stock or those with unsuitable characteristics, for example, type or sex.

3. Objectives of euthanasia: The primary criteria for euthanasia in terms of animal welfare are that the method be painless, with minimum time lag phase, achieve rapid unconsciousness and death, require minimum restraint, avoid excitement, is appropriate for the age, species, and health of the animal, must minimize fear and psychological stress in the animal, be reliable, reproducible, irreversible, simple to administer (in small doses if possible) and safe for the operator, compatible with the purpose of study, minimum emotional effect on the observer and, so far as possible, be aesthetically acceptable for the operator.

4. Signs of pain and distress to ensure euthanasia: To ensure euthanasia i.e. a gentle death, it is important to recognize signs of pain, fear and distress in the relevant species. All personnel must be trained to recognize these signs of suffering in the species with which they are working. Assessment of these factors must be based primarily on observations of abnormal behavioural and physiological responses that demonstrate anxiety and fear. Depending on the species these may include: distress vocalizations (not always in the human audible range), struggling, attempts to escape, defensive or redirected aggression, freezing or immobility response, panting, salivation, urination, defecation and evacuation of anal sacs, pupillary dilatation, tachycardia, sweating, reflex skeletal muscle contractions causing shivering, tremors, or other muscular spasms. Some of these responses can occur in unconscious as well as conscious animals. Fear may cause immobility or freezing in certain species, particularly rabbits and chickens. This immobility response should not be interpreted as unconsciousness when the animal is, in fact, conscious.

5. Acceptable methods of euthanasia for conscious animals:

a. Fish: There are over 34,000 species of fish with enormously varying lifestyles which makes it very difficult to generalize on methods of euthanasia. The physical methods of euthanasia involves concussion (blow to the back of the head), cervical dislocation (breaking of the backbone near the head by inserting a rod or thumb in the mouth by holding the fish with the opposite hand and displacing it dorsally) and maceration (placing small fishes below waste disposal unit). In addition to it, chemical agents can be

administered by dissolving the chemical in the tank water. The water level should be lowered prior to the administration of drug to ensure rapid sedation but not so much as to distress the fish before the addition of the agent. The drugs that can be utilized are tricaine methane sulphonate (buffered MS-222; most effective way to kill fishes), benzocaine (ethyl aminobenzoate), etomidate, metomidate, quinaldine (2-methylquinoline), halothane and barbiturates (injectable agent). It may be necessary to fast fish 24-48 h prior to chemical euthanasia as this will permit more rapid absorption by the gut and minimize the risk of regurgitation which could reduce the effect of the chemicals on the gill lamellae.

b. Rodents: Rodents are the most commonly used animals for experimental purposes and include mice, rats, hamsters, guinea pigs, gerbils, shrews, and dormice. The physical methods of euthanasia involves concussion, cervical dislocation, decapitation (cutting of head, not in guinea pigs), microwave (a specialized apparatus for quick killing of rodents by ensuring correct positioning of the beam on animal; not a routine method) and rapid freezing (using liquid nitrogen). The chemical methods involved are: inhalation agents where, animal is kept in inhalation chamber with cotton or gauge or wool soaked in anaesthetics like halothane, enflurane, isoflurane, CO_2 (70% in oxygen; 100% recommended for guinea pigs), CO (6% by volume) and injectable agents like sodium pentobarbitone and T-61 (acts quickly but should be injected very slowly intravenously).

c. Rabbit: The physical methods of euthanasia involves concussion, cervical dislocation, captive bolt (penetration of bolt about 3 cm into the brain), decapitation, electrical stunning (tongs should be applied on each side of the head between the eye and ear to span the brain with 0.14 amps and 100 volts for a period of 3 seconds), microwave and rapid freezing. The chemical methods involved are inhalation anaesthetics (halothane, isoflurane, enflurane, CO_2, CO) and injectable agents like sodium pentobarbitone and T-61.

d. Birds: Birds have a complex respiratory system comprising the lungs and numerous air sacs with a one-way flow of air. This may influence the rate of absorption of inhalational agents and thus, increase their efficiency. The physical methods of euthanasia involve cervical dislocation, maceration, concussion, microwave and electrical stunning. The chemical methods in this context are volatile inhalation agents like CO_2, CO, isoflurane, halothane and enflurane, and injectable agents viz. sodium pentobarbitone and T-61.

e. Dogs, Cats and Ferrets: The physical methods of euthanasia involves captive bolt, shooting (using a free bullet) and electrocution (ear clips are attached to ensure that the current flows directly through the brain; either by 500 volt or by 1 kilo-volt shock; not done in cat due to high conductivity of their coats). The chemical methods involved are volatile inhalation anaesthetics (CO_2, CO, isoflurane, halothane and enflurane) and injectable agents like sodium pentobarbitone, secobarbital, dibucaine and T-61.

f. Pigs: The animals must be suitably restrained in adequate devices to ensure that the animal remains still and calm so that the method of euthanasia is accurate and quick. Personnel should be quiet and handle the animals with care to reduce stress and anxiety

in the animals. The physical methods of euthanasia are captive bolt (most acceptable method), shooting (only used when no other method is applicable in field), concussion and electrical stunning. The chemical methods involved are volatile inhalation anaesthetics (isoflurane, enflurane, halothane, CO2,) and injectable methods (sodium pentobarbitone, IV and rapid euthanasia; quinalbarbitone/nupercaine and T-61).

g. Non-human primates: The only recommended method for killing non-human primates is by overdose of anaesthetic. Sodium pentobarbitone injected intravenously is the most acceptable agent. Exsanguination under inhalation anaesthesia is also considered acceptable, but this must be followed by perfusion.

6. Acceptable methods of euthanasia for unconscious animals:

a. Fish: The methods acceptable for unconscious fish are pithing (a metal spike is pushed into the top of head between eyes and pushed towards and backwards to destroy the brain and proximal end of the spinal cord), decapitation and exsanguination.

b. Rodents: The methods acceptable for unconscious rodents are Rapid freezing, exsanguination, air embolism, administration of KCl (cardiotoxic) and ethanol (IP).

c. Rabbits: The methods acceptable for unconscious rabbits are: exsanguination, nitrogen (kills by hypoxia), KCl and air embolism.

d. Birds: The methods acceptable for unconscious birds are: decapitation, pithing, nitrogen and KCl.

e. Dogs, Cats and Ferrets: The methods acceptable for unconscious carnivores are; exsanguination, dislocation of neck and KCl.

f. Pigs: The methods acceptable for unconscious pigs are: exsanguination, chloral hydrate and KCl.

