Open Access Multidisciplinary Online Magazine

Agri-India TODAY

Monthly e-Newsletter

ISSN : 2583-0910

Volume 03 | Issue 02 | February 2023

www.agriindiatoday.in

Editorial Board

INDEX

Article No	Title	Page No.
03/II/01/0223	**MODELLING AND FORECASTING OF CYCLICAL DATA: A REVIEW ON APPLICATION OF EXPAR FAMILY OF MODELS** BISHAL GURUNG, SAIKATH DAS, K N SINGH, ACHAL LAMA AND BIWASH GURUNG[2]	1-3
03/II/02/0223	**LAC PRODUCTION ON PIGEON PEA: AN OPTION** DHANESHWAR B. PATIL, SUMIT H. KAKADE, GOPI ANJANA, SAHAB K. PATEL, ANKIT KHICHI, VISHAL RAUT, NIRAJ K. TRIPATHI AND MONI THOMAS	4-7
03/II/03/0223	**AGRONOMIC INTERVENTIONS FOR MICRONUTRIENT BIOFORTIFICATION** ANANYA GHOSH AND ARINDAM GHOSH	8-10
03/II/04/0223	**EDIBLE COATING OF HORTICULTURAL PRODUCE** ABDULLAH ZAID, ALI KHAN, DEEPAK TOMAR, UJJAVAL RAI AND PRASHANT KUMAR	11-14
03/II/05/0223	**EDIBLE VACCINES: APPROACH TO ORAL IMMUNIZATION** PRAMOD SARGAR, SMITA DESHMUKH AND PRANJAL SHEDGE	15-19
03/II/06/0223	**IMPACT OF MYCOFILTRATION ON WATER QUALITY IMPROVEMENT AND FISH PRODUCTION** PREETI MAURYA	20-23
03/II/07/0223	**MILLET : WONDERS OF ALL GRAINS** PINAK.K.BAMANIYA AND ISHITA.J.BAMBHANIYA	24-29
03/II/08/0223	**MUSHROOM CULTIVATION AND ITS IMPORTANCE** SUNIL S. KINGE	30-35
03/II/09/0223	**NATURAL FARMING** GAGANDEEP KAUR	36-40
03/II/10/0223	**MILLETS: THE NUTRI CEREALS** INDU WALIA	41-45
03/II/11/0223	**FINANCING AGRIBUSINESS IN DEVELOPING COUNTRIES** ADEGBOLA J A, OWOJAIYE O B, OGUNREMI O B, ADEGBOLA R Q, AINA O B, ACHIME K C AND PESSU P O	46-48
03/II/12/0223	**CLIMATE RESILIENTSTRATEGIES FOR PLANT DISEASE MANAGEMENT** RITWIK SAHOO, SUMIT SOW, SHIVANI RANJAN, DINABANDHU SAMANTA AND SOUVIK SADHU	49-53
03/II/13/0223	**KALMEGH: A SUPERNATURAL MEDICINAL PLANT FOR HUMAN LIFE** RIMLEE DAS AND DINESH RAI	54-59

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/01/0223

MODELLING AND FORECASTING OF CYCLICAL DATA : A REVIEW ON APPLICATION OF EXPAR FAMILY OF MODELS

Bishal Gurung*[1], Saikath Das[1], K N Singh[1], Achal Lama[1],and Biwash Gurung[2]
[1]ICAR-Indian Agricultural Statistics Research Institute, New Delhi-110012
[2]School of Agriculture, ITM University, Gwalior-474001, Madhya Pradesh
**corresponding author: Bishal.Gurung@icar.gov.in*

Abstract
A well know ARIMA family of linear models are usually employed to model time-series data as it is comparatively easy to use and are robust theoretically. Further, many softwares for fitting the linear models are easily available free of cost. But, real-life data may not always satisfy the assumptions of the linear models and as such we have to employ nonlinear models which can capture the various characteristic features of the time-series data. Keeping this in mind a review on application of EXPAR family of models is carried out. EXPAR is capable of capturing the cyclical variability in the datasets and many other important characteristic features present in the datasets.

INTRODUCTION

Many of the data-generating processes that are encountered in the real world, including agricultural experiments, are somewhat nonlinear and cyclical. Further, data collected over time usually stands out due to the presence of dependence between subsequent observations. It is possible to think of each observation, X_t, as a manifestation of a stochastic process, $\{X_t\}$. Often, these datasets show relevant periodogram ordinates, which further points towards potential presence of limit cycle behaviour. Few examples of such datasets, which have been tested for periodicity, include datasets on global land-ocean temperatures (GT), sunspot numbers (SS), fish landings data, monthly mean minimum temperature, monthly mean rainfall data, etc.Thus, many real-world applications call for both linear and nonlinear time-series models in order to obtain an acceptable level of accuracy in prediction. Only a few families of models are able to capture this cyclicity. The family of exponential autoregressive (EXPAR) models is one such parametric family.

The EXPAR modelsare a family of parametric nonlinear time-series models, initially proposed by Haggan and Ozaki (1981), thathave been developed for modelling and predicting data sets that show cyclical fluctuations. It is a discrete-time approximation of a continuous-time nonlinear stochastic dynamical system. The parameters of these models properly explain the type of marginal distribution the time-series has, which is encouraging. The non-gaussian properties of the series can also be captured using the EXPAR models.

EXPONENTIAL AUTOREGRESSIVE (EXPAR) MODELS

Description of Model

The p^{th} order EXPAR, i.e., EXPAR(p) model is given by,

$$X_{t+1} = \{\phi_1 + \pi_1 \exp(-\gamma X_t^2)\}X_t + \ldots + \{\phi_p + \pi_p \, ex\, p(-\gamma X_t^2)\}X_{t-p+1} + \epsilon_{t+1}$$

$$\text{or}, X_{t+1} = \sum_{i=1}^{p} [\{\phi_i + \pi_i \exp(-\gamma X_t^2)\}X_{t-i+1}] + \epsilon_{t+1}$$

where, $\gamma > 0$ is a scaling constant and $\{\epsilon_t\}$ is a stochastic white noise process with zero mean and constant variance σ_ϵ^2.In such a model, we have two unknown parameters, i.e., ϕ_i and π_i for each lag $i = 1, 2, \dots, p$ and an unknown scaling constant. So, for order p, we have to estimate $2p + 1$ parameters.

It is evident that when the parameters $\pi_i = 0 \; \forall \; i = 1, 2, \dots , \; p$, the above equation reduces to the autoregressive AR(p) model. Further, one can note that this form can be viewed as a threshold autoregressive model,as it resembles anAR(p) model with parameters roughly equal to $(\phi_1, \phi_2, \dots, \phi_p)$ if $|X_t|$is high, whereas if $|X_t|$ is small, the autoregressive parameters become$(\phi_1 + \pi_1, \phi_2 + \pi_2, \dots, \phi_p + \pi_p)$. The latter scenario also occurs whenever it so happens that $\gamma = 0$. It should also be noted that the EXPAR(p) model can also be used to fit non-gaussian oscillatory time-series with peaks in their spectrum when $p > 1$. Another encouraging characteristic is that the EXPAR(p) model can demonstrate the desired property of limit cycle behaviour for $p > 1$. In their 2009 paper, Ghazal and Elhassanein covered the dynamics of the EXPAR (p) model, stability conditions, and the presence of equilibriums.

Review on application of EXPAR family of Models

Ghosh *et al*. (2011) studied the ARIMA, EXPAR and SETAR models and combined them by using the constant coefficient regression and the time-varying coefficient regression method through Kalman filter (KF) technique. It was applied it to describe annual Mackerel catch time-series data of Karnataka. Performance of fitted models were examined by computing various measures of goodness of fit and forecasting performance of fitted models was evaluated by Mean square prediction error (MSPE). It was found that the combined model fitted by using the time-varying coefficient regression method had performed best for the data under consideration.

Gurung (2013) highlighted the importance of Genetic Algorithm (GA) for fitting EXPAR nonlinear time-series model using India's annual rainfall data for the period 1901-2003. It was also demonstrated that the EXPAR model was superior over ARIMA model.

Gurung (2014) described the detailed methodology for fitting EXPAR model through Particle Swarm optimization and applied the same in India's annual lac export data. It was also shown that EXPAR model is better than ARIMA for the dataset under consideration from modelling and forecasting point of view.

Lepcha*et al*. (2014) employed EXPAR for forecasting yearly sticklac production statistics for India. The data was found to be satisfactorily represented by the fitted EXPAR model. Using several goodness of fit and forecast performance metrics, it was shown that the EXPAR model does a good job of modelling and forecasting the cyclical data under consideration.

Ghosh *et al*. (2014) developed an estimation procedure for EXPAR models using extended Kalman filter (EKF). Also established conditions for the existence of limit cycle behaviour for EXPAR models. Concluded that the EXPAR model performs better than ARIMA methodology for both modelling and forecasting purposes using Oil sardine, Mackerel and Bombay duck time-series landings data in India.

Gurung (2015) described an EXPAR model to forecast the Annual rainfall of India and showed that the cyclical fluctuations of the time-series data is properly captured by the EXPAR model. Also demonstrated the superiority of this method over ARIMA methodology.

Lama *et al*. (2021) used two broad class of models, namely, seasonal autoregressive integrated moving average (SARIMA) and EXPAR, and applied them to the monthly rainfall data of Sub-Himalayan West Bengal and Sikkim. The models were compared based on their forecasting efficiencies and pattern prediction ability.

References

Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. (2008). Time Series Analysis: Forecasting and Control. San Francisco: Prentice Hall.

Ghazal, M.A. and Elhassanein, A. (2009). Dynamics of EXPAR models for high frequency data. Int. J. Appl. Maths. Stat., 14, 88-96.

Ghosh, Himadri, Gurung, Bishal, and Prajneshu (2011). Methodology for combining linear and nonlinear time-series models for cyclical data. Journal of Indian Society of Agricultural Statistics, 65, 249-56.

Ghosh, Himadri, Gurung, Bishal, and Prajneshu (2014). Fitting EXPAR models through the extended Kalman filter. Sankhya B. 77(B 1), 27-44.

Gurung, Bishal (2013). An application of Exponential Autoregressive (EXPAR) nonlinear time-series model. International Journal of Information and Computation Technology. 3(4), 261-266.

Gurung, Bishal (2013). Modelling and forecasting of volatile time-series data: An application of Genetic Algorithm. International Journal of Agricultural and Statistical Sciences. 9, 87-94.

Gurung, Bishal (2014). Fitting nonlinear time-series model using Swarm Optimization technique. Advance in Electronic and Electric Engineering, 4(6), 537-540.

Gurung, Bishal (2015). An Exponential Autoregressive (EXPAR) model for the forecasting of All India annual rainfall. MAUSAM. 66(4), 847-849.

Haggan, V., and Ozaki, T. (1981). Modelling nonlinear random vibrations using an amplitude-dependent autoregressive time series model. Biometrika, 68(1), 189-196.

Lama, A., Singh, K.N., Singh, H., Shekhawat, R., Mishra, P. and Gurung, B. (2022). Forecasting monthly rainfall of Sub-Himalayan region of India using parametric and non-parametric modelling approaches. Modeling Earth Systems and Environment. 8, 837–845.

Lawrence Lepcha, Gurung, Bishal, Paul, Ranjit Kumar, and Kanchan Sinha (2014). Stochastic model for sticklac forecasting in India. Economic Affairs. 59(3),479- 483.

Ozaki, T. (1993). Non-Gaussian characteristics of exponential autoregressive processes. In Developments in Time-Series Analysis. (Ed.) Subba Rao, T., pp. 257-273, London: Chapman and Hall.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/02/0223

LAC PRODUCTION ON PIGEON PEA : AN OPTION

Dhaneshwar B. Patil*, Sumit H. Kakade, Gopi Anjana, Sahab K. Patel, Ankit Khichi, Vishal Raut, Niraj K. Tripathi and Moni Thomas

Directorate Research Services, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.)
*Corresponding author: dhaneshwarpatil9393@gmail.com

Introduction

Natural resources available with farmers are shrinking but crop production expenses are sky rotating. This is causing an imbalance in the income and opportunities in farmers household. Recently there have been various policies and developments focusing to increase farmer's income and to promote resources use efficiency. This is basically to cut down the cost of production so as to increase the profitability.

Box-1: Pigeonepea

Legume that has been revolutionized in recent years is the pigeonpea. The crop is a poor man's crop in rainfed region for a living. Agriculture scientists have recently transformed this subsistence crop into a versatile and high yielding crop. Pigeonpea not only provide food, fuel and forage but it also enriches soil fertility. **Pigeonpea is the only field cultivated host of lac insect, all others being forest host.**

Among many sub options, a low cost adoptable and efficient production system is lac production on pigeon pea. This means from a single plant of pigeon pea, a farmer can harvest seeds, lac and fuel wood. This can be achieved by slightly modifying the approach. The lac production model on pigeon pea is called Jawahar model, as it is developed and refined from time to time in Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur Madhya Pradesh.

The plants in Jawahar model are grown in substrate filled polypropylene bags (PPBs). There is no need to till the land of weeding, even in degraded or poor soil, Jawahar model can be successfully implemented.

Selection of Variety: Long duration pigeonpea varieties with profuse branching may be selected for lac production. Local farmer's varieties that are already adapted to the local conditions may be selected for lac production. Raut (2020) and Khichi (2020) evaluated 18 different farmers' local genotypes of Pigeon pea for lac cultivation and recommended that all the local as well as improved varieties of Pigeon pea are suitable for lac cultivation.

Preparation of field: As mentioned earlier, Jawahar model can be practiced on even poor, shallow soil depth, soil with minimum irrigation facilities. JNKVV, Jabalpur developed "Jawahar model for doubling the income of resource constrained marginal farmers" with lac production on pigeonpea as main crop. In the model, pigeonpea plants are raised in substrate filled polypropylene bags (24 x 24 inches) kept at a spacing of 6ft row to row and plant to plant.

Box-2: Versatility & suitability of pigeonpea

Small-scale and marginal farmers of rainfed area also grow pigeonpea in backyard, grow them on the field bunds or use them as intercrop or mixed crop. Pigeonpea is a woody shrub and has inherent ability to withstand environmental stress, specifically short periods of drought. Generally, tall and long duration local cultivars are grown by farmers. Apart from whole seeds,

split seeds (dal), green tender pods are also used as vegetable. As a fodder crop it is known to increase milk production in cattle and fetch weight among poultry bird.

Substrate composition: The substrate (Table 1) consists of a mixture of river basin soil or light soil and well decomposed Farm yard manure (FYM), enriched with a consortium of bio-agents (Patent no. 201921005340A). Patidar (2019), Vajpayee (2019) and Kakade (2021) formulated a composition of substrate for lac production on pigeon pea. Consortium of biofertilizers are *Trichoderma*, *Rhizobium*, PSB, *Aspergillus*, *Mycorrhiza*, *Pseudomonas* @1g/PPB. The PPBs are filled with soil and FYM in alternate layer wise fashion with base layer of soil and top layer of soil.

Table 1: Materials required

Substrate: Soil + FYM (30+15 kg/ polypropylene bag)	**Fungicides**: (Dithane M-45)
Polyprolyene bag (size: 24 x 24 inches)	Knapsack sprayer
Bio-agents: *Trichoderma viride*, *Rhizobium*, Vesicular Arbuscular Mycorrhiza, Phosphate Solubilising Bacteria, *Asperigillus niger @1g each/PPB*	**Insecticides**: Cartap hydrochloride, Emmamectin benzoate
Pigeon pea (TJT-501) seeds	Bird pirches
Rangeeni brood lac	Tree pruner

Sowing of healthy Pigeon pea seeds: Two healthy and treated seeds of pigeon pea may be sown in the centre of each substrate filled PPB in the evening hours followed by watering. Continuous supervision of the PPBs is required to check the germination, performance and protection of the newly emerged seedlings.

Nipping: As lac insects prefers to settle on branches of pencil thickness (preferably) as well as the yield of lac per plant is directly related to the number of branches, pigeon pea plants should be nipped from 40 days after sowing till the bud initiation stage at an interval of 10 days for maximum branching.

Box-3: Nipping
Nipping: Pinching (removing growing tips) during early stages of crop growth to enhance the production of primary and secondary branches.

Pesticide application: The following five sprays of pesticides were done during the experiment for the purpose mention (Table 3)

Table 3: Pesticides on *Pigeonpea* plants

Spray	Pesticide	Dose/litre	Day	Pesticide application schedule
1st	Emamectin benzoate 5%SG	1g	30DAS*	To check foliage feeders
2nd	Diafenthiuron 50%WP	0.5g	60 DAS*	To check sterility mosaic vectors
3rd	Imidachloprid 17.8%SL	0.4ml	90 DAS*	To check oviposition and incidence of pod borer and sap suckers
	Cartap hydrochloride 50%SP	1g		
4th	Cartap hydrochloride 50%SP	1g	30 BLI**	To check predators and parasitoids of lac insects

Spray	Pesticide	Dose/litre	Day	Pesticide application schedule
5th	Cartap + Dithane M-45 75%WP	2g	60 BLI**	To check predator and parasitoids of lac insect and sooty mould

*DAS= Days after sowing, **BLI= Brood lac inoculation

Nutrient application : Foliar/basal applications of the nutrients may be done as per recommendations of the variety with both the Macronutrients and micronutrients. Battery operated Knapsack sprayer can be used for the spraying operation.

Brood lac inoculation : Brood lac inoculation refers to the inoculation of emerging brood (nymphs/ crawlers) of lac insect on the desired host. Brood lac should be procured before the emergence of the crawlers from the mother lac cell. The brood lac twigs should be sorted for quality as well as for predator and parasitoids (Natural enemies) before inoculation on pigeon pea. Brood lac sticks weighing 15g must be tied with the help of twine on the lower side of the primary branch of each pigeon pea plant in the PPB.