7. Unacceptable methods of euthanasia for laboratory animals:

a. **Fish:** The methods not acceptable are removal from water, whole body crushing, electrical stunning, hypothermia, hyperthermia, 2-phenoxyethanol, CO_2, diethyl ether, amobarbitol, urethane, chloral hydrate and tribromoethanol.
b. **Rodents:** The methods not acceptable are hypothermia, nitrogen, NO, cyclopropane, ether, chloroform, decompression (creating vaccum that induces dyspnoea), asphyxia, drowning, trichloroethylene, methoxyflurane, HCN gas, strychnine, nicotine, curariform drugs and other neuromuscular blocking agents.
c. **Rabbits:** The methods not considered acceptable are hypothermia, nitrous oxide, methoxyflurane, cyclopropane, ether and chloroform, ketamine HCl, Magnesium sulphate, decompression, asphyxia, drowning, trichloroethylene, HCN gas, strychnine, nicotine and other neuromuscular blocking agents.
d. **Birds:** The methods not acceptable are neck crushing, exsanguination, decompression, nitrous oxide, ether and chloroform, cyclopropane, HCN gas, methoxyflurane, trichloroethylene, chloral hydrate, strychnine, nicotine, magnesium sulphate, ketamine alone and neuromuscular blocking agents.
e. **Dogs, Cats and Ferrets:** The methods not considered acceptable are striking of chest of cats, decompression, CO_2 (except for neonates) and CO, nitrogen, ether

and choloroform, drowning, concussion, decapitation, asphyxia, strangulation, nitrous oxide, HCN gas, cyclopropane, methoxyflurane, trichloroethylene, air embolism, HCN acid, magnesium sulphate, strychnine, nicotine and other neuromuscular blocking agents.

f. Pigs: The methods considered unacceptable are CO, methoxyflurane, trichloroethylene, magnesium sulphate, strychnine, nicotine, thiopentone sodium, ketamine HCl, curariform drugs and other neuromuscular blocking agents.

8. Recognition and confirmation of death: It varies among animals and is recognized and confirmed as:

a. Fish: Death may be recognized by cessation of respiration (opercular movement) and cessation of heartbeat (palpation). Death should be confirmed by destruction of the brain where possible.

b. Rodents and Rabbits: Cessation of respiration and heartbeat, and absence of reflexes are good indicators of irreversible death in rodents. Death may be confirmed by exsanguination or extraction of the heart, evisceration, deep-freezing or decapitation.

c. Birds: Death may be recognized by cessation of respiration and heartbeat and absence of reflexes in the head (i.e. cranial nerve reflexes rather than spinal cord reflexes). Reflexes to be checked would include pinching of wattles or blink reflexes. Death can be ensured by destruction of the brain.

d. Dogs, Cats, Ferrets, Pigs and Non-human primates: Cessation of respiration and heartbeat, and loss of reflexes are good indicators of irreversible death in carnivores. Death should be confirmed by exsanguination.

Personnel must be trained to recognize and ensure death when killing laboratory animals.

9. **Disposal of carcass**

All animal carcasses whether healthy, infectious or radioactive, bedding, leftover feed and excreta must be packed in polythene bags before sending them for disposal. Later, all may be buried deep in the ground and covered with lime and disinfectants or burnt in an incinerator.

CONCLUSION

Euthanasia is the process of inducing a painless death and is necessary to be adopted in all aspects of scientific procedures involving animals. If an animal has to be killed, death must occur with the least fear, anxiety, pain and distress. The method used for euthanasia must either kill the animal very rapidly or instantaneously render the animal unconscious so that death ensues before consciousness is regained. The application of any method must be such as to minimize the impact of any procedure on the welfare of animal. Consequently, consideration also must be given to how the animal is handled immediately prior to and during euthanasia. Ultimately, for the method to be effective,

reliable and humane, the technical competence of the persons involved in all aspects is paramount.

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Pericarp browning in litchi: A major bane to the blessed fruit

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ABSTRACT

Litchi (Litchi chinensis Sonn.), is one of the most important fruits of tropical and subtropical world and is highly prized for its perfectly blended sweet-acidic juicy pulp. The attractive bright red pericarp which determines the consumer acceptance of this fruit is lost and turns brown within 2-3 days of harvesting if stored under ambient conditions. Pericarp browning is the main limitation to long term marketing and export of litchi fruit. The oxidative enzymes like peroxidase (PDO), anthocyanase and polyphenol oxidase (PPO) are responsible for the enzymatic browning of litchi fruit pericarp. Since, PPO, which is the main enzyme involved in browning has a low affinity to litchi pericarp anthocyanin, it is supposed that the anthocyanins are first hydrolysed by anthocyanase, resulting in formation of anthocyanidin which in turn is oxidized by PPO and/or POD resulting in oxidative browning. The current research focuses on prolonging the shelf life of litchi fruits using different post-harvest treatments which can maintain the pericarp membrane integrity thus, avoiding loss of compartmentalization between litchi pericarp oxidase enzymes and their substrates and in turn preventing browning.

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.), is one of the most important fruits of tropical and subtropical world belonging to the family Sapindaceae. It is highly prized for its perfectly blended sweet-acidic juicy pulp which is enclosed within an attractive bright red pericarp. The bright red pigment of litchi pericarp which also determines its consumer acceptance is attributed to the presence of anthocyanins. In many cultivars, cyanidin-3-rutinoside and cyanidin-3-glucoside are found to be the major anthocyanin pigment while malvidin-3-acetylglucoside and peonidin-3-O-rutinoside as minor anthocyanin pigments contributing to the red colour of litchi pericarp. Anthocyanin synthesis in the fruit pericarp is regulated by different transcription factors like *BASIC HELIX-LOOP-HELIX* (*bHLH3*), *MYELOBLASTOSIS 1* (*MYB1*) and *WD40 REPEAT* (*WDR*).

Litchi pigments, like all other anthocyanins, are unstable and once harvested, litchi fruit pericarp undergo rapid senescence, turning brown within 2-3 days of harvest if stored at ambient temperature. Pericarp browning is thus, considered to be a major

post-harvest problem in litchi which restricts the window for marketing and export of this globally cherished fruit.

Since, anthocyanins are unstable they can be degraded both enzymatically and non-enzymatically. Several factors have been correlated with pericarp browning in litchi some of which include desiccation, rapid cellular de-compartmentalization, increased peroxidation of the membrane lipids, over production of the reactive oxygen species (ROS) and decreased pericarp antioxidants. However, increased oxidation of phenolics and anthocyanins catalysed by enzymes like peroxidase (PDO), anthocynase and polyphenol oxidase (PPO) has been reported to be the major cause of pericarp browning in litchi.

MECHANISMS

Some reports suggest that there is no marked change in the anthocyanin content during fruit browning and that litchi PPO cannot oxidize anthocyanin, but anthocyanin might be degraded rapidly in an anthocyanin-PPO-phenol system. These observations open up new avenues to understand browning mechanism in litchi. Two possible mechanisms have been proposed for the non-enzymatic degradation of anthocyanin. First the hydrolysis of 3-glycosidic linkages to produce more labile aglucone and second hydrolytic opening of the pyrylium ring to form a substituted chalcone. At a pH of 3.0 or below, anthocyanins exist in a stable red flavylium ion form while the stability decreases at higher pH where they exist in anhydro base form resulting in the formation of colourless chromenols. Generally, the physiological pH of the vacuole of plant with red anthocyanins is about 3.0 as is the case in litchi. With desiccation the pH values of litchi pericarp are found to increase from 4.1 to 4.7. However, the degradation of anthocyanin in litchi fruit is much faster than the half-degradation constant for anthocyanins at pH 5.0 in vitro and the fruit loses 50% of anthocyanin within three days of storage at a temperature of 30ºC and relative humidity of 70%. This suggests that the spontaneous degradation of anthocyanins cannot account for the rapid browning of the litchi pericarp indicating that enzymatic degradation of the anthocyanins may play a key role in the browning.

In comparison to anthocyanins, the degradation of the anthocyanidin is more pronounced, especially at pH 5.0. The major anthocyanin pigment found in litchi is reported to be cyanidin-3-rutinoside and the opening of cyanidin produces an o-phenol, a structure similar to catechol, a good substrate for PPO, which, in turn, can accelerate the enzymatic browning reaction by PPO. Additionally, high activity of the enzyme anthocyanase (anthocyanin-b-glucosidase) have been reported from litchi pericarp which could play a role in removal of sugar groups from anthocyanin leading to its decolorization. Thus, a possible mechanism of litchi pericarp browning may involve co-oxidation of phenols and anthocyanins by PPO with the formation of o-quinones, and the hydrolysis of anthocyanins by anthocyanase resulting in formation of anthocyanidin, which, in turn, accelerates the enzymatic degradation of the anthocyanins.

MAJOR ENZYMES AND SUBSTRATES IN PERICARP BROWNING

Polyphenol oxidase: Polyphenol oxidase (PPO) also referred to as catechol oxidase, tyrosinase, catecholase or o-diphenol oxygen oxidoreductase are a group of copper containing enzymes mainly responsible for the oxidation of phenolics and degradation of anthocyanin pigments of litchi pericarp. However, PPO has very less affinity to the anthocyanin present in the litchi pericarp and thus, cannot oxidize anthocyanins directly which suggests the presence of a non-anthocyanin substrate for this enzyme to be involved in litchi pericarp browning. Several phenols are present in litchi pericarp among which PPO has a stronger affinity for flavan-3-ol monomers and dimers mainly (-)-epicatechin, (-)-epicatechin 3-gallate, procyanidin B2 and (-)-epigallocatechin. Among these (-)-epicatechin which is an ortho-diphenol compound serves as the direct substrate of PPO. Additionally, proanthocyanidins (condensed tannins) a yellowish-white to light brown colour polymer of flavan-3-ols may be responsible for the brown discoloration of litchi fruit. PPO activity is inconsistent during the storage period of litchi fruit and can be inhibited by antioxidants, like glutathione and L- Cysteine, and activated by divalent cations, such as Mn^{2+} and Ca^{2+}.

Peroxidase: Peroxidase (POD), a heme-containing glycoprotein is another group of oxidases involved in enzymatic browning of litchi. POD activity is correlated with cellular browning and a higher POD activity is observed in exocarp along with the vascular tissues of mesocarp located in the cell wall during browning. The partially purified POD from litchi pericarp are capable of oxidizing many phenolics such as *m*-, *o*-, and *p* diphenols, guaiacol, and pyrogallol in the presence of H_2O_2, producing brown pigment polymers.

Anthocyanase: Anthocyanase promotes loss of anthocyanins by catalysing the hydrolysis of sugar moieties from anthocyanin resulting in the formation of anthocyanidin, which is a direct substrate for PPO oxidation or indirect substrate for POD as it can be degraded by POD if reacted together with guaiacol and H_2O_2. Cold injury and hot water treatments enhance anthocyanase activities whilst cool temperature and treatment with ABA, 1-MCP or HCl inhibits anthocyanase activities promoting and inhibiting the loss of anthocyanin respectively.

Phenylalanine ammonialyase: Phenylalanine ammonialyase (PAL) catalyses the first step in the phenylpropanoid pathway and plays a key role in the biosynthesis of phenylpropanoid-derived secondary products like phenolic compounds such as (-) -epicatechin which is the main substrate for PPO. The phenolic compounds synthesized during phenylpropanoid pathway can be further converted to other phenolic compounds via coumarate, such as flavonols, anthocyanins, chlorogenic acid and caffeic acid derivatives which serve as browning substrates in some other plant tissues.

LOSS OF MEMBRANE INTEGRITY AND BROWNING

In the intact red pericarp of litchi, different oxidative enzymes like peroxidase (POD), lipoxygenase (LOX), polyphenol oxidase (PPO), anthocyanase and phenylalanine ammonia lyase (PAL) and their substrates are present in different subcellular compartments which prohibits their interaction with each other, thus preventing browning. Dehydration or lipid peroxidation of the litchi pericarp results in the rapid

loss of membrane integrity and fluidity and increases its permeability thereby bringing the enzymes (e.g. PPO) in contact with substrate (e.g. –epicatechin) and initiates the browning reaction. There is an increase in peroxide and malondialdehyde concentration in the senescing litchi fruit along with decrease in the activity of superoxide dismutase which in turn make the membrane more prone to oxidative activity due to the over production of Reactive Oxygen Species (ROS).