***Phunki* removal :** *Phunki* removal operation pertains to the removal of left over brood lac twigs from pigeon pea after complete emergence of lac nymphs from female cells. *Phunki* should be removed carefully from pigeon pea plants 21 days after BLI without damaging the lac insect settlement on the plants. After removal from the plants, *phunki* can be scraped with the help of knife for recovery of lac as well as removal of predators and parasitoids.

Irrigation : Moving forward on the concept of 'more crop per drop', a drip irrigation system can be installed in the field. PPBs with pigeon pea plants require irrigations at regular intervals. Between August to October month, due to frequent rains irrigation may not be required. The irrigation scheduling can be done at an interval ten days from November to February, while from March to May it should be at seven days interval. Ten litres of water per PPB is recommended. In case if drip irrigation system is installed, the farmer can irrigate individual plants @ one litre (one mug) per plant or PPB.

Harvesting of pods : Hand pickings of pods can be done when 80 percent of the pods on the plant attains maturity. Pods plucked, shade dried and threshed for seed yield during successive pickings.

Harvesting of lac crop : Pigeon pea plants with lac insect mature ready to harvest in the 1st fortnight of June. Pigeon pea plants can be harvested with the help of Falcon 2X gear loaping shear. Cut plants are then shade dried, kept on a clean tarpaulin sheet, lac is scraped with the help of knife. The scraped lac collected on the tarpaulin is later collected in bags.

Box-4: Utilization of interspaces
Shade loving tuber crops like turmeric and ginger can also be grown in PPBs in between the plants as these crops perform better in partial shade.

Regular cash inflow: In the early stages of pigeon pea crop, presoaked coriander seeds are sown in the PPB for additional income to the farmers. The interspaces may also be utilized for vegetable crops.

Importance in Cropping System

Box-5: The concept of cropping system
A cropping system is a combination of crops in space and time and their interactions with farm

resources, other farm enterprises and available technology. The term cropping system is also used interchangeably with multiple cropping in which two or more crops are grown consecutively on the same field in the same year. It represents a philosophy of maximum crop production per unit area of land within a calendar year with minimum impact on the soil health and environment.

Resource poor farmers practice subsistence agriculture. The ideal cropping system should make most efficient use of the natural resources and provide stable and high returns by adopting efficient cropping system. The efficient use of the basic resources in cropping systems depends on the inherent efficiency of the individual crops that make up the system, and partly on complementary effects between the crops. The choice of crop is determined by rainfall pattern, moisture capacity of the soil, and the availability of water during the cropping season. Stability is achieved by using crops and varieties that have a wide range of adaptability and by improved management practices. Improved production packages are developed to help farmers improve their cropping systems and harvested yields.

References

Khichi A. 2020. Study on the performance of *Rangeeni* lac insect (*Kerria lacca* Kerr.) on tall and long duration genotypes of *Cajanus cajan* (L.) Millsp. Jabalpur, Madhya Pradesh. M.Sc. (Ag) thesis submitted, JNKVV, Jabalpur

Raut V. 2020. Evaluation of local pigeonpea genotypes for *Baisakhi* lac crop production, Jabalpur, Madhya Pradesh. M.Sc. (Ag) thesis submitted, JNKVV, Jabalpur.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/03/0223

AGRONOMIC INTERVENTIONS FOR MICRONUTRIENT BIOFORTIFICATION

Ananya Ghosh[1*] and Arindam Ghosh[2]

[1]Department of Agronomy, [2]Department of Agricultural Extension
School of Agricultural Sciences, Sister Nivedita University, Newtown, Kolkata
*Corresponding email: ananya.ghosh0193@gmail.com

Introduction

Globally two billion population has been affected with dietary deficiency of iron, zinc and other micronutrients (Ghosh *et.al.,* 2019). Out of 795 million malnourished population 98% belongs to developing countries (Riesgo*et al.*, 2016). Possible ways to combat micronutrient deficiency is diversified diet (healthy balance diet), food fortification (nutrient enrichment during processing), biofortification (process of increasing nutrient concentration in plant edible parts of commercially accepted cultivars that are already in food chain by agronomic intervention, breeding approaches or microbes) and supplementation. But a balance diet containing fruits, vegetables, animal products is out of reach to 78% of world's population who has an income of < 1.25 USD person^{-1} year^{-1} (World bank, 2015). Biofortification is an effective strategy in long run to overcome the current situation as it is more cost effective, sustainable and practical one. Agronomic biofortification is the effective way to reach the poorest of the poor rural masses to enhance the composition of desired nutrient in their diet (Shivay*et al*., 2016).

Agronomic biofortification

It is commonly believed that the application of mineral nutrients from external sources advances their concentration in developing grains as well as improving soluble and mobilizable mineral elements in the soil. In developing nations, agronomic biofortification is the fastest and easiest method to supply food grains with Zn, Fe, or additional essential micronutrients for human body. Pre-harvest agricultural practices that increase the nutritional value of food are supported by following approaches namely seed priming, seed coating, soil applications of micronutrient fertilizers and foliar application of fertilizers.

Seed priming

Seed priming is the practice of treating the seeds with micronutrients by soaking in nutrient solution of a specific concentration for a specific time or duration. It allows the metabolic process of germination to take place but not sprouting. The idea of this method is to obtain nutritional effect together with biochemical advantages of priming in order to improve seed quality (nutrient concentration), germination parameters, and seedling establishment. It is a low-cost and simple method for increasing nutrient availability. According to Praharaj*et al*., (2019) the Zn concentration in wheat grains improved significantly after the seeds were primed with different concentrations of a zinc sulfate heptahydrate solution.

Seeds coating

Seed coating is the practice of applying finely ground solid or liquid which contains dissolved or suspended solids to form a uniform continuous layer covering the seed-coat. Under this practice, beneficial inputs like microorganism, plant-growth regulators, chemicals and nutrients are

adhered/ applied around the seed with some adhesive/ gummy materials. Seed coatings with trace elements, viz. molybdenum, iron, zinc, manganese and boron, have been found more effective. Varieties of chelated and mineral forms of trace elements have been used in seed coatings. The effectiveness of seed coating depends largely on chemical used, soil type, soil health or fertility status, coating time, coating agent, ratio of chemical to seed etc. Application of zinc through seed coating improves zinc concentration in seeds (Shivay*et al*., 2016) besides improving seed emergence, plant growth and leaf area.

Soil applications of fertilizers

Among the strategies of increasing micronutrient concentration in food grains, applying nutrients through soil appears to be an important strategy. Although nutrient recovery efficiency is reported low due to soil application over foliar application and other methods, it is the easiest and rapid solution to tackle the micronutrient deficiency or hidden hunger without additional expenditure, because the farmers apply fertilizers to soil anyway (Prasad *et al*., 2014). Among sources of fertilizers, zinc sulphate heptahydrate, iron sulphate, borax and ammonium molybdate are the most widely used micronutrient fertilizers.

Foliar application of micronutrients

The practice of applying easily-soluble inorganic fertilizers directly to the leaves of the crop plants is more effective under the situations where mineral elements become unavailable to the plant immediately after application during later stage of growth or when mineral elements are not readily translocated to edible tissues. Therefore, foliar fertilization is the easiest and fastest way of bio fortification with Fe, Zn, or other desirable micro-mineral nutrients. Foliar-applied nutrients (Zn, Fe, urea etc.) are absorbed by leaf epidermis following transportation to other parts of the plant via phloem and xylem (Singh *et al.,* 2015) and subsequently enhanced concentration of respective nutrient through synergy. The elements which are even partially mobile in phloem (e.g., zinc) have the potential to improve concentration in the grain.

Conclusion

Among the different methods of application, foliar application is more efficient as it can manage soil immobilization and quick availability of nutrients to the crop. Combined application in both soil and foliar often showed better results. Other biofortification methods like seed priming and seed coating are spotted to give very infrequent result. Zinc and selenium biofortification are most fruitful with agronomic interventions.

References

Shivay, Y. S., Singh, U. M. M. E. D., Prasad, R. A. J. E. N. D. R. A., & Kaur, R. A. M. A. N. J. I. T. (2016). Agronomic interventions for micronutrient biofortification of pulses. *Indian Journal of Agronomy*. 61(4th IAC Special Issue): 161-172.

Praharaj, S., Singh, R., Singh, V.K., Chandra, R. (2019). Yield and grain zinc concentration of wheat as affected by nutri priming and foliar application of zinc. *Journal of Pharmacognosy and Phytochemistry*. 8: 503–505.

IIPR. (2014–15). Annual Report, Indian Institute of Pulses Research, Kanpur, Uttar Pradesh, India, pp. 10.

Masuthi, D. A., Vyakaranahal, B. S., & Deshpande, V. K. (2009). Influence of pelleting with micronutrients and botanical on growth, seed yield and quality of vegetable cowpea. *Karnataka Journal of Agricultural Sciences*. 22(4): 898-900.

Singh, M.V. 2007. Efficiency of seed treatment for ameliorating zinc deficiency in crops. (In) Proceedings of Zinc Crops: Improving Crop Production and Human Health, 24–26 May (2007), Istanbul, Turkey

Prasad, R., Shivay, Y.S. and Kumar, D. (2014). Agronomic biofortification of cereal grains with iron and zinc. *Advances in Agronomy.* 125: 55–91.

Singh, U., Kumar, N., Praharaj, C.S., Singh, S.S. and Kumar, L. (2015). Ferti-fortification: an easy approach for nutritional enrichment of chickpea. *The Ecoscan.* 9(3 and 4): 731–736.

Riesgo, L., Louhichi, K., Gomez y Paloma, S., Hazell, P., Ricker-Gilbert, J., Wiggins, S., Sahn, D.E. and Mishra, A.K. (2016). Food and nutrition security and role of smallholder farms: challenges and opportunities. In Institute for Prospective Technological Studies; Information for Meeting Africa's Agricultural Transformation and Food Security Goals (IMAAFS). Luxembourg: European Commission Publications Office. World Bank. 2015. Ending Poverty and Hunger by 2030, An Agenda for The Global system, (Washington, D.C).

Ghosh, A., Reja, H. M., Nalia, A., Kanthal, S., Maji, S., Venugopalan, V., & Nath, R. (2019). Micronutrient biofortification in pulses: an agricultural approach. *Current Journal of Applied Science and Technology*. 35(4): 1-12.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/04/0223

EDIBLE COATING OF HORTICULTURAL PRODUCE

Abdullah Zaid[1*],Ali Khan[2,] Deepak Tomar[2], Ujjaval Rai[1]and Prashant Kumar[3]

[1]M.Sc. Research Scholar, College of Horticulture,
Banda University of Agriculture and Technology, Banda Uttar Pradesh
[1]M.Sc. Research Scholar, College of Agriculture,
Banda University of Agriculture and Technology, Banda Uttar Pradesh
[2] M.Sc. Research Scholar, College of Forestry,
Banda University of Agriculture and Technology, Banda Uttar Pradesh
Mob No. 7271918786,
*Corresponding author, Email: **abdullahzaid265@gmail.com**

Abstract
According to recent data releasedIndia has surpassed china in terms of population now India is having largest population in the world andIndia is second largest producer of fruits and vegetable after china in order to feed this large population sufficient amount of food should be available, but 20 to 30% horticultural produce waste every year due to improper storage facility and lack of post-harvest handling. In India only 1 to 2 % of fruits and vegetable are processed where as in European countries they processed around 40 % fruits and vegetable every year. To increase shelf life of horticultural produce new technique is gaining popularity which is cheap and best this technique is called as edible coating which attaches on the surface of produce and reduce the rate of transpiration and increase shelf life of produce.

Introduction
India is the second largest producer of fruits and vegetables in the world and over the last decade, the area under horticulture grew by 2.6% per annum and annual production increased by 4.8%. During 2017-18, the production of horticulture crops was 311.71 MT from an area of 25.43 Million Hectares. The production of vegetables has increased from 101.2 MT to 184.40 MT since 2004-05 to 2017-18 and production of fruits has increased from 50.9 MT to 97.35 MT since 2004-05 to 2017-18 (Horticulture Statistics Division, NHB 2018). but loss of horticultural produce measure around 20-30 % due to insufficient storage capacity as well as improper knowledge about post-harvest handling of horticultural commoditiesAt present storing in cold storage is only method to increase shelf life of horticultural produce and cold storage play an important role in delay ripening, lowers ethylene production, avoid breakdown of calcium pectate which results in softening, changes in their pigments, lowers respiration rate, acidity and decrease in weight (PLW) in perishable fruits and vegetables.Uttar Pradesh have maximum number of cold storage (2368) followed by Gujarat (890) and Punjab (672).So to protect horticultural produce mainly fruits from deterioration waxing should be done to increase its shelf life by reducing the rate to transpiration and ethylene production. But at present there is a huge demand of edible coated product throughout the world.Due to the non-degradability of synthetic packaging materials, there have been a new research towards natural resources for makingbiodegradable edible coatings. Edible coating is used to improve food appearance and provide safety to the food by its eco-friendly nature. It may be obtained from both animal and vegetable sources. Coating may be of protein,

lipid, polysaccharide and resin. They act as a barrier for moisture and gases during processing, handling and storage.

Definition of Edible Coating

Edible coatings is a type of biodegradable coating that can be consumed and it has the ability to provide barrier against moisture, gases and solute movement.Other advantages of using edible coating is to reduce packaging waste, to extend the shelf life of fresh and minimally processed product and it also protect from harmful environmental effect by maintaining the transfer of oxygen, carbon dioxide, moisture, aroma and taste in a food. Edible coating may also contain functional ingredient such as antioxidants, nutrients and flavor to enhance food stability, quality, functionality and safety. Fruits and vegetables are generally coated by dipping/brushing or by spraying with edible material so that a semi permeable membrane is produced on the surface by which it reduces the rate of respiration.

Types of edible coating material

1. Coatings based on Polysaccharides

Polysaccharides are natural polymers used extensively to produce edible coatingpolysaccharides such aspectin, cellulose, starch, chitosan, alginates and pullulan is used in the production of these films Polysaccharides are the basic coating that are considered to be an efficientblocker of oxygen because of its structure.

- **Starch**

Starch is widely used in coatings for food materials since it is abundant in nature with cost effective. They possess less oxygen permeability and have an oil-free appearance. They make an important contribution to decrease in the respiration rate for the fresh fruits and vegetables.

- **Chitosan**

Chitosan is mostly used as coating materials because of its anti oxidative and antimicrobial properties presence in fruits and vegetables. It is non-toxic, biodegradable,biocompatible and micro-resistant in nature. Chitosan are partial permeable coatings and films, which can control the interior structure by reducing transpiration rates and lowers down ripening process in fruits and vegetables.

- **Alginate**

Alginates are indigestible natural polysaccharides acquired from seaweed and have been reported to be astabilizing and thickening agent in the food market. It has good film forming properties as it can form gels through crosslinking with divalent cations like Ca2+. Due to this
Reason, alginate finds interesting application for coating fresh and processed food items.

2. Pullulan-based coatings

Pullulan is a polysaccharide which is usually a thickener that may form effective films. The use of pullulan edible films and coatings in combination with chito-oligosaccharide, which has antibacterial properties and glutathione which is also a powerful reducing agent. This makes it effective in increasing the shelf life of various foodproducts.

- **Cellulose**

Cellulose is also a linear chain polysaccharide which is a major component of plant cell wall which has a large number of intra-molecular hydrogen bonds causing its water insolubility with highly associated crystalline structure. The native cellulose has very low water solubility properties and is a less suitable film forming material. However, various chemically modified forms of cellulose like

carboxymethyl cellulose, methylcellulose, hydroxypropyl cellulose and hydro-oxypropylmethyl cellulose are quite suitable for film and coating applications

- **Pectin**

Pectin is the main compound of plant cell walls, which found in middle lamella of plant cells. They are the complex heteropolymers made up of D-galacturonic acid units that may present variations in composition, structure and molecular weight.

3. Protein-based coatings

Protein-based coatings which include the use of casein, gluten and soy protein serve as good oxygen blockers and thus help preserve the food products from any deteriorative reactions. Proteins are reported to impart good mechanical and gas barrier properties

4. Corn zein-based films and coatings

Corn is a major source of zein which is a prolamin protein that can be dissolved in 70–80% ethanol and hydrophobic in nature. Edible coating made from zein shows very good film properties. They are good moisture blockers than other films.

5. Gelatin-based coatings and films

Gelatin coatings usually depict good transparency, mechanical and barrier properties and can be manufactured *via* an extrusion or casting process. The nature of the gluten has significant impact on its filming properties

6. Lipid-based coatings and films

Lipids are naturally hydrophobic in nature making them very good materials to be used in edible coating since they can help resolve moisture migration into the fresh food product which can cause some significant deteriorative changes in the food material. Some examples of lipids used in edible coatings include wax and paraffin (Oduro, 2021).

Application of edible coating on horticultural produce

Produce	Coating	Concentration	Effect
Papaya	CMC Chitosan and oxidized starch	4 % 1:3	Minimum change in TSS, physiological weight and vit C.
Apple	Alginate and gellan	Bifidobacterium lactis @ 2.0 (w/v)	Maintenance of fruit quality during storage
Pineapple	Alginate	Calcium chloride 2% w/v	Retention of internal liquids
Melon	Alginate	Calcium lactate 2% w/v	Maintenance of firmness
Tomato, Carrot	Glycerol+ Gum	20% + 1%	Reduce moisture loss
Mushroom	Glycerol+ Gum	20% + 1%	Reduce moisture loss and avoid shriveling of surface

Properties of edible coating

Properties of edible coatings are based on their molecular structure, molecular size and its chemical composition these properties are –

(1) Edible coatings have good barrier properties to water, moisture, O_2, CO_2 and ethylene.

(2) It contains active components such as antioxidants, vitamins, etc., which enhance nutritional composition of fruits and vegetables without effecting its quality.
(3) These coatings provide a protective covering on fruits and vegetables and enhance their shelf life.

Mode of actions

Fruits and vegetables continue to respire even after harvest and use up all the oxygen with in the produce, which is not replaced as quickly as by edible coating and produces carbon dioxide, which accumulates within the produce because it cannot escape as easily through coating. Eventually the fruit and vegetable will shift to partial anaerobic respiration that requires less oxygen (1-3%). With less oxygen, the production of ethylene (which accelerates ripening process) is disrupted and physiological loss of water is minimized. Thus, the fruits and vegetables remain firm, fresh, and nutritious for longer period and their shelf life almost doubles. The natural barrieron fruit and vegetable, and the type and amount of coating will influence the extent to which the internal atmosphere (oxygen and carbon dioxide) are modified and the level of reduction in weight loss (Dhall, 2013).

Advantages of edible coating

- Edible coatings improve water retention capacity.
- Edible coatings improve retention of acids, color, flavor and sugar.
- Maintain quality of fruits and vegetables during storage.
- Edible coatings can be consumed along with fruits and vegetables, they contain health beneficial nutrients.

Disadvantages of edible coating

- Thick coating can prohibit Oxygen exchange, causes off- flavour development
- Some edible coatings are hygroscopic in nature, which helps to increase microbial growth.
- Some edible coatings are hygroscopic in nature, which helps to increase microbial growth.

Conclusion

To increase shelf life of fruits such as apple, kinnow, plum, grapes, guava and pear edible coating can be successfully used. It is also not very expensive as compared to packaging technology and it is bio degradable nontoxic in nature. In India waxing is mostly done on apple and it increases shelf life of apple for several months followed by storing it in cold storage. It is successfully used in vegetable such as carrot, radish, brinjal, and tomato. This waxing technology can regulates the market demand by providing horticultural produce during the off season.

References

(Horticulture Statistics Division, NHB 2018)

Dhall, R.K., 2013. Advances in edible coatings for fresh fruits and vegetables: a review. *Critical reviews in food science and nutrition*, *53*(5), pp.435-450.

Oduro, K.O.A., 2021. Edible Coating. In *Postharvest Technology-Recent Advances, New Perspectives and Applications*. Intech Open.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/05/0223

EDIBLE VACCINES : APPROACH TO ORAL IMMUNIZATION

Pramod Sargar[1*], Smita Deshmukh[1] and Pranjal Shedge[2]

[1]Research Scholar, Department of Agricultural Botany
(Genetics and Plant Breeding), V.N.M.K.V., Parbhani. Maharashtra. India 431 402.
[2]Research Scholar, Sorghum Breeding Programme.
ICRISAT, Patancheru. Telangana, India. 502 324.
*Corresponding email – pramodsargar28@gmail.com

Introduction

The edible vaccine involves inserting desired genes into plants and then inducing these altered plants to produce the altered protein. Antigens of bacterial and viral pathogens can be expressed in plants while retaining their native immunogenic properties. Initially, edible vaccines were thought to be only useful for preventing infectious diseases. It has also been used in the prevention of autoimmune diseases and cancer treatment. In the 1990s, Arntzen developed the idea of edible vaccines. The expression of a surface antigen from the bacteria Streptococcus mutans in tobacco was the first demonstration of an Edible Vaccines. Because this bacterium causes dental caries, it was thought that stimulating a mucosal immune response would prevent the bacteria from colonising the teeth and thus protect against tooth decay. Vaccine antigens can be delivered orally by administering transgenic edible parts created using molecular biology methods.

The desired genes can be introduced into plants, where they are expressed in plant tissues, including edible components. This is known as "transformation," and the genetically modified plants are known as "transgenic plants." These genes encode vaccine antigens that protect against viral, bacterial, and parasitic pathogens that cause disease in humans and animals. The vaccine can be administered through ingestion of the edible part of the genetically modified plant or through high-yield production of refined protein for oral administration. Edible Vaccines are like unit preparations in that they are designed to contain antigens, but they lack the genes that could change entire pathogens to cause harmful effects in humans. These genes encode vaccine antigens against pathogens that cause disease in humans and animals, such as viruses, bacteria, and parasites. The vaccine can be administered by ingesting the edible part of the genetically modified plant or by producing a high yield of refined protein for oral administration. Edible Vaccines are like unit preparations in that they are designed to contain antigens, but they do not contain any genes that could change entire pathogens to cause harmful effects in humans.

Creating an Edible Vaccine

Edible vaccines are subunit vaccines; they contain antigen proteins for a pathogen but do not contain the genes required for the pathogen to form fully. The identification, isolation, and characterization of a pathogenic antigen are the first steps in developing an edible vaccine. The antigen must elicit a strong and specific immune response in order to be effective. After identifying and isolating the antigen, the gene is cloned into a transfer vector. Agrobacterium tumefaciens is one of the most common DNA transfer vectors used in edible vaccines. To generate the antigenic protein, the pathogen sequence is inserted into the transfer DNA (T-DNA). It is then

inserted into the genome, expressed, and passed down in a mendelian fashion, resulting in antigen expression in the fruit or plant. Traditional vegetative methods and techniques are used from then on to grow the plants and propagate the genetic line.

Antigen-encoding genes from pathogenic organisms (viruses, bacteria, or parasites) for which antibodies are available can be handled in two ways. In one case, the entire structural gene is inserted into a plant transformation vector between the 5' and 3' regulatory elements, allowing transcription and coding sequence accumulation in the plant. In the second case, epitopes within antigen are identified, and DNA fragments encoding these can be used to construct genes through fusion with coat protein genes from plant viruses, such as TMV or CMV. After that, the recombinant virus is used to infect stabilised plants. The resulting edible plant vaccines are being used in further immunological research. Figure 2 depicts strategies for producing candidate vaccine antigens in plant tissues.

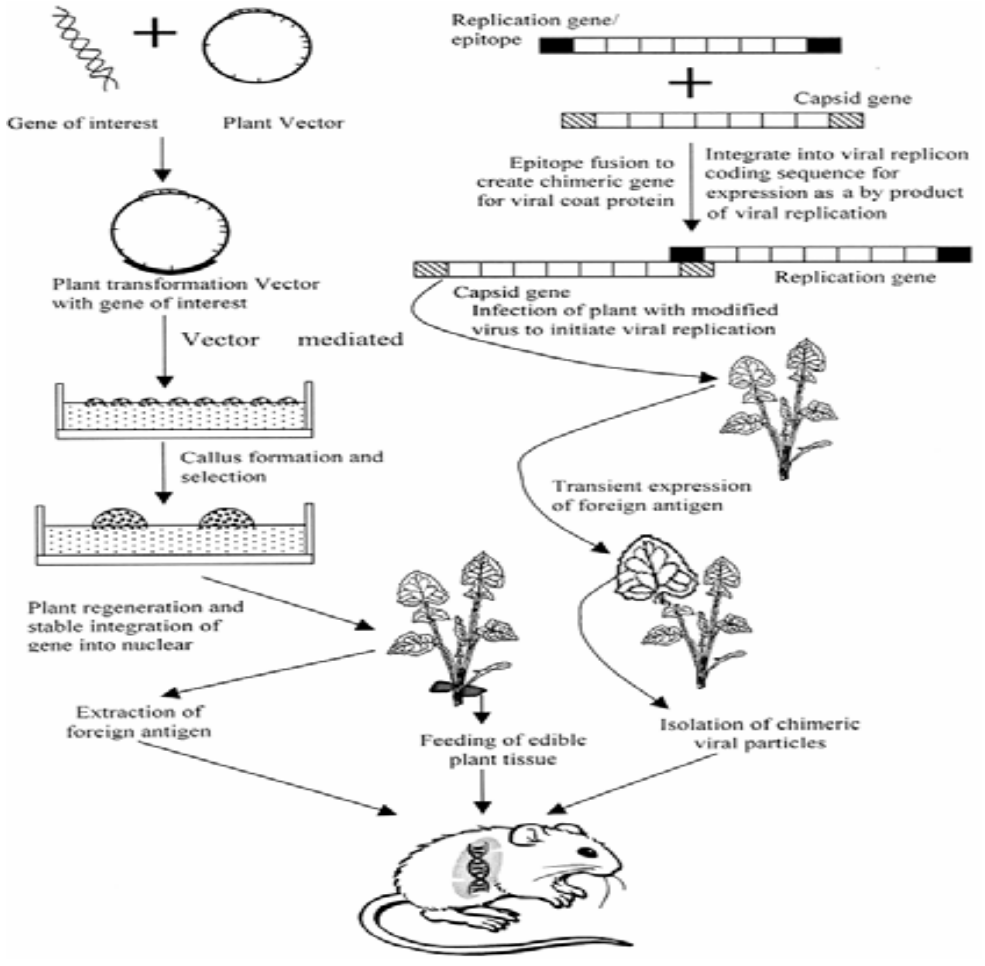


Figure:- Strategies for the production of candidate vaccine antigens in plant tissues.
(Image Source – Neeraj *et al.,* 2008)

Major Plant Species Used as Vaccine Models

Potato : Potato is an appropriate model for producing vaccines against tetanus, diphtheria, hepatitis B and Norwalk virus. The first attempt to develop edible vaccine in potato is for enteritis caused by *E. coli* strain. Potato may also have a role as an oral strengthening to the hepatitis B

vaccines in humans. An edible vaccine against mink enteritis virus attack was developed in potatoes. Potato edible vaccine also tried against rabbit haemorrhagic virus in wild rabbits. The main benefit of producing edible vaccine from potato is the ease of transformation and propagation. There is no need of refrigerators for storing and one of the main disadvantage is cooking leads to denature of antigens.

Rice : Rice is the other plant species used for the development of edible vaccines. Advantages over other plants were commonly used in baby food and high expression of antigen. But it grows slowly and requires glasshouse condition. In 2007, a study conducted in transgenic rice called Oryza sativa persuades significant number of antibodies against E coli. Functional expression of HBsAg in rice seeds was confirmed in 2008. Vaccines developed from rice plant will have a massive power on the public health where rice is the major source of food.

Banana : Banana is the commonly used plant species in the production of edible vaccine. It does not need cooking. Proteins were not destroyed even after cooking. Inexpensive when compared to other plants. Banana plants express HBsAg. The leaf contains antigen. The main disadvantage is it takes 2–3 years to mature and spoils fast after ripening.

Tomato : An effective vaccine against acute respiratory syndrome, SARS caused by coronavirus was first established in tomato. It produces better effect against Norwalk virus than vaccines produced from potato. The leaves, stem, fruits, and other tissues has the ability to express CT-B proteins from Vibrio cholera B toxin.

Lettuce : This plant is an effective model system against enteric diseases in both animals and humans caused by E coli. Glycoprotein E2 expressed lettuce for classical swine fear hog pest virus was developed. This plant is mainly used up in the raw form and it produces beneficial effects against hepatitis B virus. It is the utmost effective plant that can be used as an edible vaccine.

Tobacco : Tobacco is not an edible plant. It is used as a model for the development of edible vaccines. A vaccine was developed in tobacco for Norwalk virus in 1996 that causes gastroenteritis. Transgenic tobacco expresses VP1 protein against chicken infectious anaemia. Tobacco has the ability to express a polypeptide related to hepatitis B. It is also used to develop vaccine against coccidiosis.

Alfalfa : Alfalfa is the plant used to develop edible vaccines mainly for veterinary purposes. Transgenic alfalfa containing hog pest virus glycoprotein E2 was developed in 2005. Alfalfa plants was developed to express Eeg95-EgA31 of Echinococcus ganulosus.

Carrots : Carrots were not only healthy and delicious but also can be consumed in the form of edible vaccines. Vaccines against HIV, E coli, Helicobacter pylori shows potential effects when it is produced in transgenic carrots. People having weak immune system gets proper benefit by consuming this type of antigen containing carrot edible vaccine.

Advantages of Edible Vaccines

Potential advantages of plant-based vaccines are:

- A method of administration that is edible.
- Less reliance on medical personnel and sterile injection procedures.
- Cost-effective in mass production and transportation.
- Therapeutic proteins are pathogen and toxin-free.
- Storage close to the point of use.
- Heat stable, so no need for refrigeration.
- Antigen defence via bioencapsulation.

- Improved safety with subunit vaccine (no attenuated pathogens).
- Seroconversion when maternal antibodies are present.
- The development of systemic and mucosal immunity.
- Improved compliance (especially in children).
- Multiple antigens are delivered.
- Integration with other vaccine strategies.
- Plant-derived antigens spontaneously assemble into oligomers and virus-like particles.

Limitations of Edible Vaccines

- Immune tolerance to vaccine peptides or proteins.
- Dosage consistency varies from fruit to fruit, plant to plant, and generation to generation.
- The vaccine's stability in fruit is unknown.
- Evaluating dosage requirements is time-consuming.
- Choosing the best plant is difficult.
- Certain foods, such as potatoes, should not be consumed raw, as cooking them may weaken the medicine contained within them.

Mechanism of action

When taken orally, edible vaccine undergoes mastication, and the majority of plant cell degradation occurs in the intestine as a result of the action of digestive or bacterial enzymes on edible vaccine. Peyer's patches are an enriched source of IgA-producing plasma cells that can populate mucosal tissue and serve as mucosal immune effector sites. The Edible vaccine breakdown near PP, consisting of 30-40 lymphoid nodules on the intestine's outer surface containing follicles. These follicles serve as the entry point for antigen into the intestinal epithelium, where it accumulates within the organised lymphoid structure. The antigen is then exposed to M-cells. M-cells deliver antigen to macrophages and B-cells. This B-cell activates the T-cell, causing it to respond with an immune response.

Factors affecting efficacy of edible vaccines.

- Antigen selection.
- Efficacy in the model system.
- Choice of plant species.
- Delivery and dosing issues.
- Safety issues.
- Public perceptions and attitudes to genetic modification.
- Quality control and licensing

Future prospects and Conclusion

Edible vaccines have enormous potential, particularly in Third World countries where transportation costs, poor refrigeration, and needle use make vaccine administration difficult. While research is also being conducted on laboratory animals, diabetics may benefit from an edible form of insulin in the future. The National Science Foundation and other government and industry-funded researchers have developed technologies that allow the introduction of a hybrid gene that produces human insulin in potatoes. Insulin-containing potatoes may help diabetics train their bodies' defences to stop reacting to insulin as if it were a foreign material.

Edible vaccines are created using genetically modified plants. The gene-encoding bacterial or viral disease-causing agent can be incorporated into plants without losing its immunogenicity in the production of edible vaccines. The primary mechanism of action of edible vaccines is to stimulate systemic and mucosal immunity against a foreign pathogen. Edible vaccines can be created by inserting a transgene into a specific plant cell. At the moment, edible vaccines are being developed for both veterinary and human use. However, the main challenge for edible vaccine is public acceptance, so it is necessary to educate the public about its use and benefits. Edible vaccines are less expensive, more efficient, and safer than other traditional vaccines. Edible vaccines may be a solution for extending vaccine benefits and reducing some of the risks associated with parenteral vaccines, such as toxic compounds, allergic reactions, and the risk of attenuated strains reverting to pathogenic strains. Edible vaccines provide a method to deliver a vaccine orally without the need for a cold chain, lowering the cost of production and shipping and potentially being ideal for dealing with bio-weapons and veterinary use, among other advantages.

References

Conrad U & Fiedler U, Expression of engineered antibodies in plant cells, Plant Mol Biol, 26 (1994) 1023-1050.

Neeraj Mishra, Prem N Gupta, Kapil Khatri, Amit K Goyal and Suresh P Vyas (2008). Edible vaccines: A new approach to oral immunization, Indian Journal of Biotechnology Vol 7, pp 283-294.

Tacket C O, Mason H S, Losonky G, Clements J D, Wasserman S, Immunogenicity in human of a recombinant bacterial antigen delivered in transgenic potato, Nat Med, 4 (1998) 607-609.

V. M. Kurup and Thomas, J., (2020) “Edible Vaccines: Promises and Challenges.”, Mol Biotechnol, vol. 62, no. 2, pp. 79-90,.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/06/0223

IMPACT OF MYCOFILTRATION ON WATER QUALITY IMPROVEMENT AND FISH PRODUCTION

Preeti Maurya

PG Scholar, Govind Ballabh Pant University Agriculture and Technology, Pantnagar, Uttarakhand.
Corresponding email: preetimaurya070297@gmail.com

INTRODUCTION

The quality of water is of vital concern for the mankind as well as fish as it is directly linked with their welfare.In recent years, many of the water bodies have become polluted due to inflow of sewage, industrial waste and synthetic chemicals.With increasing industrialization and population growth water resources available for various purposes viz. drinking, irrigation, recreation, fish farming, *etc.* Polluted sewage water contains solid and dissolved organic compounds that imparts an offensive color and serve as an excellent medium for the growth and multiplication of microorganisms.High level of pollutants mainly organic matter in river water causes an increase in chemical oxygen demand, total dissolved solids, etc.

Ground water and surface water sources, such as dams, rivers, lakes and canals serve as important sources for fish production. It thus becomes of great importance that good water quality is attained, because it influences the health status of any ecosystem.

In recent years, biological technologies involving manipulation of naturally occurring microorganisms, such as fungi, to remove pollutants. One of the methods by using fungi is known as Myco-filtration.

IMPORTANCE OF WATER QUALITY

Water quality is one of the major concerns in fish production. The quality of the water in the production systems can significantly affect the organism's health. Optimal water quality varies by species and must be monitored to ensure growth and survival. When the effluent is released into the aquatic environment without the proper treatment, it alters the ecosystem.

The major important role of bio-filtration is ensuring the water quality for sustainable environment system. Many techniques now a days developed for purifying the water coming from natural resources in order to reduce the heavy metals, harmful chemicals and microbial load. The common technique that are suitable for remediating the pollutant from water are bioremediation, bioaccumulation, myco-restoration but among them one technique which is developed recently as a low cost, low-technology, user friendly is myco-filtration technique.