Management

Maintaining the membrane integrity: Preserving membrane structure can be helpful in maintaining fruit quality and extending shelf-life. In this regard, the regulation of Phospholipase D (PLD) which functions as a key enzyme in mediating the membrane phospholipid degradation that embarks rapid and early event in postharvest senescing tissues can have an important role in maintaining the postharvest fruit quality. Several chemicals such as n-butanol, N acylethanolamines and 2,3-diphosphoglycerate are considered as potent PLD inhibitors. Among these, n-butanol is a specific inhibitor of PLD dependent production of the signalling molecule phosphatidic acid and may protect membrane integrity by inhibiting phosphatidic acid production and membrane lipid degradation. Additionally, exogenous anthocyanin treatment enhances the free radical-scavenging activity and inhibits lipid peroxidation which can also reduce browning by maintaining the membrane integrity of litchi pericarp tissues.

Sulphur fumigation: It is one of the oldest methods to improve shelf life of litchi. However, it is associated with several side effects like bleaching effect of sulphur, altered lower pH and flavor of fruit along with sulphur content in aril. Hence, this practice has been discouraged due to increased consumer concerns.

Sodium metabisulfite: It is an improvement over sulphur fumigation. Dipping of fruits in metabisulfite at different concentrations with acid results in increased anthocyanin content with decreased POD/PPO activities and the arils are found to have no sulphur content.

Hydro-cooling: Hydro-cooling for 30 minutes not only reduces the temperature of pericarp by 6°C but also delays the electrolyte leakage and polyphenol oxidase/peroxidase activity in pericarp thus, increasing the shelf life of litchi.

Acid treatment: Treating fruits with 1% HCl for 6 min is found to inhibit PPO activity and has been recommended for commercial application to prevent browning of frozen litchi fruit and maintaining its quality during storage and marketing.

Anti-oxidant treatment: Different compounds with anti-oxidant activities like *Para*-aminosalicylic acid (PAS), melatonin, Tea seed oil extracted from *Camellia oleifera* (0.1%) have been used in litchi to prevent pericarp browning. This could be attributed to the ability of these compounds to maintain membrane integrity by maintaining redox homeostasis and modulating the repair of oxidatively damaged proteins.

Wax coatings: Use of Ascorbic acid, a potent anti-oxidant in combination of chitosan results in increased shelf life of litchi fruits owing to the reduced activities of browning enzymes (PPO and POD) along with maintenance of membrane integrity.

Modified atmosphere packaging: MAP packaging of litchi fruit suppresses the polyphenol oxidase (PPO) activity while maintaining the membrane integrity and redox homeostasis thus, delays browning and conserve biochemical attributes and antioxidative enzymes during 28 days cold storage.

CONCLUSION

Pericarp browning is the main limitation to long term marketing and export of litchi fruit. The oxidative enzymes like PPO, POD and anthocyanase are responsible for the enzymatic browning of litchi fruit pericarp. Several methods have been used to overcome this problem which include exogenous treatment of harvested litchi fruits with ascorbic acid, 1-methylcyclopropene, hydrochloric acid, oxalic acid, irradiation, salicylic acid, pyrogallol, Potassium metabisulfite, apple polyphenols, tea seed oil, biocontrol bacteria, novel chitosan formulation and methionine. Pericarp browning deserves an extensive research for understanding and alleviating this problem. However, one good observation that has been made is that the PPO substrates present in litchi pericarp (_)-epicatechin and procyanidin A2 possess a good antioxidant activity and can be used as potential antioxidants in litchi waste opening up a new avenue for litchi waste utilization.

Use of Sewage Water in Agriculture

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The use of urban wastewater for agricultural irrigation is a growing practice worldwide. Both in semi-arid and arid countries at all levels of development, and in low-income countries where urban agriculture provides livelihood opportunities and food security, irrigation is the most prominent and the most rapidly expanding use of wastewater. Agricultural wastewater use helps to conserve and expand available water supplies, and can contribute toward a more integrated management of urban water resources. If not planned, managed and implemented properly, it is associated with a number of risks, including public health, agronomic, and environmental risks. Microbial health risks are especially severe in low- and middle-income countries, where the practice often involves the direct use of untreated wastewater and/or the indirect use of polluted waters from rivers and streams to irrigate food crops. Farmers and the urban poor are disproportionally affected. Chemical health risks assume greater importance as industrialization occurs. This article aims to highlight the importance of improving wastewater use in agriculture across the spectrum from low- to high-income countries, assess the outstanding issues and proposed responses, and suggest a strategic focus for implementing wastewater irrigation policies and programs. It sets out the trends and challenges of wastewater use in agriculture, identifies the risks and benefits of wastewater irrigation, describes the risk assessment and management framework adopted by WHO, FAO and other international and national organizations, and proposes measures for reducing health risks and promoting an integrated approach to plan wastewater use for irrigation.

The trends and challenges of wastewater use in agriculture

In many regions, as freshwater sources become scarcer, wastewater use has become an attractive option for conserving and expanding available water supplies. Wastewater use can have many types of applications, including irrigation of agricultural land, aquaculture, landscape irrigation, urban and industrial uses, recreational and environmental uses, and artificial groundwater recharge. Wastewater can be used with appropriate treatment for all purposes for which freshwater is used. Wastewater use in agriculture is by far the most established application, and the one with the longest tradition. Estimates on wastewater use worldwide indicate that about 20 million

hectares of agricultural land is irrigated with (treated and untreated) wastewater. Powerful drivers for the expansion of wastewater irrigation include increasing water stress (in part due to climate change), increasing urbanization, growing urban wastewater flows due to the expansion of water supply and sewerage services, and more urban households engaged in agricultural activities that could be intensified with additional sources of irrigation water and nutrients. These key drivers are expected to become even more powerful in the near future, making improved wastewater use in agriculture an emerging priority.

The problem with this growing trend toward more wastewater irrigation is that in low-income countries, also in many middle-income countries, the practice either involves the direct use of untreated wastewater or the indirect use of polluted waters from rivers and streams that are the recipients of untreated wastewater discharges. With freshwater either unavailable or too expensive, and wastewater treatment not keeping up with urban growth, urban farmers often have no alternative but to use highly polluted water. Many of them belong to the urban poor who depend on agricultural activities as a source of income andemployment generation as well as food security. With the advent of modern sewerage systems and wastewater treatment processes in the early 20th century, industrialized countries began to establish regulatory frameworks for controlling wastewater treatment and use for irrigation.

The risks and benefits of wastewater use in agriculture

Wastewater use in agriculture has substantial benefits for agriculture and water resources management, but can also pose substantial risks to public health – especially when used untreated for crop irrigation. There can also be chemical risks to plant health, and risks to the environment in the form of soil and groundwater pollution. Countries seeking to improve wastewater use in agriculture must reduce the risks, in particular those to public health, and maximize the benefits through properly planned, implemented and managed wastewater irrigation practices.

What is Sewage?

- Sewage water comprises liquid wastes generated by households, commercial sources as a result of daily usage, production and consumption activities.The disposal of sewage water is a major problem faced by municipalities in urban areas.It is water-carried waste, in solution or suspension that is intended to be removed from a community.Also known as waste water.
- The Use of sewage water for the production of agricultural crops is an accepted practice in many areas of the world.So, in most of the Asian countries, due to the limited facilities for the treatment of sewage water, the raw sewage water is used as such in agricultural land.Sewage water is a resource can be applied for productive uses as it contains nutrients that have potential for use of agriculture.It provides water and nutrients in combine and has potentiality to supply plant nutrients for better plant growth.It is reported that Ahmedabad city alone generates as much as 742 million liters per day of sewage water (Patel *et al.,*2006).In India there are about 216 sewage water irrigation farms which

covering 10,693 ha area.However, use of sewage water causes negative extremely effect on humans and increase heavy metal content in soil and ecological systems.

Sewerage System

The network of collecting and conveying sewage by water carriage system through underground pipes sewers is known as Sewerage. Sewage has to be removed as early as possible.If not removed, it will cause insanitary condition.

Drain: Is isa plumbing fixture that provides an exit-point for waste water that is to be re-circulated.

Man hole: The opening or hole through which a man can enter the sewer line or other closed structure for inspection and cleaning.

Pumping Station: It includes pumps andequipments for pumping fluids. It supplies water to remove sewage from processing site.

Types of Sewage:

1. Sanitary Sewage
2. Combined Sewage

1. Sanitary Sewage:
   - Also known as Domestics Sewage
   - The foul discharges from residential and commercial area
   - It mainly includes discharges from latrines, urinals, laundry etc
2. Combined Sewage:
   - Combination of Sanitary sewage and Storm water

Storm water is rain and snow melt that runs off surfaces such as rooftops, paved streets, highways and parking lots.

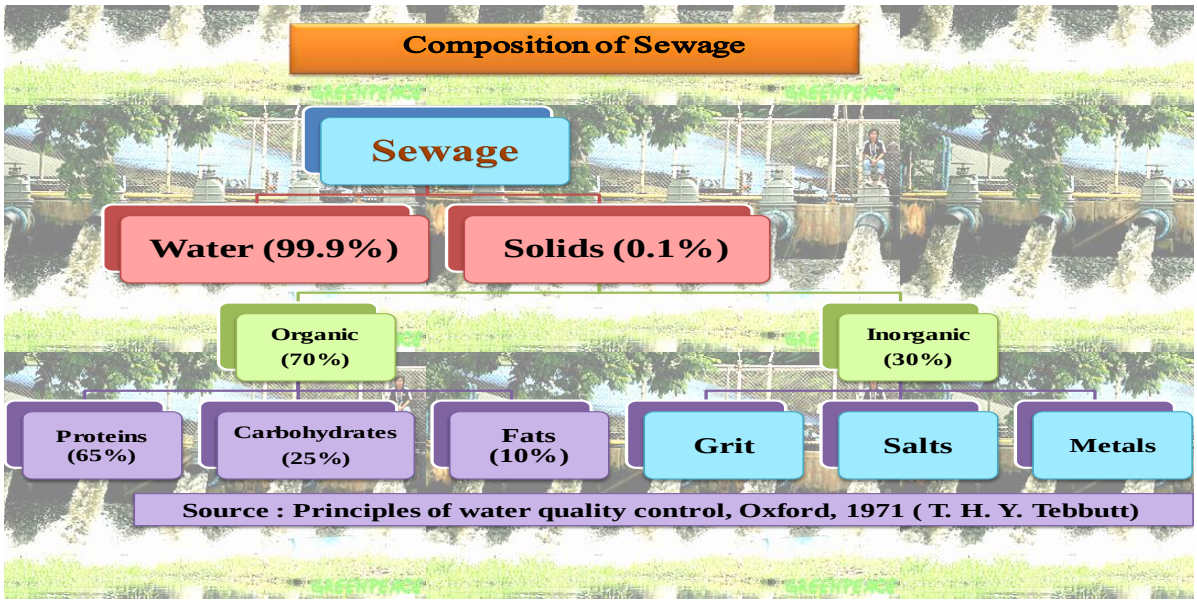


Table 1: Physico-chemical characteristics of sewage water irrigated soil of *peri*urban area of gujarat

Characteristics	Sewage water
pH	7.73
Electric Conductivity	0.43 dS m^{-1}
Organic Carbon	3.8 g kg^{-1}
Available P_2O_5	33.0 kg ha^{-1}
Available K_2O	415 kg ha^{-1}
Micro nutrients	
DTPA extractable Fe	10.8 mg kg^{-1}
DTPA extractable Mn	12.0 mg kg^{-1}
DTPA extractable Zn	2.4 mg kg^{-1}
DTPA extractable Cu	2.1 mg kg^{-1}
Heavy metals	
Pb	2.1 mg kg^{-1}
Ni	0.71 mg kg^{-1}
Cd	0.8 mg kg^{-1}
Co	0.23 mg kg^{-1}

Source: Patel *et al.* (2008)

Table 2: Physico-chemical characteristics of ground water and sewage water

Characteristics	Ground water (mg l^{-1})	Sewage water (mg l^{-1})
pH	7.2	7.9
Nitrate	0.63	6.12
Phosphate	0.14	1.78
Calcium	15.30	148.24
Magnesium	56.30	102.12

Javid*et al.* (2003)

Table 3: Micronutrient and heavy metals content in sewage water in different cities of gujarat.