MYCOFILTRATION

Myco-filtration is the pioneering technique of using fungi to filter out pollutants from water. It is the treatment of contaminated water by passing it through a network of fungal mycelium. Mushroom-forming fungi are primarily terrestrial, aerobic organisms whose vegetative growth takes the form a three-dimensional web like cells called mycelium. Fungal colonies composed of mycelium are found in and on soil and many other substrates. Myco-filtration is an environment friendly technology.

Fungal Mycelium

Mycelium (plural mycelia) is a root-like structure of a fungus consisting of a mass of branching, thread-like hyphae. Mycelia are vital in terrestrial and aquatic ecosystems for their role in the decomposition of plant material. They contribute to the organic fraction of soil, and their growth releases carbon dioxide back into the atmosphere. Mycelium is a primary factor in a plant's health, nutrient intake, and growth. In this technique fungal mycelium uses extracellular enzymes in degradation of the pollutants and reduces the toxic waste from the environment. Fungal mycelium can also work as a filter network used in buffer zones around streams to filter the runoff from farms and other urban zones.

Species for Myco-filtration

Many mushroom-forming fungi of the phylum basidiomycota, which includes well known species such as the oyster mushroom (*Pleurotusostreatus*) and turkey tail mushroom (*Trametes versicolor*) are further described as “white rot,” named for the white cellulose-rich material that is left behind as these organisms metabolize the lignin from their wood substrate. White rot fungi cover’s about 30% of fungal bioremediation.

There are various other white rot fungi *viz. Pleurotusostreatus, Trametes versicolor, Bjerkanderaadusta, Lentinula edodes, Irpexlacteus, Agaricusbisporus, Pleurotustuberregium, Pleurotuspulmonarius.*

Fungal species, either live or in the form of dried biomass, have a very effective biosorption potential for metals such as Cu, Zn, Fe and Mn.

FUNCTIONS OF FUNGI

One of the primary roles of fungi in an ecosystem is to decompose organic compounds.The process of using fungi to degrade contaminants in the environments stimulating the microbial and enzymatic activities. Some fungi are hyper accumulators, capable of absorbing and concentrating heavy metals in the mushroom fruit bodies. The fungal mycelium as an active filter for removing contaminants from water, in which mushroom forming fungi purposely grow on substrates as an active filtration media.Fungi continues to support the development of myco-filtration as an environmentally available for surface water management. The use of intentionally vegetative network of mycelium to facilitate water quality improvement in ecosystem.Fungi have been proven to be a cheap and effective for removing a wide array of contaminants from damaged environment or wastewater.

HOW MYCOFILTRATION WORKS

A typical myco-filtre comprises a sack layered with substrate (*e.g*. straw or woodchips) and saprophytic mycelium.

↓

The mycelium grows throughout the sack as a network of filaments, before being placed in the water bodies for remediation.

↓

Myco-filtration has shown to efficiently remove microbial pathogens from storm water, treat industrial brewery effluent, remediate heavy metal contaminated drinking water sources, as well as remove total nitrogen and phosphorus from a dairy waste.

MYCOFILTERATION AND ITS APPLICATION

- ❑ This ecologically rational biotechnology is a promising technique for enhancing management of stormwater, graywater, and agricultural runoff.
- ❑ The intentional and judicious use of cultivated fungal mycelium to facilitate water quality improvements in ecosystem.
- ❑ Mycelia are made of a mass of string like structures called hyphae. The hyphae thick shape, extensive systems underground that retain supplements in the dirt by emitting catalysts.
- ❑ Their enzymatic and retention capacities make growths an extraordinary for a few technique's remediation, or myco-remediation.
- ❑ Mycelia can be utilized as natural channels, wipes for poisons, and strengtheners of soil.
- ❑ The filtration part of mycelia, or myco-filtration, has been generally as a technique to sanitize storm water.

Impact on Water quality

- Natural water quality differs from one place to another, depending on, e.g., change in seasons, climate, geochemical settings and biochemical processes, anthropogenic activities add to the differences that ultimately change the water use potential.
- Quality of water for fish production is evaluated by various hydrological factors pH, dissolved oxygen, ammonia, *etc.* these factors may directly or indirectly affect the growth and production of fishes and other aquatic flora and fauna.
- Myco-filtration has potential for use, to filter out and reduce levels of organic, inorganic and microbial contaminants in water.

Physico-chemical factors affect fish production

- The main physico-chemical factors that affects fish production are pH, dissolved oxygen, free CO2, alkalinity, nitrate, ammonia, conductivity, TDS, etc.
- Presence of heavy metals are harmful to most of the fish species resulting in the decreased production.
- It has the capacity to bioaccumulate in fish tissues leading to higher concentration in fishes.
- The other factor that many microbial pathogens enter's in fish farming through sewage effluent or from runoff of soil and other land surfaces.
- The pathogens that can be found in water include viruses, bacteria, protozoa etc.

CASE STUDY RELATED TO MYCOFILTRATION

A. A study investigates the impact of mycofiltration technique on various hydrographical parameters of the water and the fish growth. The mushroom mycelium used pink oyster mushroom (*Pleurotusdjamor*) and white oyster mushroom (*Pleurotusostreatus*).Results showed that variation in physico-chemical parameters and increased in specific growth rate of fishes. Also showed that the presences of coliforms bacteria at initials, then after the filtration process the count was decreased. So, the study concludes that myco-filtration technique is an excellent technique for filtering water and improve water quality.

B. In Nigeria, the frequent cases of aquatic pollution from anthropogenic activities especially from oil drilling and exploration processes. The study had shown that the use of myco-filtration by agricultural wastes, maize cobs can be used as substrates in a low cost and efficient cultivation method for the production of fungal filtration membranes to

ameliorate their contaminated drinking water.The myco-filters produced by the fungus *Pleurotustuberregium*was effectively used to remove heavy metals from contaminated drinking water sources.

CONCLUSION

The purpose of utilization of the vegetative development of mushroom farming on substrates as a naturally dynamic filtration media. This technique makes the suitable condition of the water quality parameters and does not cause any stress in the environment as well as growth of the fishes. This technique can be used for growing fishes in filtered water through mycofiltration as it absorbs heavy metals, microorganisms and enhance the productivity of water. Through this process we maintain the physico-chemical parameters for improving the water quality in fish production.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/07/0223

MILLET : WONDERS OF ALL GRAINS

Pinak. K. Bamaniya and Ishita. J. Bambhaniya

College of Fisheries Science, Kamdhenu University, Veraval (Gujarat)
*Corresponding Email: pinakbamaniya@gmail.com

Introduction

The word "millet" comes from the French word "Mile," which means "thousand," suggesting that a small amount of millets contains many thousands of grains. Millets were first domesticated and grown for human use and animal feed between 8700 and 10,300 years ago, making them one of the world's oldest crops. (Lu et al. 2009a, b). Millets, also referred to as small millets, are grown for their small kernels, which are produced by small grassy plants in the Poaceae family. The alternative name for minor millets may imply that they are minor crops, although they are significant for their nutritional content, medical advantages, animal feed, and role as lifesavers in times of food scarcity. (Joshi and Agnihotri 1984; Yenagi et al. 2010).Millets are frequently produced in marginal or degraded areas with very low nutrient levels and semi-arid conditions with very little rainfall. The crops provide food for people in areas where drought is a common occurrence, and millets provide a more consistent harvest than other crops in regions with low rainfall. (Tadele 2016). Millets are C4 plants that have very high levels of photosynthetic efficiency, a short duration, a higher capacity to produce dry matter, and a high level of heat and drought tolerance. With 26.6% of the world's millet farming area and 83% of Asia's, India is the greatest millet producer in the world. Millets have long been a staple of tribal food in the Indian states of Odisha, Madhya Pradesh, Jharkhand, Rajasthan, Karnataka, and Uttarakhand. (Sood et al. 2019). India, China, and Nepal account for the majority of millet production in Asia. India is the world's top producer of millets, accounting for about 37.5% of the total output, followed by Sudan and Nigeria. The majority of India's dry, arid regions—where rainfall is scarce and irregular where millet is produced. Pearl millet, which accounts for 56% (9 Mt) of all millets produced in India, is the most extensively produced millet and is mostly farmed in the states of Rajasthan, Uttar Pradesh, Gujarat, Madhya Pradesh, and Haryana. With an output of 1.79 Mt from the total cultivated area of 1.17 M ha, finger millet is the most extensively produced minor millet in India. Karnataka, Uttarakhand, Maharashtra, Tamil Nadu, Odisha, and Andhra Pradesh are the main finger millet producing states, accounting for more than 90% of the national production. The second-most widely cultivated minor millet in India is kodo millet.

Types of millets

There are at least 10 genera and 14 species of millets, that include pearl millet (Pennisetum glaucum L.), foxtail millet (Setaria italica L. subsp. italica), Finger millet (Eleusine coracana L.), barnyard millet (Echinocloa esculenta A. and Echinocloa colona L.), proso millet (Panicum miliaceum L. subsp. miliaceum), kodo millet (Paspalum scrobiculatum L.), and little millet (Panicum sumatrense Roth.) that are cultivated widely throughout the world.Millets are commonly subdivided into two most important groups of species, major millets and minor millets. The crops underneath the umbrella of minor millets are finger millet (Eleusine coracana), barnyard millet (Echinochloa frumentacea), proso millet (Panicumm iliaceum), foxtail millet

(Setaria italica), kodo millet (Paspalum scrobiculatum), little millet (Panicum sumatrense), and browntop millet (Brachiaria ramose) which can be cultivated as food and fodder crops (Fig. 1).

Fig 1. Seven cultivated species of minor millets in India, viz., 1. finger millet, 2. barnyard millet, 3. foxtail millet, 4. proso millet, 5. little millet, 6. kodo millet, and 7. browntop millet

Pearl millet (*Pennisetum glaucum* L.): According to Andrews and Kumar (1992), bajra, also known as pearl millet, is thought to have originated in Africa more than 5000 years ago and was brought to the Indian subcontinent about 3000 years ago. The crop is mostly farmed by subsistence farmers in Africa, Asia, and Australia and is well adapted to harsh weather conditions with rainfall of less than 250 mm and temperatures of 30 C and above. Most of the world's millets are grown on this crop, which is recently becoming more important as a commercial crop in Australia. (National Research Council 1996).

Foxtail millet (*Setaria italica L. subsp. italica*): Foxtail millet, also known as Italian millet, is said to have originated in China, although it was domesticated during the Neolithic period. It is one of the oldest cereals that is grown in both Asia and Europe, with China accounting for more than 45% of global production (Jiaju and Yuzhi 1994). The crop matures in less than 70-120 days and is ideally suited to cooler climes.Like most millets, foxtail millet is an excellent source of crude fibre, aids in digestion, and encourages bowel movement, generating a laxative effect that supports a healthy digestive tract. Additionally, foxtail millet exhibits numerous health advantages, including the prevention of cancer and the reduction of blood sugar and cholesterol (Sharma and Niranjan 2018).

Proso millet (*Panicum miliaceum L. subsp. miliaceum*): Broom millet, also known as proso millet, is currently grown in northwest China, southern and central India, Australia, the United States, and Europe. It is believed to have its origins in the Manchurian region of China (House 1995). After pearl millet and foxtail millet, it is the third most significant millet crop grown, and it is well suited to moderate climatic conditions up to altitudes of 3500 m and a variety of soil types (Baltensperger 2002). It may thrive in a variety of soil types and climatic conditions. Compared to

other millets, proso millet has a shorter growing season and can finish its life cycle 60 to 100 days after sowing.

Finger millet (*Eleusine coracana L.*): The crop gets its name from the way its ear heads resemble human fingers. Ragi or finger millet likely originated in the highlands of Ethiopia and Uganda (National Research Council 1996). India is the world's top producer, with significant production hubs in Asia and Africa. The crop may grow in tropical settings with low to moderate rainfall and an intermediate height (500–2400 m) (500–1000 mm). In well-drained soils, the crop can grow in hot, dry weather up to 35 C. Finger millet grains can be kept in storage for up to 50 years, making them an excellent famine reserve (National Research Council 1996).

The whole meal is used to make traditional dishes like roti (unleavened bread), ambali (thin porridge), and mudde (dumplings) by milling the finger millet with testa, which is normally rich in dietary fibre and minerals (Devi et al. 2014). In Uttarakhand, finger millet is consumed as roti and in the form of a savoury buttermilk porridge. The Monpa tribes of Arunachal Pradesh's Zan is the most well-known porridge recipe made from finger millet and veggies (Bhat et al. 2019).

The products made from finger millet are helpful for preventing osteoporosis and other bone problems in adults and older populations as well as for increasing bone mass in developing children (Kumar et al. 2016).

Barnyard Millet or Sawa millet (*Echinocloa esculenta A.* and *Echinocloa colona L.*): While sawa millet was domesticated in the Indian subcontinent, barnyard millet, or Japanese millet, has its origins in the province of Japan (House 1995). Both millets have a similar shape and are members of the same genus. Although the crops do best in warm climates, they can also be grown in colder climates. Barnyard millet is largely grown in Japan, China, Korea, and India, and is prized for its excellent storability.

Dehusked barnyard millet is prepared like rice and consumed or made into porridge. Barnyard millet is consumed as paleu or chencha, a savoury boiled porridge in buttermilk, in Uttarakhand. The sprouting seed of barnyard millet has stomachic, astringent, acidic, and emollient properties. Abdominal dyspepsia, poor digestion, and nutritional stagnation are all treated with it. White seeds are cooling and are used to treat fever and cholera. Green seeds have diuretic properties and increase virility (Chauhan and Jhonson 2011).

Kodo Millet (*Paspalum scrobiculatum L.*): Kodo millet (Paspalum scrobiculatum) is widely cultivated in rocky or gravelly soils where other crops would not thrive, and it is thought to be exceptionally tough and drought-resistant. Compared to other millets, which mature in 2-4 months, the length takes 5 or 6 months to reach maturity (Bhat et al. 2019). India produces the majority of the world's kodo millet, which accounts for 90% of global production (Hedge and Chandra 2005). Despite being well adapted to tropical and subtropical climates, kodo millet has relatively low grain yields (250–1000 kg/ha) and takes 120–180 days to reach maturity.

Indian tribal tribes use kodo millet grains as rice and grind the seeds to make flour for chapattis. Idli, dosa, chapatti, pongal, puttu, idiyappam, kozhukattai, boli, cutlets, biscuits, bread, cookies, laddoo, and other traditional culinary items are made with kodo flour. Kodo contains water-soluble fibre, and this characteristic can be used to maintain or minimise blood glucose response in diabetics and people with cardiovascular disease. Glycemic load (GL), which reflects both the

quality and quantity of carbohydrates in food and allows comparison of the potential glycemic impact of practical food portions, has been shown to increase glucose tolerance in both healthy and diabetic subjects (Riccardi et al. 2008; Thakur et al. 2018).

Little millet (*Panicum sumatrense Roth.*): Small millet Paspalum sumatrense is also known as Indian millet because it is indigenous to India. The species' name is derived from a specimen that was collected in Sumatra, Indonesia (de Wet et al. 1983). It is primarily grown in Malaysia, Malaysia, eastern Asia, and India. Little millet may grow in both tropical and chilly climes. The crop is currently virtually exclusively grown in a few mountainous regions of India. Indian tribal people produce it as a significant catch crop (Kalaisekar et al. 2017). The Eastern Ghats of India are where little millet was first domesticated more than 2000 years ago, and peninsular Indian states like Andhra Pradesh, Karnataka, Tamil Nadu, and Kerala are where the crop is still most commonly farmed today. The crop matures quickly and can tolerate harsh conditions, so it can be grown in both dry and humid climates and in locations that are prone to drought as well as waterlogging. Due to its restricted cultivation in India, Sri Lanka, Nepal, and Myanmar—India accounts for more than 98% of the acreage and output of small millet—the genetic diversity of this crop is extremely low. Little millet is grown in Madhya Pradesh and Chhattisgarh in India, where it is eaten during fasting as bhagaar meal.

For patients with diabetes and cardiovascular conditions, little millet is used to regulate or lessen the blood glucose response (Riccardi et al. 2008). Additionally, little millet is a good source of nutraceuticals such phenolics, butyric gamma-amino acid (GABA), lignans, starch resistance, sterols, and phytates. The synergistic and cumulative impacts of these bioactive nutraceuticals in millet-based diets can have a significant positive impact on health (Prathapan et al. 2011).

Browntop Millet (*Brachiaria ramosa*)

A South-East Asian annual grass imported to the West, browntop millet (Brachiaria ramosa (L.) Stapf; Panicum ramosum L.) (Clayton et al. 2006). Although it may also be grown in low-flooding locations, browntop millet is heat and drought resistant. In 1915, it took off from India and arrived in the United States (Oelke et al. 1990). In the Karnataka state districts of Tumakuru, Chitradurga, and Chikkaballapura, browntop millet is grown in especially in rainfed areas. This region has a lot of the crop, which is mostly used for food by those in economically disadvantaged sections. Several types of soils and climatic conditions are used to grow this millet seed. Similar to other millets, it is a resilient crop that grows well in dry areas.

Making porridge or unleavened bread using browntop millet grains is common (Nesbitt 2005). It is not only healthy but also delicious, full of vital nutrients, and gluten-free. Some of these foods are employed in religious rituals, which may contribute to the lifespan of their cultivation.

Due to its 12.5% fibre content, browntop millet is used as a medication to alleviate ailments caused by a sedentary lifestyle. Millets are known to have a lower incidence of diabetes, duodenal ulcers, and cardiovascular problems in people who frequently consume them.

International Year of Millets (IYM 2023)

Fig 2. IYM 2023 (source - FAO)

At its 75th session in March 2021, the United Nations General Assembly proclaimed 2023 the International Year of Millets (IYM 2023). In cooperation with other pertinent stakeholders, FAO is the primary organisation for the Year's celebration. Millets are tolerant of climatic fluctuations and can be grown on arid lands with few inputs. As a result, they are the perfect way for nations to boost national independence and lessen their dependency on imported cereal grains.