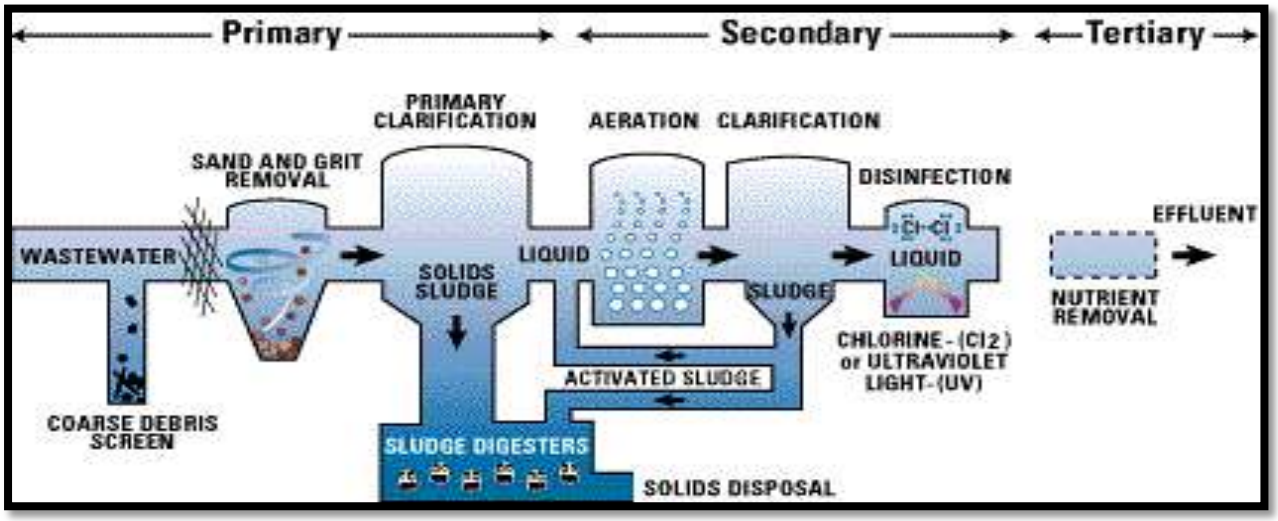
Class	City	Site	Fe	Mn	Zn	Cu	Cd	Co	Cr	Pb	Ni
			Total content (ppm)								
Big	Ahmedabad	Behrampur	1.78	0.20	0.05	0.02	0.02	0.02	0.01	0.03	0.04
		Jespur	2.20	0.15	2.13	0.11	0.02	0.01	0.02	0.38	0.21
		Pirana	1.01	0.54	0.13	0.06	0.03	0.02	0.01	1.10	0.11
Mean			1.66	0.30	**0.77**	0.06	**0.02**	**0.02**	**0.01**	0.17	**0.12**
Medium	Vadodara	Model farm	8.35	0.13	0.44	0.08	0.02	0.02	0.03	0.30	0.10
		Atladara	4.70	0.14	0.21	0.02	0.04	0.09	0.01	0.25	0.31
Mean			**6.53**	0.14	0.33	0.05	0.03	0.06	0.02	0.28	0.21
Small	Anand	Lambhwel-1	6.11	0.41	0.15	0.04	0.03	0.01	0.01	0.09	0.08
		Lambhwel-2	3.29	0.66	0.13	0.08	0.02	0.02	0.01	0.21	0.32
Mean			4.70	**0.54**	0.14	0.06	0.03	**0.02**	**0.01**	**0.15**	0.20

Patel *et al.* (2008)

Waste water treatment plant

- **Primary treatment**
  - Removes large suspended organic solids
  - Accomplished by sedimentation in settling basins
  - Liquid effluents from primary treatment often contains a large amount of suspended organic materials and has a high BOD(60% of original)
  - Organic solids are separated out in sedimentation tanks, stabilized in digestion tanks and residue used as soil conditioners
- **Secondary treatment:**
  - Oxidation of effluents from primary treatment units
  - Accomplished using filters (Intermittent sand filters and trickling filters), aeration tanks, oxidation ponds etc.
  - Less BOD (5-10% of original)
  - Enough DO
- **Tertiary treatment :**
  - Removes the organic load left after secondary treatment

- Particularly to kill pathogenic bacteria
- Normally carried out by chlorination



Waste water treatment plant

Methods of applying sewage effluents to farms

- Surface irrigation
  - Free flooding
  - Border flooding
  - Check flooding
  - Basin flooding
  - Furrow irrigation
- Sub-surface irrigation: Applied directly to root zone like Drip irrigation

  Highest risk is associated with practicing sewage water irrigation by furrow or flood methods like soil contamination.Drip irrigation is thesafest irrigation method for sewage water. Use of appropriate filters such as gravel, screen and disk filters in combination with drip systems has been observed to tremendously reduce the clogging.

Table 4: Types of sewage effluents and crops suggested

Types of sewage	Suggested crops in order of preference
Raw sewage(preferably diluted)	A) Commercial crops : Cotton, jute, sugarcane, tobacco B) Essential oil bearing crops: Citronella, lemon grass C) Cereals and other crops with well protected grains: Wheat, Paddy, Arhar, moong D) Oil seeds: Linseed, Til, Castor, Mustard, Sunflower, Soybean E) Fruit crops : Coconut, Banana, Citrus
Primary treated sewage	All the above crops + Vegetables exclusively cooked before eating and are borne away from soil e.g. Brinjal, Okra, Cucurbits, Beans etc.

	Fruit crops : Guava, Sapota, Grapes
Secondary treated sewage	All the above+ vegetables borne near the soil but that are cooked before eating
Secondary treated and disinfected sewage	All types of crops without restriction

Reference: Practical Handbook on Public Health Engineering, 2003 (Er. G. S. Bajwa)

Effect of sewage water on crop growth and yield

Javid*et al*. (2003) reported significantly the highest shoot and root length and no. of tillers per plant, yield per plant and total yield of wheat with application of sewage water than use of ground water. Khan *et al*. (2011) reported that application of sewage water along with half dose of N, P and K fertilizers found significantly higher plant height, fresh and dry biomass production of tomato than irrigation of tubewell. Chauhan*et al.* (2014) reported that the plor receiving application of sewage water found lowest disease percent at different growth stages and yield loss per plant after harvest of mustard.