The #IYM2023 campaign will be an opportunity to spread knowledge about millets' health and nutritional advantages as well as their potential for cultivation in challenging and changing climatic circumstances. Additionally, millets' potential to open up new sustainable market prospects for both farmers and consumers will be highlighted, along with the Year's promotion of their sustainable production.

REFERANCE

Andrews DJ, Kumar KA (1992) Pearl millet for food, feed, and forage. Adv Agron 48:89–139

Bhat BV, Arunachalam A, Kumar D, Tonapi VA, Mohapatra T (2019) Millets in the Indian Himalaya. Indian Council of Agricultural Research, New Delhi. 84p

Chauhan B, Johnson DE (2011) Ecological studies on Echinochloa crusgalli and the implications or weed management in direct-seeded rice. Crop Prot 30:1385–1391

Clayton WD, Vorontsova MS, Harman KT, Williamson H (2006) Grass base–the online world grass flora. Royal Botanic Gardens, Kew, UK

de Wet JM, Brink DE, Rao KP, Mengesha MH (1983) Diversity in kodo millet, Paspalum scrobiculatum. Econ Bot 37(2):159–163

House LR (1995) Sorghum and millets: history, taxonomy, and distribution. American Association of Cereal Chemists, St Paul, MN, pp 1–9

Jiaju C, Yuzhi Q (1994) Recent developments in foxtail millet cultivation and research in China. In: Riley KW, Gupta SC, Seetharam A, Mushonga JN (eds) Advances in small millets. International Science Publisher, New York, pp 101–108

Joshi PK, Agnihotri AK (1984) Millet production in India: problems and prospects. Agric Situation India 39:329

Kalaisekar A, Padmaja PG, Bhagwat VR, Patil JV (2017) Introduction. In: Kalaisekar A, Padmaja PG, Bhagwat VR, Patil JV (eds) Insect pests of millets. Academic, London, pp 1–25. https://doi.org/10.1016/B978-0-12-804243-4.00001-X

Lu H, Zhang J, Liu KB, Wu N, Li Y, Zhou K, Ye M, Zhang T (2009a) Earliest domestication of common millet (Panicum miliaceum) in East Asia extended to 10,000 years ago. Proc Natl Acad Sci USA 106(18):7367–7372

Lu H, Zhang J, Wu N, Liu KB, Xu D, Li Q (2009b) Phytoliths analysis for the discrimination of foxtail millet (Setaria italica) and common millet (Panicum miliaceum). PLoS One 4(2):e4448

Nesbitt M (2005) Grains. In: Prance G, Nesbitt M (eds) The cultural history of plants. Routledge Press, New York

Niramala B. Yenagi (2004) Value adding strategies for conservation and sustainable use of indigenous minor millets. Presented at First National Convention on "Science and tradition of food - India's heritage of 5000 years" during 25–27 July 2004 organised by Academy of Sanskrit Research Melkote, India, and CFTRI, Mysore. p 80

Oelke EA, Oplinger ES, Putnam DH, Durgan BR, Doll JD, Undersander DJ (1990) Millets. Alternative field crops manual. University of Wisconsin-Madison, Madison, WI

Prathapan A, Singh MK, Anusree SS, Soban Kumar DR, Sundaresan A, Raghu KG (2011) Antiperoxidative, free radical scavenging and metal chelating activities of Boerhaavia diffusa l. J Food Bio-Chem 35:1548–1554

Riccardi G, Rivelluse AA, Giacco R (2008) Role of glycemic index and glycemic load in the healthy state, in prediabetics and in diabetes. Am J Clin Nutr 87:269S–274S

Sharma N, Niranjan K (2018) Foxtail millet: properties, processing, health benefits, and uses. Food Rev Int 34(4):329–363

Sood S, Joshi DC, Chandra AK, Kumar A (2019) Phenomics and genomics of finger millet: current status and future prospects. Planta 250:731–751

Tadele Z (2016) Drought adaptation in millets. In: Shanker AK, Shanker C (eds) Abiotic and biotic stress in plants: recent advances and future perspectives. InTech, Rijeka, pp 639–662

Thakur J, Kanwar RR, Kumar P, Salam JL, Kar S (2018) Studies of genetic parameters for yield and yield attributing traits of kodo millet (Paspalum scrobiculatum L). Int J Curr Microbiol Appl Sci 7(09):278–287.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/08/0223

MUSHROOM CULTIVATION AND ITS IMPORTANCE

S. S. Kinge[1*], H. D. Pawar[2] and U.R. Phondekar[3]

[1]Ph.D.(scholar) Department of Agronomy,
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli.
[2]JRA,Department of Plant Pathology,
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli.
[3]Ph.D.(scholar) Department of Plant Pathology,
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli.
Corresponding authors E-mail: sunilkinge40@gmail.com

Introduction

Mushroom is a fungus producing a fleshy fruiting body, especially one consisting of a stalk with an umbrella cap. It has two parts caps like structure is known as PILEUS, attached with thread like structure MYCELIA. Mycelia absorb nutrient from soil, it do not require sun light for their growth. Mushrooms are the fruiting bodies of a fungus.

The mushroom is the heterotrophic organisms (lower plants). In contrast to the higher, green plants, these heterotrophs are not capable of photosynthesis. Fungi are the scavengers of nature. Mushrooms, a form of fleshy edible fungi, are rich source of proteins, having most of the essential amino acids, minerals and vitamins with low calories.

Mushroom cultivation

Mushroom cultivation is most profitable agricultural field can be started with minimum investment and space. Mushroom farming in India is growing steadily as an alternative source of income. Mushroom cultivation has been in practice since ancient times. Globally, China, Italy, U. S. and Netherlands are the top producers of mushrooms. In India, Uttar Pradesh is the leading producer of mushrooms followed by Tripura and Kerala. Edible mushrooms have tremendous nutritional and medicinal value. Hence, they are of significance in domestic international market.

Mushrooms themselves are tasty, popular to eat and a beneficial source of nutrients for people. Much of Asia's environment is suitable for cultivating many different mushrooms. In addition, the low costs associated with growing mushrooms helps farmers get started and make relatively quick and good financial returns, positively contributing to the country's economy. Mushrooms play a significant role in forest ecology, as they help decompose dead plants and animals, including dead trees, branches, leaves, fruits, seeds and animal droppings on the ground.

Edible Mushroom

- Edible mushrooms are consumed by humans for their nutritional value and they are occasionally consumed for their supposed medicinal value.
- Edibility may be defined by criteria that include absence of poisonous effects on humans and desirable taste and aroma.
- Edible mushrooms include many fungal species that are either harvested wild or cultivated.

- **Agaricusbisporus**:
  - Also known as 'the white cultivated mushroom. Agaricusbisporus is grown on composted cereal straw and animal manure.
  - Agaricusbisporus is the most extensively cultivated mushroom in the world, accounting for 38% of the world production of cultivated mushrooms.
- **Volvariellavolvacea**:
  - The 'Chinese' or 'paddy straw' mushroom. Volvariellavolvacea is a high temperature mushroom grown largely in tropical and subtropical regions of Asia e.g. China, India.
  - This mushroom can be grown on a variety of agricultural wastes Volvariella mushrooms account for 16% of total production of cultivated mushrooms in the world.

Poisonous Mushrooms (Non-Edible)

Poisonous Mushrooms look like edible mushroom in their morphology and lifecycle. However, they can be distinguished by following features:

- Brightly coloured fruit bodies.
- Greenish tinge on gills and Yellow-Green spores.
- Pink coloured spores in gills.
- Presence of Vulva and Annulus on the Stalk.
- Oozing of milky or coloured latex at damaged portions
- Unpleasant odour
- E.g., Amanita phalloides and Tricholomamuscarium

Mostly four types of mushrooms are grown commercially in India.

1. White button mushroom (Agaricusbisporus).
2. Oyster mushroom (Pleurotus spp.).
3. Milky mushroom (Calocybe indica).
4. Paddy straw mushroom (Volvariellavolvacea).

White button mushroom is contributing about 75% of in the country production itsglobal share of about 31%.

Present three major types of mushrooms are being cultivated in India

1. **Button Mushroom**
   - Known as European Mushrooms.
   - cultivated from September to March.
   - Temperature for spread of mycelium is 24-25°C.
   - 16-18°C is essential for formation fruit bodies.
   - Higher temperature is harmful and low temperature retard development of both mushroom, mycelium and fruit bodies.
2. **Paddy Straw Mushroom**
   - Cultivated in temperature of around 25-35°C and relative humidity of 75-80%.
   - High content of protein and vitamins and minerals.
   - Good attributes aroma, delicacy. like flavor,
3. **Oyster Mushroom**
   - Known as Dhingri.
   - Cultivation temperature is 22- 28°C.

- Grown in Northern Plains from October to March

Key environmental factors to consider for mushroom cultivation

- Temperature
- Light
- PH Levels
- Oxygen

Key steps in mushroom production

The key generic steps in mushroom production a cycle that takes between one to three months from start to finish depending on species are

- Identifying and cleaning a dedicated room or building in which temperature, moisture and sanitary conditions can be controlled to grow mushrooms in choosing a growing medium and storing the raw ingredients in a clean place under cover and protected from rain.
- Pasteurizing or sterilizing the medium and bags in which, or tables on which, mushrooms will be grown (to exclude other fungi that would compete for the same space - once the selected fungi has colonized the substrate it can fight off the competition).
- Seeding the beds with spawn (spores from mature mushrooms grown on sterile media);
- Maintaining optimal temperature, moisture, hygiene and other conditions for mycelium growth and fruiting, which is the most challenging step; adding water to the substrate to raise the moisture content since it helps ensure efficient sterilization.
- Harvesting and eating, or processing, packaging and selling the mushroomcleaning the facility and beginning again.

Cultivation method

A. Garden & field cultivation
B. Cave cultivation
C. Indoor cultivation

A. Garden & field cultivation:

- Small ridges made in gardens and fields. Soil inoculated with spawn is covered with leaf litter to prevent moisture.
- The ridges should be periodically watered mushroom when appear can be picked.

B. Cave cultivation:

- Small tunnels are made in rocky areas and mushroom farms can be established.
- Abandoned mines can be used to develop mushroom farms.
- moisture.

C. Indoor cultivation:

- Mushroom are grown in small rooms of the house.
- These rooms may be constructed in such a way that they will be partly above ground and partly below ground.
- In some cases, arrangement may be made to maintain accurate temperature and moisture.
- Inside this room mushroom may be cultivated either in small beds. The room should be properly ventilated but sunlight should not fall directly on the mushroom-beds.
- The room should also have air-conditioning facility.

- E.g. techniques for cultivation of white button mushroom.

Nutritional Value of Mushrooms

All these nutritional values occur in high concentrations in mushrooms.Mushrooms are very popular in many countries and often considered to be as nutritious as meat.India, Taiwan, Japan, Korea and Thailand have the highest global export rates of mushrooms.Scientific research has shown that mushrooms contain many kinds of carbohydrates, proteins and fat, B-complex vitamins, important minerals.

- A fresh mushroom contains, about 80% to 90% moisture, 3% protein, 0.3% to 0.4% fat, 1% minerals and vitamins.
- Protein - Most mushrooms have a high protein content, usually around 20-30% by dry weight.
- Fibre - Helps lower cholesterol and is important for the digestive system.
- Vitamin D - Essential for the absorption of calcium. Copper - Aids in helping the body absorb oxygen and create red blood cells.
- Selenium - An antioxidant that helps neutralize free radicals, thus preventing cell damage and reducing the risk of cancer and other diseases. Mushrooms contain more selenium than any other form of produce.
- Potassium - An extremely important mineral that regulates blood pressure and keeps cells functioning properly and Potassium is necessary for a healthy blood pressure and for muscle and nerve activity.
- Other important minerals - Such as phosphorous, zinc, and magnesium.
- Low levels of fat, calories, sodium and No cholesterol.
- Mushrooms contain an extra amount of vitamins D, B_2 and B_3.
- These vitamins take care of the metabolism and the release of energy from carbohydrates, proteins and fats.
- Vitamin B_2 is also necessary for a Lalthy skin.
- It is the best food for diabetic patients due to presence of dietary fibers with less carbohydrate and more protein.
- Folic acid is necessary for growth and the production of blood. It is one of the few vitamins of which, on average, we take in too little from our food.
- Phosphorous takes care of healthy bones and teeth and of energy metabolism.
- Copper is necessary for your immune system, nerves and for the synthesis of body cells.
- Constitute an ideal diet for diabetics, obesity, mental tension, blood pressure, cancer, HIV virus, heart diseases and hypertensive patients as they contain low carbohydrate, fat and sugar contents and no presence of salt.

Spawn Preparation

Preparation or procurement of spawn: Mother spawn can be procured from any mushroom research centre and primary culture of spawn can be prepared by following procedure:

- Select good quality jowar or wheat grains free from pest and moulds.
- Boil the grains submerged in clean water for 20-30 minutes. When the grains become soft, remove and spread evenly on a cotton cloth to drain out the water and cool the grains.
- Mix 3% chalk powder (30g/ kg of grain) for adjusting the pH and to keep the grains loose.

- Fill 250gms of grain in cleaned and dried glucose bottle of 500ml capacity or propylene bags and plug the mouth of the bottle tightly with non-absorbent cotton.
- Sterilize the bottles in autoclave by exposing to 121°C and 15lbs pressure/sq inch for 20 minutes. After cooling, transfer the bottles to inoculation chamber.
- Transfer few grains with mycelial growth into sterilized substrate bottle under aseptic condition and plug it with cotton.
- Shift the inoculated bottles to spawn running room having temperature range of 25-30°C.

Cultivation in polythene bags

- Polythene bags measuring 20 x 30 cm, or 18 x 25 cm, are used as mushroom beds. Open the bag and put a handful of straw inside it.
- Press the straw down tightly, to make a layer 3-5 cm thick at the bottom of the bag. Spread the spawn/rice husk mixture around the edges of this layer (but don't put any in the middle). This makes the first straw- spawn layer.
- Continue to add 3-4 additional layers in the same way until you have nearly filled the bag. Put a final layer of straw on top, so the top of this final layer is 5-7 cm below the mouth of the bag.
- Put a clean piece of cotton in the mouth of the bag. This makes a ventilation hole, and filters out harmful microorganisms. Then close the mouth of the bag with a rubber band.
- Tie the bags each to other with nylon rope (3-5 bags per rope) and hang them in the mushroom house. The mouth of each bag should be pointing upwards.
- The bags should not touch each other, but should be a few centimetres apart.
- The bags should be covered, sheltered from wind and light, but with good ventilation.
- After 25-30 days, mycelium will develop throughout the bag. Use a sharp knife to cut 4-6 slits in the sides of the bag. Each slit should be 3-5 cm long, and an equal distance from the other slits. The cuts should not be in a line around the bag, as this will weaken the bag.
- After the bags have been cut, they should be sprayed with water two or three times a day to keep the mushrooms moist. Be careful not to give them too much water. No water should collect inside the bag.
- Take the cotton out of the mouth of the bag and suspend the bags on a wire or rope, with the mouth of the bag pointing downwards.
- Soon the mushrooms will begin to appear in the slits, looking like small round buttons. As soon as these begin to appear, move the bag to the growing/harvesting area.
- The bags should be placed 7-10 cm apart.

Harvesting of mushroom

- The first harvest of mushroom is picked in 3 to 5 days and yields 15 to 20 kg.
- The second harvest comes after about 5-7 days and yields a little less, 9-11 kg/m2 for hand-harvesting.
- The third harvest takes about 6 to 8 days at most yields 10-15% of production and is of lower quality, because diseases and pests are increasing very strongly.
- Hand-picking mushrooms can be stored and consumed fresh.
- Mechanically harvested mushrooms are harvested in a once-over operation and directly processed and preserved.

Washing and Grading

- It is observed that the mushrooms are inclined to browning because of the enzymatic oxidation of the phenols.
- Browning apparently reduces the business estimation of mushrooms The treatment is finished with the assistance of an answer of potassium metabisulphite (0.05%) in water.
- Mushrooms are plunged in the arrangement and afterward are conceal dried on white net sheets to free the dampness after which they are exposed to bundling.

Packing

- After various post-reap forms, the mushrooms are then stuffed in slim straight forward polyethene.
- The instruments utilized in bundling are gauging machine and sealer (electric and manual). The mushrooms are weighed around 200g and afterward they are fixed with the assistance of sealer both electric and manual.
- Around 2 groups of 2-3 people can pack in excess of 100 packets in about 60 min.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/09/0223

NATURAL FARMING

Gagandeep Kaur

Assistant professor, Post Graduate Department of Agriculture,
G.S.S.D.G.S. Khalsa College, Patiala, 147001

Introduction

Agriculture is the center of food resources for animals, humans, birds and best source of employment for individual, supplies raw material to industries increase economic status but due to excess use of chemicals cause hazardous problems to humans, affect soil health and make ecological imbalance. To improve this status it is necessary to adopt natural farming system. It is a zero budget farming system.

Definition

It is a system of growing crops without use of chemicals and low input costs called "Natural Farming".

Meaning of Natural Farming

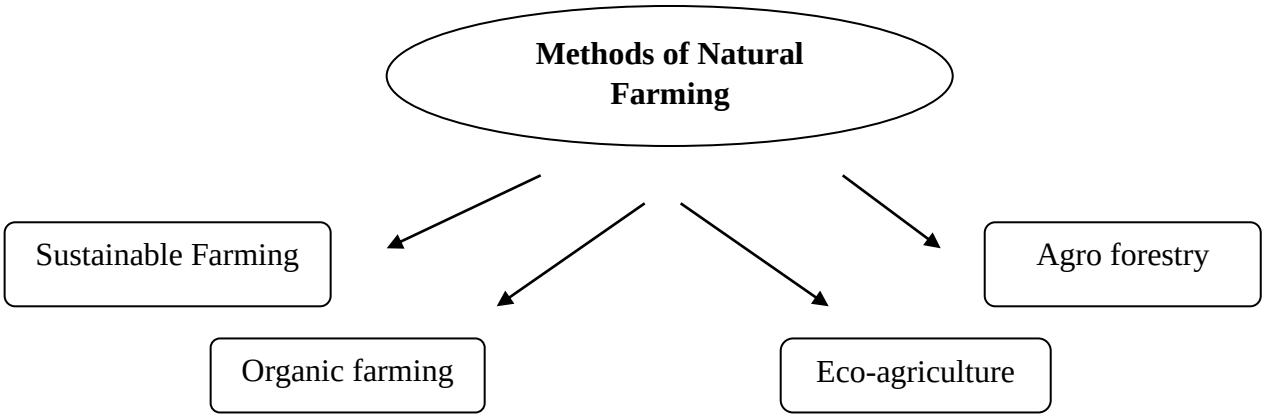
It is a combination of two words as "natural + farming".

- **Natural**: It stands for use of nature's products as animal waste, plant waste, farm waste and animal use in farming activities.
- **Farming**: It is a process of cultivation on land.

In a combination it clearly defined the use of natural resources in cultivation to improve soil health, low input costs and make ecological balance.

Methods of Natural Farming-

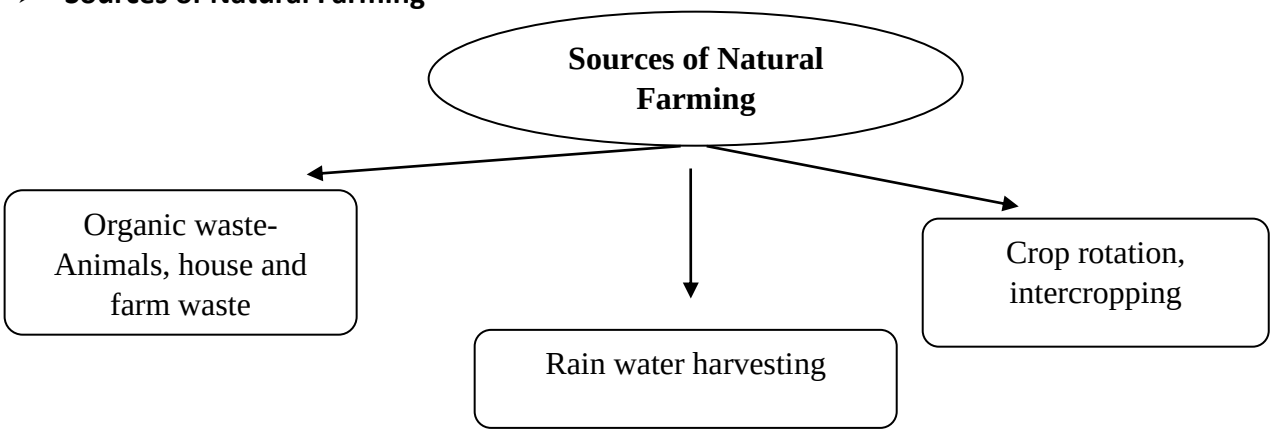
It consist several methods as follows:



- **Sustainable Agriculture**- It is integrated system of plant and animals' production practices by conventional tillage method, green manuring, intercropping and crop rotation method.
- **Agro forestry**- It involves tree plantation combine with crops and animals on same land area.
- **Organic Farming**- It is a biological farming system by uses animal and farm waste as manure and crop rotation to improve soil fertility and reduce environmental pollution.

- **Ecoagriculture**- It avoids use of chemicals in farming as fertilizer and pesticides and monocropping. Because it damage soil health and create pollution ultimately affect on human health. To avoid these problems for soil nutrient restoration natural resources used that makes a balance system in environment so, known as ecological balance and this type of farming is ecofarming.

➢ **Sources of Natural Farming**



- **Conventional tillage**- With the help of animals soil ploughing operations and labeling etc. done in field by ancestors. But now-a-days due to machinery availability this method avoided. Due to excess use of machines fuel consumption increase and pollute environment. To make ecological balance adopt again conventional method of tillage.

Conventional Tillage

- **Animal waste**- Animal excretes as cow urine and dung contains nutrients that improve soil fertility, soil structure and soil's physical-chemical conditions. It is also a food for microbes they feed it and helps in soil pulverization.

Organic products preparation from Cow urine for soil health

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

- **Green manuring**- Ploughing of leguminous crops in field and plant waste to increase soil's nutrient status for improving fertility is known as green manuring.
- **Crop waste**- Like straw used as mulch improves soil moisture, maintain temperature and suppress weed growth.

Mulching from Paddy straw

- **House waste**- As kitchen waste to make compost. Because fertilizer consist chemicals so avoid their use natural manures prepared. And **'whey'** stored in earthen pot for more than one week used as organic **insecticide**.

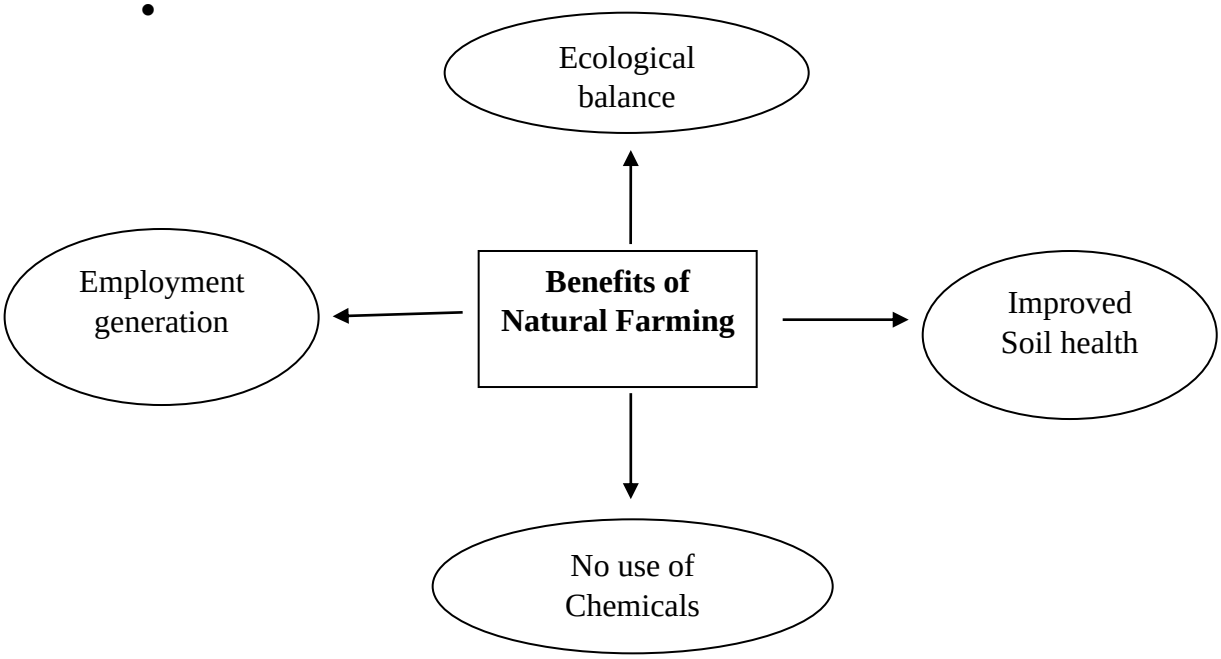
Compost preparation from house and farm waste

- **Crop rotation**- Due to monocropping soil fertility decreases so crop rotation is necessary.

- **Intercropping**- In less area for more production and income more number of crops grown.
- **Rain water harvesting**- Collection of rain water and use it on crop requirement.

➢ **Benefits of Natural Farming-**

- **Increased income-** Income sources increased by intercropping and costs of machinery reduced.
- **Reduced production cost-** Organic manures prepared from house, farm waste and biological inputs used in field reduced costs of production.
- **Ecological balance-** By preventing use of chemicals makes environment pollution free.
- **Reduced groundwater consumption-** Use of diverse crop system helps loss of water.
- **Improve soil health-** By feeding organic feeds to microbes, soil's living organisms as earthworm's population increases and ultimate improve soil condition.
-



- **Livestock sustainability-** Because animal plays important role in natural farming operations as in tillage operation and their waste used as manure except it ecofriendly bio-inputs like "Beejamrit" prepared from cow urine and dung. They are also a best source of income with cultivation of crops.
- **Employment generation-** Source of employment for field activities, value addition of farm products and marketing of farm products. Except this preparing compost from house waste and farm waste is also a source of employment.
- **Avoiding use of Synthetic chemicals-** Chemicals as herbicide, insecticide and fertilizer alters soil structure and loss soil's carbon fertility. But with the use of organic waste risk of chemicals affect eliminated.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Application of Organic manure in soil

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/10/0223

MILLETS : THE NUTRI CEREALS

Indu Walia
Ph. D. Scholar, Department of Agricultural Economics, CCSHAU, Hisar
Corresponding email: indu2995@gmail.com

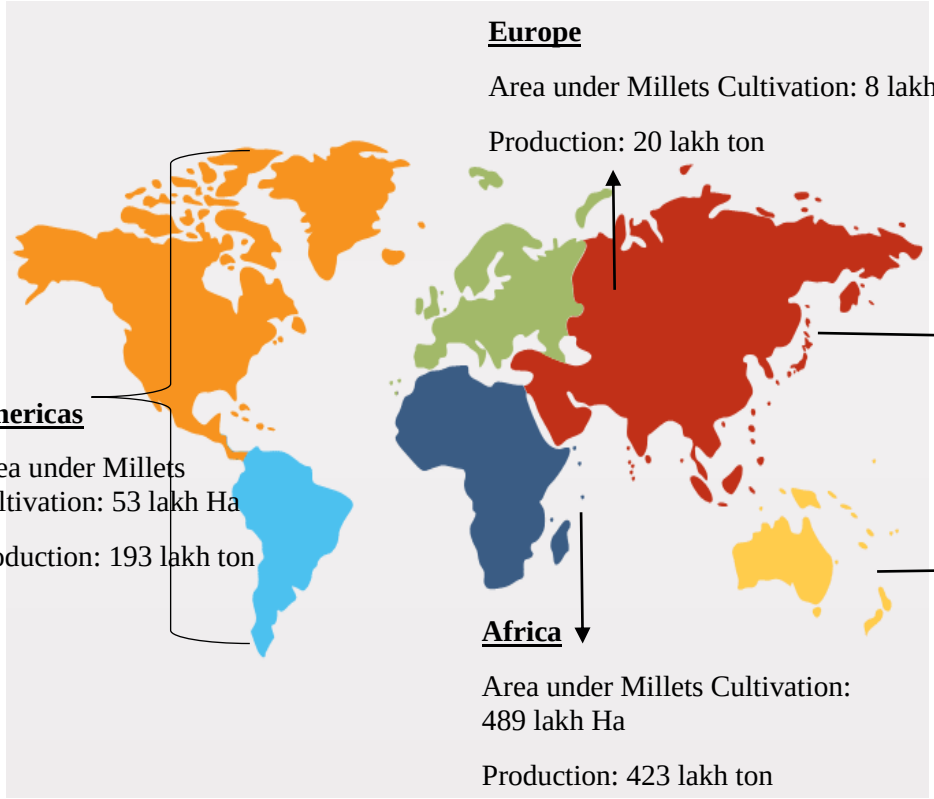
Abstract
Millets are member of small-seeded grasses that are commonly cultivated as cereal crops or grains for human and animal nourishment all across the world. Sorghum and bajra are major millet crops grown globally. Millets are extremely resilient to drought and other harsh weather. Sorghum, finger millet, pearl millet, proso, foxtail, tiny, kodo, and barnyard millet are among the principal millets that make up millets. They are rich source of many nutrients and minerals and thus also known as Nutri Cereals. Government of India has taken many important initiatives to promote their production and value addition. It has also decided to celebrate IYOM, 2023 to make it peoples' movement so that the Indian millets, recipes, value added products are accepted globally.

Introduction
Millets are a group of cereal grains belonging to the Poaceae family, also referred to as the grass family. Millets were among the earliest plants to be cultivated. They have been a traditional source of food for hundreds of millions of people in Sub-Saharan Africa and Asia for more than 7,000 years and they are today cultivated all over the world. They offer food, fuel, fodder and nutrition security and can be grown in intercropping (or maybe under mixed cropping with oil seeds and pulses).They are rich source of nutrients like protein, carbohydrate, good quality fat, dietary fibre and many minerals. Due to their high nutritional value, millets are also referred to as **"nutri-cereals".** Despite being a staple food source for millions of people worldwide, its production is declining now. In light of this, the Indian government suggested that **2023** to be designated as the **International Year of Millets**. It was endorsed by members of FAO governing bodies and at the 75th session of the UN General Assembly (UNGA).India produces a nine commonly known millets and is the largest producer and second-largest exporter of millets in the world. Among the nine types, most popular millet variety is pearl millet, an important crop in Africa and India. Other significant crop species include finger millet, foxtail millet and proso millet. They are considered ancient grains and are consumed as food for humans, birds and animals.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Millets Scenario – World and India

Global Scenario



Source: FAOSTAT 2020

Sorghum is the major millet cultivated globally constituting 65 per cent of total millets. During 2010–2020, the Sorghum area was near stable between 42.16 million hectares (m ha) to 40.98 m ha while production between 60.18 million metric tonnes (MMT) to 58.70 MMT. During the same time period, the area under other millets showed a decreasing trend from 36 m ha during 2010 to 33.02 m ha during 2020, while production decreased from 32.79 MMT in 2010 to 30.46 MMT in 2020.

India Scenario

India is one of the leading producers of millets in the world. In India, millets are cultivated on an area of 12.45 m ha, producing 15.53 million tonnes with a yield of 1247 kg/ha. Sorghum is the fourth most important food grain in India after rice, wheat, and maize in terms of area (3.84 m ha) and production (4.31 MMT). Bajra (7.05 m ha) contributes more than 50 per cent of the country's area under millets with almost equal percentage of production. It is interesting to note that, India is the topmost producer of Barnyard (99.9%), Finger millet (53.3%), Kodo (100%), Little millet (100%) and pearl millet (44.5%), producing about 12.46 MMT from an area of 8.87 m ha.

Rajasthan has the highest area under millets cultivation (29.05%) followed by Maharashtra (20.67%), Karnataka (13.46%), Uttar Pradesh (8.06%), Madhya Pradesh (6.11%), Gujarat (3.94%) and Tamil Nadu (3.74%). The states of Gujarat and Madhya Pradesh have increased their area under millets over the recent years. However, the highest yields were recorded in Andhra Pradesh

(2626.58 kg/ha), Tamil Nadu (2153.22kg/ha), Haryana (1906.78 kg/ha), Gujarat (1762.05 kg/ha) and Madhya Pradesh (1729.70 kg/ha).

Millets and the Nutritional Benefits

- Millet grains are rich sources of nutrients like protein, carbohydrate, good quality fat, dietary fibre and have substantially higher amounts of minerals like calcium, potassium, iron, magnesium,manganese, zinc, and B complex vitamins, making them a preferable alternative over the cereal grains.
- Millets also contain several bioactive phytochemicals including lignans, β-glucan, inulin, sterols, resistant starchand phenolic compounds (e.g., ferulic acid, caffeic acid and quercetin). Many studies have supported the role of polyphenols in antioxidant, anti-carcinogenic, anti-inflammatory, antiviral and neuroprotective activities which in all have shown to be beneficial against diseases like cancer and cardiovascular disease, diabetes, high cholesterol, high blood pressure, metabolic syndrome and Parkinson's disease.
- The millets are also regarded to have DNA damage protection antimicrobial and activities due to their phytochemical content. The millet grain contains a very high percentage of non-starch polysaccharides and dietary fibre, both of which aid in controlling weight. Due to the slow release of glucose, millets are a fantastic option for diabetics.
- Fermentation of millets using various cultures promotes the growth of Gram-negative bacteria that makes millets an effective probiotic food in the gut.

Comparison on Nutritional Composition of Rice and Wheat with Millets

Table 1: Nutritional profile: Comparison of millets and cereals for quality

Crop	Protein (g)	Carbohydrates (g)	Fat (g)	Fiber (g)	Minerals (g)	Calcium (g)	Phosphorus (g)
Bajra	11.6	67.5	5.0	1.2	2.3	42	296
Sorghum	10.4	72.6	1.9	1.6	1.6	25	222
Finger millet	7.3	72.0	1.3	3.6	2.7	325 44	283
Foxtail millet	12.3	60.9	4.3	8.0	3.3	31	290
Proso millet	12.5	70.4	1.1	2.2	1.9	14	206
Barnyard millet	11.6	74.3	5.8	14.7	4.7	14	121
Rice	6.8	78.2	0.5	0.2	0.6	10	160
Wheat	11.8	71.2	1.5	1.2	1.5	41	306
Maize	11.5	66.2	3.6	2.7	1.5	20	348
Barley	11.5	69.6	1.3	3.9	1.2	26	215

Parameters (per 100g of seed)

Source: National Institute of Nutrition (NIN), Hyderabad

Role of Government in Millet Promotion

The Government of India has realized the value of millets in ensuring thenutritional security in the country and made series of efforts such as gazetting millets as Nutri-Cereals, the declaration of the National Year of Millets in 2018. Declaration of International year of millets by UNGA with India along with the support of more than 70 nations is an important step in popularizing millets across the world with India in the lead. The IYoM 2023 is offing the mandate to scale up the interventions for increasing the millets area and production, and diversifying the processing machinery and technologies, and thus to cater to various segments in domestic and export markets.