Effect of sewage water on Crop Quality

Javid*et al.* (2003) stated significantly the highest content of N, P and K in leaves of wheat crop with sewage water irrigation than ground water. Dhankar*et al.* (2005) reported that concentration of sodium and potassium in straw of wheat and barley as well as in leaves of mustard were increased with increasing levels of sewage water. Zavadil (2009) reported significantly the highest sugar content and sugar yield of sugar beet highest with sewage water irrigation over the control.

Effect of sewage water on soil health

Mitra*et al.* (1999) reported that content of organic matter, nitrogen and phosphorus (kg ha^{-1}) was comparatively higher in sewage irrigated soil as compared to tube well irrigated soil. Sidhu*et al.* (2010) reported that concentration of Zn, Cu, Mn and Fe found significantly the highest with irrigation of sewage water than other treatments but at par with mixture of sewage water and tubewell water irrigation of Zn and Cu. Singh *et al.* (2012) reported that irrigation with sewage water improved physico-chemical properties of the soil over irrigation of well water in different crops *viz*., wheat, gram, spinach and berseem. Ladwani*et al* (2012) reported comparatively higher organic matter, available nitrogen, phosphorous and potassium (kg ha^{-1}) in sewage irrigated wheat, gram and spinach as compared to ground water irrigated soil.

Limitations of sewage water irrigation.

Swaroop*et al.* (2006) observed that application of sewage water without mix with well water recorded significantly higher Pb, Cr and Cd in soil than the rest of treatments but was at par with Sewage water (75%) mix with Tube well water(25%) .Patel *et al.* (2008) reported that uptake of P, K, Fe and Zn nutrients decreased with increasing the level of Pb concentration of sewage irrigated water over control. Singh and Singh (2009) stated that the content of heavy metals in sewage irrigated brinjal and radish were

comparatively higher than irrigated with tube well water. Khan *et al.* (2011) revealed that accumulation of heavy metals in tomato fruits was found significantly the higher with sewage water irrigation and was at par with sewage water mix with half dose of N, P and K fertilizers.

What is sewage sickness?

The phenomenon by which the soil loses its capacity of receiving the sewage load is known as sewage sickness.

Prevention of sewage sickness:-

- Primary treatment like screening and sedimentation should be given to sewage before its application to land so that suspended solids are removed and the pores of soil will not be clogged.
- The sewage should be applied intermittently on land i.e. by giving rest to the land for some time.The land should be ploughed during non-supply period of sewage so that soil gets aerated.
- Do not apply the sewage in excess quantity.

Possible solutions to tackle the problem:-

- Primary treatment of the sewage
- Heavy metal removal from sewage water
  - Use of non-conventional low cost adsorbents like bagasse, saw dust, fly ash as against PAC for removal of heavy metals like Cr in waste water treatment plants
  - Application of organic manures like FYM (amendments)
  - Chromiumremoval using activated groundnut husk carbon
  - Bio-remediation and Phyto-remediation techniques
- Health risks
  - Protective measures such as wearing boots and gloves.

Benefits and Risks of wastewater use

Benefits of wastewater use

When properly planned, implemented and managed, wastewater irrigation schemes can have several benefits that accrue to the agricultural, water resources management, and environmental sectors.

- **Agricultural benefits:** Agricultural benefits may include: reliable, and possibly less costly irrigation water supply; increased crop yields, often with larger increases than with freshwater due to the wastewater's nutrient content; more secure and higher urban agricultural production, and contribution to food security; income and employment generation in urban areas; and improved livelihoods for urban agriculturalists, many of whom are poor subsistence farmers, including a large share of women.
- **Resources management benefits:** In terms of water resources management, the benefits may include: additional drought-proof water supply, often with lower cost than expanding supplies through storage, transfers, or desalinization;

more local sourcing of water; inclusion of wastewater in the broader water resources management context; and more integrated urban water resources management.

- **Environmental benefits:** Among the environmental benefits that may accrue to well-managed wastewater irrigation schemes are: avoidance of surface water pollution, which would occur if the wastewater were not used but discharged into rivers or lakes – major environmental pollution problems, such as dissolved oxygen depletion, eutrophication, foaming, and fish kills, can thereby be avoided; conservation or more rational use of freshwater resources, especially in arid and semi-arid areas – that is, freshwater for urban demand, wastewater for agricultural use; reduced requirements for artificial fertilizers, with a concomitant reduction in energy expenditure and industrial pollution elsewhere; soil conservation through humus build-up and through the prevention of land erosion; and desertification control and desert reclamation, through irrigation and fertilization of tree belts.

Risks of wastewater use

- **Microbial risks to public health:** In low- and middle-income countries, the greatest risks are primarily to public health from the microbial pathogens (disease-causing organisms) contained in domestic wastewater, including bacteria, viruses, protozoa and helminthes. Epidemiological studies carried out over the past four decades have linked the uncontrolled use of untreated or partially treated wastewater for edible crop irrigation to the transmission of endemic and epidemic diseases to farmers and crop consumers. Actual risks of usinguntreated wastewater for irrigation include the increased prevalence of helminthic diseases (such as cariasis and hookworm) in field workers and consumers of uncooked vegetables, and bacterial and viral diseases (such as diarrhea, typhoid, and cholera) in those consumingsalad crops and raw vegetables (Table 5).

Table 5: Pathogens in the sewage water and disease caused by them

Pathogen	Disease
Bacteria	
Escherichia coli	Diarrhoea
Salmonella typhi	Typhoid fever
Vibrocholerae	Cholera
Clostridium perfringens	Gastroenteritis

- **Chemical risks to public health:**Chemical risks are greater for middle- and high-income countries where industrial wastewaters may be discharged to public sewers and contaminate municipal wastewaters. Chemical risks to human health may be caused by heavy metals(such as cadmium, lead, and mercury) and

by many organic compounds (such as pesticides). There is also increasing concern in high-income countries about an emerging class of "anthropogenic" chemical compounds, which include pharmaceuticals, hormones and endocrine disruptors, antibiotics, and personal care products – although their long-term health effects are less clearly understood.