Important initiatives and schemes undertaken to promote production processing and value addition of millets in India:

1) **Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP)** was introduced in 2012 as a part of the Rashtriya Krishi Vikas Yojana (RKVY). The scheme aimed to demonstrate the improved production and post-harvest technologies in an integrated manner with visible impact to catalyse increased production of millets in the country. Besides enhancing production of millets, the Scheme through processing and value addition techniques was expected to generate consumer demand for millet-based food products.
2) **Odisha Millet Mission (OMM):** OMM aims to revive millets on farms and plates with simultaneous focus on production, processing, marketing, consumption and inclusion of millets in Government schemes. The program's goal is to address the issues of food and nutrition security through the promotion of native millets. The major objectives of the Odisha Millets Mission (OMM) are to increase productivity of millets crops through improved agronomic practices, increase household consumption, setting up decentralized processing units at block level,better marketing of millets through farmer producer organizations conservation and promotion of local landraces and inclusion of millets in ICDS, MDM and PDS.
3) Comprehensive Revival of Millets cultivation' by tribals in north Coastal Andhra and parts of Rayalaseema is an end-to-end program on Millets Revival in Andhra Pradesh. The program aims to develop tribal, and rain fed areas into MILLET-HUBS that can potentially supply millets to meet growing demand and find its place in the grain economy. This project aims to increase productivity, value addition, household consumption by making ragi biscuits, idli and dosa, setting up of processing centres, marketing support and establishing seed production centres.
4) **Millet Village Scheme** was started by Government of Kerala to promote the cultivation of cereals such as millet, bajra, ragi and maize by setting up a millet village at Attappady. The project aimed at preserving seeds of traditional varieties of millets and ensures food security livelihood for tribals.
5) **Introduction of millets in PDS, mid-day meal:** The Government of India has increased the Minimum support price (MSP) for millets to promote millet cultivation substantially and they were introduced in public distribution system (PDS) and mid-day meals in primary, secondary schools and welfare hostels.
6) Department of Agriculture and Farmers' Welfare has supported in establishing of three Centres of Excellence (CoE) on millets atCCSHAU, Hisar; IIMR, Hyderabad and UAS, Bengaluru. These CoE have come out with many value-added technologies. IIMR alone came out with 70

plus value added technologies with SOPs (including technology dockets) for 30 products which were commercialized under their own brand eatrite, and an equal number of processing machineries were retrofitted and standardized.

Conclusion and Way Forward

Consumption of millets as direct food has significantly decreased in India due to policies centred around Green Revolution–led food security from the 1960s onwards. During the journey towards food security, nutritional security was not the main focus, which has resulted inthe rise of Non-Communicable Diseases (NCDs) and current state of malnutrition.The transformative role of millets in preventing lifestyle diseases, the benefits of including millets in public-funded programs and the growing realization of high potential for export markets, are projecting them as immune boosters due to their rich nutritional profile. It is assumed that the world is looking towards India's traditional foods, and it turned to be the mandate of the Government of India to scale up the interventions for enhancing the millets area and production, expanding the private food processing ecosystem, diversifying the processing machinery and technologies and thus to cater to the various segments in domestic and export markets.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/11/0223

FINANCING AGRIBUSINESS IN DEVELOPING COUNTRIES

Adegbola, J. A.[1], Owojaiye, O. B.[1], Ogunremi, O. B.[1], Adegbola, R.Q.[2], Aina, O. B.[1], Achime, K. C.[1] and Pessu, P. O.[2]

[1]Research Outreach Department, Nigerian Stored Products Research Institute, Ilorin
[2]Durable Crops Research Department, Nigerian Stored Products Research Institute, Ilorin

Summary
Financing is one of the growth factors in the push/ drive to agricultural development, and agribusiness financing is necessary to spur economic growth in the sector. Agripreneurs may either obtain funds through institutional or non-institutional means. The former is characterized by standardized procedures and collateral/security requirement while the latter, which is more popular in developing countries, do not have uniform procedures and may not require collateral or security. This article delves into the definition of agribusiness, highlights the different subsectors, and delineates the major sources of funding and their characteristics.

Introduction
Globally, improved awareness of sustainable food production and security is swiftly transforming agriculture into one of the key industries at both the international and local level. As part of the current universal evolution, agriculture today involves a dynamic fusion with industry that reaches far beyond the farm to comprise all actors/activities involved not only in production (producers) but also input providers, processors, distributors, marketers, and other supporting services till it get to the final consumers. Simply put, this synthesis between agriculture and industry, termed in many spheres as agribusiness, include not only those that cultivate the land or raise fish/livestock but also the people and firms that provide the inputs, process the output, manufacture the food products, and transport and sell the food products to consumers.

Agribusiness is a combination of the words "agriculture" and "business" and refers to any business related to farming and farming-related commercial activities. One of the earliest definitions of agribusiness describes it as the total sum of all activities involved in the manufacturing and distribution of farm supplies, production operations on the farm, the storage, processing, and distribution of farm commodities as well as items made from them (Davis and Goldberg, 1957). The sector consists of three subsectors: (i) farm supply (farming input) (ii) farm production (food production) (iii) processing distribution (manufacturing and processing) (Pawa, 2014). Agribusinesses common in the Sub-Saharan Africa sub-region include foodstuff wholesaling, storage of commodities, cottage processing of agricultural commodities, sales of agricultural inputs, livestock and fish feed production, marketing of commodity crops, packaging, warehousing, distribution and transportation etcetera.

Financing is a critical factor in starting an agribusiness. Financing is required by agripreneurs to purchase/lease land, construct/rent buildings, acquire improved technologies, hire labour and other agribusiness needs requirements. Nonetheless, poverty, corruption, institutional barriers (difficulty at securing formal land titles and cumbersome credit/loan approval processes) and concomitants of underdevelopment has been a bane of financing agribusiness in the Third-World milieu.

SOURCES OF FINANCING AGRIBUSINESS

Institutional/Formal Sources

These are sources of capital available to agribusinesses from recognized institutions which follow standardized procedures of lending. Loans from Institutional sources normally require some collateral. They include but are not limited to the following:

Commercial banks: Commercial banks are run outrightly to make profit. They make long term, intermediate and short-term loans. They represent a viable source of funding as they can aggregate or make available large funds to medium and large-scale agribusinesses.

Cooperative banks: Cooperative banks operate on a smaller scale than commercial banks and are usually located in rural areas. They offer members borrowing facilities at relatively cheaper costs than traditional commercial banks. Cooperative banks unlike commercial banks are service oriented and they aim at profit but not at the expense of their members. They majorly provide funding for small scale agribusinesses which often have sole proprietorship.

Community banks/Microfinance banks: These are established to promote rural development, stimulate productive activities, and support agricultural enterprises that lack access to conventional banking and related services. They are feasible source(s) of funding for medium scale agribusinesses but may also cater for small scale agribusinesses.

Non-Institutional Sources

These are sources which do not have any uniformity in their collateral requirement. Loans from these sources are devoid of administrative delays, often do not require collateral or security, and are usually made directly to the borrower by the lender. Non-institutional sources are however characterized by small business loans and high interest rates. Prominent examples under this source include:

"*Ajo*" and "*Esusu*": The "*Esusu*" is a fund to which a group of individuals sharing common characteristic make a contribution that is handed to one of them. Each member is able to make use of the money in turn. In the case of "*Ajo*" individuals contribute fixed amount of money on a daily basis for a specified period usually a month. At the end, contributors receive their total savings less one day's contribution, the latter being the collector's fee.

Money Lenders: Money lender lend out to agripreneurs at exorbitant interest rates. Often borrowers have to pledge their lands, crops, and other valuables to secure these loans.

Conclusion

Formal (commercial, cooperative and community/microfinance banks) and informal (*Ajo*" and "*Esusu* and money lenders) sources of finance are vital for establishing, nurturing and expanding agribusinesses in developing countries. They are all the more important because of these countries' inherent features such as poverty, corruption, difficulty at securing formal land titles and cumbersome credit/loan approval processes etc. Adequate financing of agribusinesses in the short and long run will promote food security, generate employment, advance sustainability, and drive industrialization of the agricultural sector.

References

Pawa, T. (2014). Agribusiness as a veritable tool for rural development in Nigeria. *International Letters of Social and Humanistic Sciences* Vol. 14 (2014) pp 26-36 © (2014) doi:10.18052/www.scipress.com/ILSHS.14.26

Davis, J. and Goldberg, R. (1957). A concept of Agribusiness. Graduate School of Business administration, Harvard University. The Alpine Press, Inc., Boston, Massachusetts, U.S.A. https://babel.hathitrust.org/cgi/pt?id=uc1.32106006105123 accessed on Wednesday, 14th December 2022.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/12/0223

CLIMATE RESILIENT STRATEGIES FOR PLANT DISEASE MANAGEMENT

Ritwik Sahoo[1]*, Sumit Sow[2], Shivani Ranjan[2], Dinabandhu Samanta[3] and Souvik Sadhu[4]

[1]Ph.D. Student, Department of Plant Pathology,
Uttar Banga Krishi Viswavidyalaya, Punibari, Cooch Behar, West Bengal, India-736165
[2]Ph.D. Student, Department of Agronomy,
Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India-848125
[3]Ph.D. Student, Department of Pomology and Post-Harvest Technology,
Uttar Banga Krishi Viswavidyalaya, Punibari, Cooch Behar, West Bengal, India-736165
[4]M.Sc(Ag.) Student, Department of Soil Science and Agricultural Chemistry,
Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India-813210
*Corresponding email : ritwik98best@gmail.com

Abstract

Research into the effects of climate change on plant diseases is limited, as much of the work focuses on the effects of a single climate or climate change on host, pathogen, or their interactions under controlled conditions. The results from various research work show that climate change may alter the stages and levels of pathogen development, alter host resistance, and cause changes in the physiology of host-pathogen interactions. The most likely consequences are changes in the distribution of host and pathogen habitats as well as altered plant losses, which are due in part to change in the effectiveness of control strategies. Climate change affects the incidence, prevalence and severity of plant diseases. Ultimately, advances include understanding the nature and extent of evolutionary adaptation of plants and pathogens, and moving beyond short-term variability to multi-year trends to determine plant fate under future climate change.Prediction of future requirements in disease management is of great interest for agro – industries, extension, services and practical farmers (Zayan et al., 2019).Recent advances in testing and modelling techniques offer great promise of developing an improved ability to assess the impact of climate change and mitigation. Compared with major technological, environmental, and societal changes affecting agricultural production during the next century, climate change may be less significant; however, it will add another complexity and uncertainty to a system that is already extremely difficult to manage in a sustainable manner. Intensive research on climate change issues can lead to improved understanding and control of plant diseases in light of current and future adverse weather conditions.

Keywords : Climate change, Host-pathogen interactions, Prevalence, Sustainable, Intensive.

INTRODUCTION

Earth's climate has been constantly changing in response to changes in the cryosphere, hydrosphere, biosphere, and many other atmospheric and other factors that combine to shape the global climate. The possible changes in temperature, precipitation, CO2 concentration, CH4, nitrous oxide (N2O) and O3 are expected to have significant impact on crop growth. This have major implications for practical processes such as crop sowing, harvest or pest and pathogen infection epidemiology and therefore all the activities that cascade from these effects.

	2013	2095
Temperature	Rise by 0.74°C	Rise by 3.4°C
CO_2 Concentration	400 ppm	1250 ppm

(Pachauri and Reisinger, 2007)

Climate change will probably influence the occurrence, prevalence and severity of plant diseases that will affect crop productivity. Population growth will double global grain demand by 2050. In 2008, the International Food Policy Research Institute estimated that due to climate changes, by 2050, 25 million additional children will suffer from malnutrition. Each year an estimated 10-16% of global harvest is lost to plant diseases plus additional 6-12 % post-harvest losses (International Food Policy Research Institute). Throughout the 21st century, India is projected to experience warming above the global average. Temperature increases of 1°C, 2°C, and 3°C in Punjab, would reduce the grain yield of rice by 5.4%, 7.4% and 25.1% respectively (Kumar et al., 2014). In temperate regions, temperature is of primary importance in defining the length of the growing season and spatial and temporal variability in agriculture. Rainfall is the major production-limiting factor in the tropics, where a small variation in timing and amount results in high variation in interannual crop yields.

CAUSES OF CLIMATE CHANGE

Climate change refers to changes in climate over a period of time. It can be due to natural variability or as a result of human activity (IPCC, 2007).There are different reasons which effect the climate and become causes of climate change, like –Natural Causes, Anthropogenic Causes, Land Uses Change, Green House Effect, Global Warming**.**

EFFECT OF CLIMATE CHANGE ON PLANT DISEASES

The development of plant disease is occurred by three important factors: (i) susceptible host, (ii)virulent and compatible pathogen (and vector if desired), and (iii) favorable environment. The climate changes affect optimal conditions for infection but also host specificity and mechanisms of plant infection.

Effect of elevated CO_2 - An increase in co_2 concentration resulting in greater fungal spore production and change in leaf chemistry.

Effect of temperature –It alters the growth stage, development rate and pathogenicity of infectious agents.

Effect of moisture - Moisture helps in the activation of bacterial, fungal and nematode pathogens.

Effect of drought - Drought stress affect the incidence and severity of viruses such as Maize dwarf mosaic virus (MDMV) and Beet yellows virus (BYV).

Effect of wind - Wind is also more important in the development of the disease. Pathogens such as fungi, bacteria, and viruses that are disseminated either directly by the wind or indirectly by insect vectors.

Effect of Light -Intensity and the duration of light may either increase or decrease susceptibility of plants to infection and also the severity of the disease.

Effect of air pollutants -Air pollutants, such as ozone, may affect a pathogen and sometimes the diseased it causes. Ozone may increase the percentage of diseased leaf area.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

PLANT DISEASE MANAGEMENT STRATEGIES

Agronomic Practices : It includes selection of optimal site, introducing new crop species, enhanced diversity in cropping systems, soil solarization, planting of cultivar mixtures and intercropping (e.g. potatoes and faba beans), conservation agriculture, management of overwintering pathogens in crop residues, drip irrigation. Hannukkala et al., 2007, concluded that increased and earlier occurrence of late blight (*Phytophthora infestans*) epidemics in potato (*Solanum tuberosum*) were probably associated with change of climate and lack of crop rotation. An extra dose of potash reduced the downy mildew of cucumber by 30.93%.

Host plant resistance : Host-plant resistance involves the use of cultivars that are able to resist or tolerate pathogen attack, like - R-gene (*Xa7*) for *Xanthomonas oryzae*pv. *oryzae*in rice performs better under increased temperature.

Biological control with antagonistic organisms : Biological control agents (BCAs) may be effective either upon introduction by application or through strengthening their natural occurrence, like - fluorescent pseudomonads suppress the pathogens by the production of various antibiotic substances such as 2,4-diacetyl phloroglucinol, phenazine-1-carboxylic acid etc., in rice, seed treatment followed by root dipping and foliar spray with *Pseudomonas fluorescens* showed a higher induction of induced systemic resistance (ISR) against sheath blight pathogen *Rhizoctonia solani.* (Kumar et al., 2014)

Integrated Pest Management (IPM) : IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of methods such as biological control, use of resistant breeds, habitat management, and cultural practices(Strand,2000). In implementing integrated pest management, farmers who understand the potential for pest infestation on their crops follow a four-step approach. These steps include:

a) Setting action thresholds : Setting a threshold level for pests.

b) Monitoring and identification of pests : Detection and screening for pests and proper management decisions

c) Prevention : By using proper crop rotation, planting resistant plant varieties, and the use of pest-free rootstock/seeds.

d) Control : The IPM pyramid was created to provide an easier understanding of the approach. The IPM pyramid consists of three main processes which include 1) preventive or indirect crop protection, 2) risk assessment or monitoring, and 3) responsive or direct crop protection.

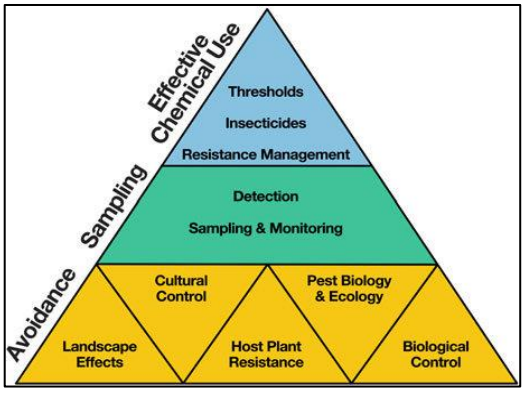


Fig 1: IPM Pyramid (Ellsworth et al., 2001)

Forecasting and early warning system : The main concept involves the use of a mobile telemetry automated weather station system to monitor environmental conditions and software to interpret the input. The purpose of this system is to warn farmers about the impending onset of an infection period or to inform them an infection period has already occurred. The first computer simulation model for prediction of late blight in potato, **EGY-BLIGHTCAST**. It was applied in 1998

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

and 1999, preserved the crop from the risks of epidemic infection, pesticide savings reached 50% in a season and 75% in another, and the productivity increased by a ton and 300 kilograms per acre.Currently, early warning systems are being used to deal with pathogens of certain crops such as fababeans(Zayan S.A., 2019).

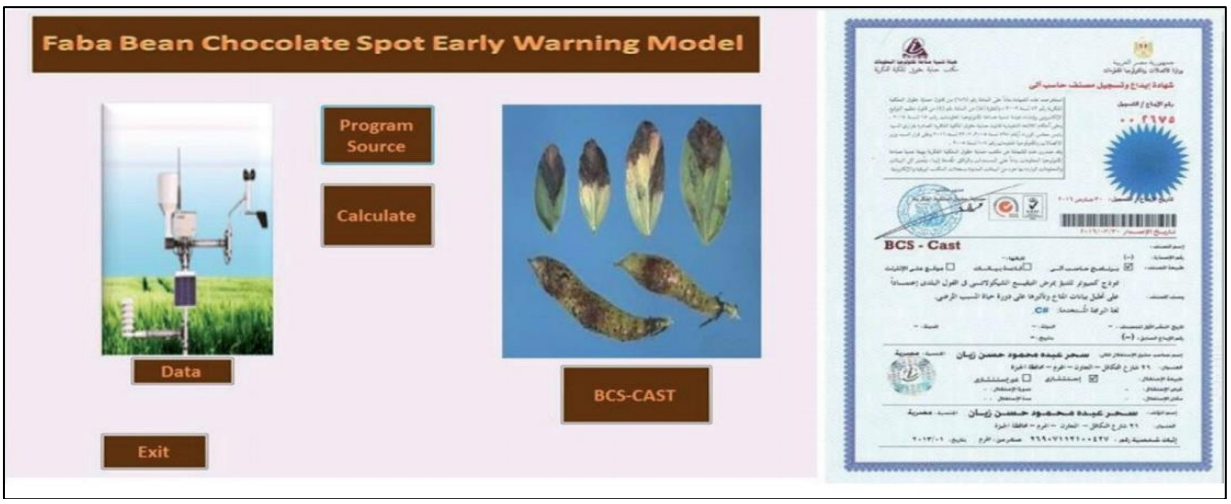


Fig2: Certified early warning system for faba bean chocolate spot (Zayan S.A., 2019)

Quarantine – It is applied to control of import and export of plants to prevent spread of diseases and pests. A detailed pest risk analysis (PRA) is obligatory prior to import of any plant material.

Novel fungicides – It should be more ecofriendly and used at lower dose rate, it enhances general stress resistance and higher yield in plants. Most noted among these types of fungicides areStribulurins (QoIs) derived from Strobilurustenacellus, a wild mushroom, more recently new classes of fungicides, include anilinopyrimidines (cyprodinil, pyrimethanil), phenoxyquinolines (quinoxyfen), oxazolidinediones (faoxadone) etc. Fungicidal application had a better impact when used within an Integrated Disease Management strategy (Kumar et al., 2014).

CONCLUSION

Precise prediction of pathogen responses to climate change will be limited by a lack of comprehensive, current multi-factor and multi-species data and, moreover by the diversity and adaptability of pathogen populations. So, precise prediction of pathogens under climate change has to improve. New cultivars with more durable resistances within shorter time periods by biotechnological approaches play a key role in crop adaptation to changing climate.

REFERENCES

Ellsworth P.C and Martinez-Carrillo J.L (2001). IPM for *Bemisiatabaci*: a case study from North America. Crop Prot 20: 853– 869.

Hannukkala A.O, Kaukoranta T, Lehtinen A andRahkonen A (2007). Late-blight epidemics on potato in Finland, 1933–2002; increased and earlier occurrence of epidemics associated with climate change and lack of rotation. Plant pathology, 56(1): 167-176.

https://www.ipcc.ch/2007

Kumar S.N, Aggarwal P. K, Rani D.S, Saxena R, Chauhan N and Jain S (2014). Vulnerability of wheat production to climate change in India. Climate Research, 59(3): 173-187.

Pachauri R.K and Reisinger A (2007). IPCC fourth assessment report. IPCC, Geneva, 2007.

Strand J. F (2000). Some agrometeorological aspects of pest and disease management for the 21st century. Agricultural and Forest Meteorology, 103(1-2): 73-82.

Zayan S A (2019) Impact of climate change on plant diseases and IPM strategies. In Plant Diseases-Current Threats and Management Trends. Intech Open.

ISSN : 2583-0910
Agri-India TODAY
visit us at www.agriindiatoday.in
Peer reviewed
monthly newsletter

Article ID : 03/II/13/0223

KALMEGH : A SUPERNATURAL MEDICINAL PLANT FOR HUMAN LIFE

Rimlee Das[1] and Dinesh Rai[2]

[1]PG Scholar, Department of Plant Pathology
[2]Assistant Professor, Department of Plant Pathology
Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar (848125), India
Corresponding Author: e-mail: rimlee783124@gmail.com

Introduction

With the WHO naming coronavirus a global pandemic on 11th March, 2020, it raised the concern over the efficacy of alternative system of medicines i.e., on medicinal herb formulations in preventing and treating various diseases. Among many other medicinal plants such as Giloy, Ashwagandha, Tulsi, etc. Kalmegh is one such herb which has been used in ancient oriental and ayurvedic medicine for its immunopotenting ability against regular illness. Kalmegh is ranked 17th out of 32 prioritised medicinal plant lists presented by the Indian National Medicinal Plants Board. It plays a significant role in 26 ayurvedic formulas and holds a significant place in the Indian pharmacopoeia.Medicinal properties of *A. paniculata* have also been highlighted by WHO in its 2002 monograph.

Kalmegh

Kalmegh (*Andrographispaniculata* Nees.) belonging to the family Acanthaceae is one of the nineteen species of the genus *Andrographis* indigenous to India and has been used in Indian systems of medicine since time immemorial. Commonly known as “King of Bitters” or “Bhuineem” as it looks very similar to neem and though smaller, has a bitter taste. It is found in Sri Lanka, Pakistan, Java, Malaysia, Indonesia and throughout India. In India, it is cultivated in Uttar Pradesh, Himachal Pradesh, Assam, Bihar, Madhya Pradesh, Tamil Nadu, Karnataka and Kerala. The fresh and dried leaves of kalmegh and juice extracted from the herb are official drugs in Indian pharmacopoeia. Brimming with antioxidants, it is used as a wonder drug in tribal medicine and in Indian Siddha, Ayurvedic systems of medicine.

Cultivation practices of Kalmegh:

- It may be grown on a wide range of soils with moderate fertility, from loam to lateritic or gloomy wastelands.
- For the plant to flourish, it needs hot, humid weather with lots of sunlight. The plant grows lushly with the arrival of the monsoon and starts to bloom in September, when the temperature starts to regulate.
- Early in September, seeds are sown in rows with a 5 cm spacing in a nursery that has been prepared with a 1:1:1 ratio of soil, sand, and organic matter. Germination takes 8–10 days.
- When seedlings are six weeks old, they are planted in the field at 30x15 cm or 15x15 cm spacing
- The seed rate for a directly planted crop is 1.5 kg/ha and it is dispersed thinly.

- During the crop season, two to three weeding are required, at 20 days and 60 days after transplantation.
- The crop matures after 120 days of sowing and is ready to harvest. The plants should be uprooted at this point. A small number of healthy plants, on the other hand, should be left in the field for seed production.
- A well-maintained crop grown during monsoon season yields (whole pant) 2.5 tons per hectare should be recorded. It has sizeable demand and yields a reasonable profit to the growers.

Medicinal uses and properties of Kalmegh

Consuming Kalmegh extracts is simply a hack to maintain health and to ward off seasonal disease. It has the following medicinal properties:

1. **Anti-microbial properties :** When andrographolides, aqueous extract, and arabinogalactan proteins isolated from the dried herb of Kalmeghwere tested for anti-microbial activity, it was discovered that the latter two had antibacterial activity against *Bacillus subtilis*, *Escherichia coli*, and *Pseudomonas aeruginosa*, while the former was only effective against *B. subtilis*.
2. **Anti-malarial properties :** Kalmegh extract contains an antimalarial compound that has been shown to be active against *Plasmodium berghei* (malaria-transmitting parasite). Its effects were discovered to be even more effective than those of a malaria medicine. It might prevent the spread of the parasite that spreads malaria, making it more efficient.
3. **Rich in anti-oxidants :** It is packed with polyphenols and antioxidants that could aid in the battle against the body's dangerous free radicals. This appears to shield the body cells from dangerous germs and viruses in turn.
4. **Hepato-protective properties** : By generating a cleansing solvent and preventing the generation of free radicals, which damage the cellular membranes that surround liver cells, kalmegh may be useful against liver toxicity. Liver cirrhosis may be brought on by free radicals. Further consequences of this include coma and death. Kalmegh may be a useful treatment for infective hepatitis, according to studies. A study found that a decoction made from the kalmegh plant has cleaning and purifying properties, particularly for blood. It can therefore be used to treat jaundice. The herb kalmegh can help treat fatty liver and lower the risk of gallstone development. It may therefore facilitate the digestion of fat.
5. **Anti-inflamatory properties:** It was found to inhibit oedema. It may also be used to treat renal inflammation brought on by a local bacterial infection as well as chronic inflammation of the colon.
6. **Anti-diabetic properties**: For diabetics, kalmegh may be advantageous since it effectively lowers blood sugar levels by boosting insulin secretion and helps prevent hypoglycemia.
7. **Antithrombotic properties and cardiovascular activity**: According to studies, kalmegh may lengthen the time it takes for blood to clot, decreasing the risk of restenosis—the blood vessel closure that occurs after angioplasty. Utilizing kalmegh can also dramatically lessen blood vessel constriction brought on by dietary cholesterol excess or damage to the inner lining of blood vessels. Heart tissues may die if their blood supply and oxygen availability are reduced. Studies have shown that kalmegh stimulates the body's natural fibrinolysis mechanism, which dissolves blood clots.

8. **Aids in Digestion :** Due to its laxative qualities, kalmegh aids in the removal of faeces, which helps to improve digestion. It also has choleretic properties, which aid in enhancing bile's qualities and significantly enhance bile flow, aiding in digestion.
9. **Immunity building properties :** Andrographolides can enhance immune system functions such as production of white blood cells which are scavengers of bacteria and other foreign matter, release of interferon, and activity of the lymph system.According to a study conducted on mice,*Andrographispaniculata* is a strong activator of the immune system in two ways
   (1) Antigen-specific response: antibodies are created to combat invasive microbes, and (2) Nonspecific immune response: Invaders are scavenged and destroyed by macrophage cells.
   It stirs up both reactions, making it potent against a range of infectious and cancerous agents.
10. **Acts as painkiller as it is analgesic** : Kalmegh may have painkiller properties in addition to reducing swelling and blood loss.
11. **Can kill cancer cells :** The herb kalmegh is thought to have a cancerolytic effect. Kalmegh has the potential to be effective against a wide range of infectious and cancer-causing substances since it induces dual responses, according to studies. Kalmegh is classified as a cytotoxic agent by the National Cancer Institute because of this potential. It might also be less hazardous than the majority of chemotherapy drugs.
12. **Eliminates mucus from respiratory tract :** It contains immunomodulatory, anti-inflammatory, and antibacterial effects. It might prevent nasal mucous membrane inflammation. Additionally, it might lessen nasal secretions. According to Ayurveda, Kalmegh's ability to balance Kapha and Pitta makes it effective in the fight against upper respiratory infections, common cold, and flu.
13. **Anti-viral properties :** It has been discovered that kalmegh inhibits interference with the cell cycle. Such interference is the cause of viral infections like HIV-1. Interferon, a cytokine produced by cells in reaction to viruses, is released by Kalmegh. It has strong antiviral and antiproliferative properties (stops the growth of viruses).
14. **Increases white cell phagocytosis, improves T-lymphocyte counts.**
15. **Can be used as a sedative :** This herb produces an adequate and long-lasting anaesthesia that engages the brain's barbital receptors.
16. **Anti-helminthic properties:** The herbkalmegh aids in killing of intestinal worms and promotes intestinal health.
17. **Anti-fertility properties :** Ovulation is prevented by kalmegh. The production of human progesterone, which is necessary for a healthy pregnancy, is effectively inhibited by Kalmegh. It is used as a contraceptive method.
18. **Treats Filaria** : Extracts from kalmegh may be useful for treating filaria, a condition in which a lymphatic channel obstruction causes a noticeable swelling known as elephantiasis.
19. **Can fight against snake venom :** Used as an antidote against snake and insect bite.
20. **Anti-pyretic properties** : reduces fever both in humans and animals, caused by multiple infections or by toxins

It is widely used in Indian systems of medicine in the treatment of many diseases such as ulcer, diabetes, high blood pressure, chronic malaria, skin disease, flatulence, influenza, cervical erosion, pelvic infection, chickenpox, mumps, burns. leprosy, bronchitis, dysentery, dyspepsia, cancer and HIV infections. Kalmegh forms the principle ingredient of a house hold medicine called `Alui', extensively used in West Bengal for general debility and certain forms of dyspepsia amongst adults and infants. In Traditional Chinese Medicine, *A. paniculata* is regarded as a bitter and cold property herb used to treat hot conditions such as acute infections and fever, including throat infection, pneumonia, tonsillitis, dysentery, gastroenteritis and pyelonephritis. The hot water extract of the whole plant is used for acute jaundice where the powder is mixed with garlic and given orally with butter milk for four days and also as febrifuge while the extract of dried leaf is used to treat stomach worms and the fresh leaf juice along with the leaf juice of *Azadirachtaindica* and *Tinosporacordifolia* are taken to cure cholera. Kidney and retina related problems can be cured by the magic of Kalmegh. It is used in Malaysian folk medicine for treating diabetes and hypertension. Scientists today, however, are focusing on the herb's application in treating the 'killer' diseases that blight modern life, such as heart disease, cancer and even AIDS. It has been widely used in Chinese medicine as an antiinflammatory and antipyretic drug for the treatment of cold, fever and laryngitis. The plant is also one of the components of Nilavembu Kudineer Chooranam, a poly herbal Siddha preparation containing equal proportion of nine plants used in the prevention and treatment of dengue viral fever and COVID-19 in human and hence approved for use by Government of India.

KalmeghBoti
Source: Bengali Food and Stories, Barnali Dutta, 2013

Medicinal constituents:

1. **Terpenoids :** The entire herb is a source of various diterpenoid compounds, the most important of which is andrographolide, which is a 'diterpene lactone' water soluble substance. It is dispersed in various ratios throughout the entire plant body. The amount of andrographolide in the stem is less (2.0%) than that in the leaves, which have the highest concentration (2.5%). Andrographolide is a colourless, crystalline substance with an extremely bitter taste. Deoxyandrographolide and neoandrographolide are two more dominant diterpenoids that have mostly been isolated from the aerial sections of A. paniculata in addition to andrographolide.
2. **Flavonoids :** Besides andrographolides, the plant also contains flavonoids, Cinnamic acid, caffeic acid, ferulic acid and chlorogenic acid.
3. **Misscellaneous :** Particularly from the roots of *A. paniculata*, a number of diverse chemicals have been identified. Using a combination of thin layer and column chromatography, four xanthones were isolated from the roots. Its roots are used in Japan to extract a variety of flavonoids, including andrographidin A, B, C, D, E, and F, whose quantity ranges from 0.015 to 0.15 percent. Arabinogalactan proteins were also isolated

from the dried herbs. The roots' trace elements (Cr, Mn, Co, Ni, Zn, Cu, Se, Rb, Sr, and Pb) and macroelements (potassium and calcium) have been identified and quantified.

How to Use Kalmegh?

Leaves, stem and roots of kalmegh plant harbour active pharmacological compounds which can be used by the following methods.

- Fresh and dried leaves, and juice of the plant used as an official drug.
- Traditionally, garlic added to kalmegh leaf powder with buttermilk for treating jaundice.
- The paste formed by leaves and fresh twigs of the plant.
- Boiling the leaves with water is good for treating stomach infections.

Dried herb

Before taking any herbal supplements, it is however advised to always consult a doctor.

Side Effects of Kalmegh:

Like all natural things, Kalmegh abides by the Earth's and its surroundings' inherent balance. Anything consumed in excess is bad, and kalmegh is no exception. Overusing kalmegh may result in negative side effects such.

- May lead to lethargy and decreased activity
- Allergic reactions ranging from mild skin rashes to the potentially fatal condition known as anaphylaxis
- Loss of appetite
- Swollen lymph glands
- Elevations of liver enzymes
- Nausea problems
- It shows an antifertility effect as it prevents ovulation and reduces sperm count.

Precautions to take:

- **Pregnancy issues**: Pregnant women shouldn't use it since it has pregnancy-terminating effects that could end the pregnancy. There is no clear information provided regarding whether it can be used when nursing.
- **Children:**It can be consumed orally by kids. However, sometimes it increases immune system activity, which ultimately leads to auto immunological illness.
- **Slow Blood clotting**: It can slow blood clottingand raise the possibility of significant bleeding. Therefore, it should not be used on patients with bleeding disorders.
- **Lower Blood Pressure**: This medicine can lower blood pressurelevels, and people already have low blood pressure should avoid this.

Conclusion

We are all aware that this pandemic has put medical science in a precarious position and has put doctors and biologists under pressure to find treatments and vaccinations as soon as possible for the benefit of humanity. In order to find novel treatments that can heal a person of any fatal condition, we should engage more with our natural plants, like kalmegh. Unexpectedly, its pace of

cultivation is also rising to meet the need. The incredible advantages of kalmegh have made its bitter flavour sweeter! We have an ally to help us preserve our health throughout the season, whether we decide to take kalmegh as a supplement or on its own.

References

Benny, N.R., Ns, S., Gs, S. (2021). Hepatoprotective medicinal plants traditional knowledge to scientific evidences : A review. 10(2):285-288.

Kour, N. (2016). *Andrographis paniculata* : a review on ethnomedicinal potential and biological activities. *J Plant Dev Sci*. 8(1):1-6.

Siddhartha, K.M., Neelam, S.S., Rajendran, S.S. (2007). Plant Review *Andrographis paniculata* (Kalmegh): A Review. *Pharmacogn Rev*.1(2):283-298.

Verma, H., Negi, M., Mahapatra, B., Shukla, A., Paul, J. (2019). Evaluation of an emerging medicinal crop Kalmegh [*Andrographis paniculata* (Burm. F.) Wall. Ex. Nees] for commercial cultivation and pharmaceutical & industrial uses: A review. ~ *835* ~ *J Pharmacogn Phytochem*. 8(4):835-848.

Official Address :
Peshok Tea Estate
P.O.- Peshok, Dist.- Darjeeling
West Bengal, India
PIN-734312

Contact No : +91 7501389678
email : agriindiatoday@gmail.com