- **Risks to plant health:** The principal risk to plants is reduced crop yields if the physicochemical quality of wastewater used for irrigation is unsuitable – for example by being too saline or having excessive concentrations of boron, heavy metals or other industrial toxicants, nitrogen, and/or sodium. Risks to plant health are reduced if there is little industrial effluent in the wastewater, but in all cases five parameters should be monitored during the irrigation season: electrical conductivity, the sodium adsorption ratio, boron, total nitrogen, and pH.
- **Environmental risks:** Soil and groundwater pollution is the main risk of using wastewater in agriculture; the microbiological pollution of groundwater is a lesser risk as most soils will retain pathogens in the top few meters of soil except in certain hydrogeological situations like limestone formations. Chemical risks include, among others, nitrates in groundwater from sewage irrigation, salination of soils and aquifers, and changes in soil structure.

The key to controlling many of the chemical risks to humans, plants and the environment is to put in place effective industrial wastewater pretreatment and control programs. Of course, effective programs are not the norm in developing countries, so special attention has to be paid to chemical risks in such circumstances.

CONCLUSION

- Application of sewage water increase the yield of field crops and vegetable crops compared to irrigation with well water
- Incorporation of FYM showed beneficial effect in mitigating the adverse effect of Pb and restricted its uptake by the crop
- Sewage water increased organic carbon and major nutrients in soil
- The presence of harmful pathogens in waste water is most serious hazard causes different diseases like diarrhea, typhoid and cholera, etc.
- The use of waste water for irrigation over long period of time increases heavy metal content in the soil

Future thrust

- Establishment of soil, plant and water testing laboratories for heavy metals
- Commercializing the Phyto-remediation and Bio-remediation techniques
- Create awareness of farmers about sewage water
- Treated sanitary and combined sewage water in the agriculture

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Importance Of Management Education in Agriculture

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ABSTRACT

Agribusiness management education is a discipline of blend of economics, agriculture, business (commerce) and management principles. Agribusiness management field is of very recent origin and gaining brisk popularity among students as a carrier alternative. Agribusiness program is planned to develop management workforce to cater agricultural industry which serves as a good option for the students who are eager to accomplish in corporate sector. Agribusiness professionals have bright future in academic field due to new emerging discipline and lack of agribusiness faculty in the country. Hence, this article tried to make the farmers aware about the importance and potential in agribusiness education which can also be a best option in career progress.

INTRODUCTION

Our nation is an agrarian economy and agriculture is considered as the backbone of our economy. In India, agriculture has been practiced since ancient times, when other developmental sectors were not even in existence and farming was mostly treated as a life sustaining activity. India was a net importer of food grains in early 60s and now it has become an intermittent exporter of various agricultural commodities. Due to the impact of globalization production and marketing have become the buzz words in agriculture sector, bio-technology, precision farming and various hi-tech and mechanized technique have resulted in paradigm shift in agriculture. Besides, government's special emphasis on privatization, public private partnership, farmer organizations too have contributed to the agricultural growth. Above all, education plays a crucial role in achieving the development in any sector.

Currently, agribusiness education is one of the promising qualifications which help to mould the personnel into potential managers having managerial expertise. To realize the real potential in Indian agriculture and to grow it to the point of prospective sector, it is essential to manage the sector like a professional enterprise. The same can be expected by utilizing the agribusiness managers having the qualities to serve the agriculture sector efficiently. The purpose of this article is to make farmers aware about the importance of agribusiness education so as to sustain in today's competitive world.

Need, Importance and Scope of Agribusiness Education

Agriculture has achieved a satisfactory growth since last few decades, but presently due to the various national and international factors, the growth of agriculture is relatively stagnated. Up gradation is needed right from harvesting the agricultural produce till it reaches at consumer level. Majority of the farmers and small entrepreneurs are not well versed about standard practices required during pre-harvest as well as post-harvest operations, which undoubtedly plays a vital role in overall productivity. On other side, too many middlemen in the marketing channel are a major cause of concern.

As a result of this, the farmer, who is the key performer in farming, is not getting passable returns to his produce. Consequently overall distortion in marketing channels and high price of final produce adversely affect the cost competitiveness. In addition to these, growing global population has resulted into disparity between market demand and supply side of agricultural produce. Thus, special consideration is required on following proper management practices, reducing raw material wastages at farm and processing level, effective marketing strategies like advertising, brand positioning at national and international level etc. Finally, proper management of all the agribusiness activities right from planting the seed to getting the actual reward at market place is required. These issues are expected to be addressed by management education in agricultural sector which certainly has hidden potential of creating second wave of agricultural revolution.

Potential in Agribusiness Education

Agribusiness is applicable to industry, commerce as well as trade. Industry is merely manufacturing of goods, while commerce and trade involved in distribution activities. Agriculture is the foundation of Indian economy. It provides food for the mankind and raw material for the industry. India has suitable climatic and geographic conditions favourable to agricultural growth and undoubtedly agriculture will always be an indispensible sector of the economy. In India about 60% population is directly or indirectly dependent on agriculture. But after analyzing the employment scenario of the sector, it is observed that most of the students after completing the education in agriculture ignore their own farming land and join private companies or any other institutions in order to make progress in their career. Therefore, there is a need to divert the knowledgeable, expert and dynamic manpower to the rural area to manage the agricultural land effectively.

Agribusiness education gives an option of joining the agricultural corporate sector as one of the good career alternatives. The corporate sectors involved in production and distribution of pesticides, fertilizers, seeds, farm equipment are some of the usual options available. In this day and age there is excellent job potential in food processing sector involving fruits, vegetables, fishery, meat & poultry, dairy, apiculture, sericulture sector etc. The other blooming sectors which have tremendous growth opportunities are organic farming, bio-fertilizer industry, retail sector, agri-banking, biofuel sector, FMCGs etc. All these sectors are excellent for the scholars who want to be

distinctive in terms of their profession. Another best option can be developing their own farming land into profitable venture by applying the managerial skill plus knowledge and agribusiness managers can perform well in the same due to their suitable educational background.

CONCLUSION

To shape the Indian agriculture into a commercially viable entity, there is a vital need to inculcate the spirit of entrepreneurship so that agriculture would become a major contributor to the nation's gross production. By the involvement of corporate sector, agriculture field can shift from merely the stage of self-sufficiency to profit gaining enterprise which will result in overall development of country's economy. Agribusiness management has wide scope in developing the trained manpower in different area of operations viz. management personnel to cater cooperatives and agriculture industry, policy makers for overall financial sector, trained teaching staff to cater academic field, technically sound team to serve research area etc. Henceforth, management education surely helps in developing trained personnel to cater to the agricultural industry and by creating such dynamic workforce India will certainly become the leader in agriculture sector.

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