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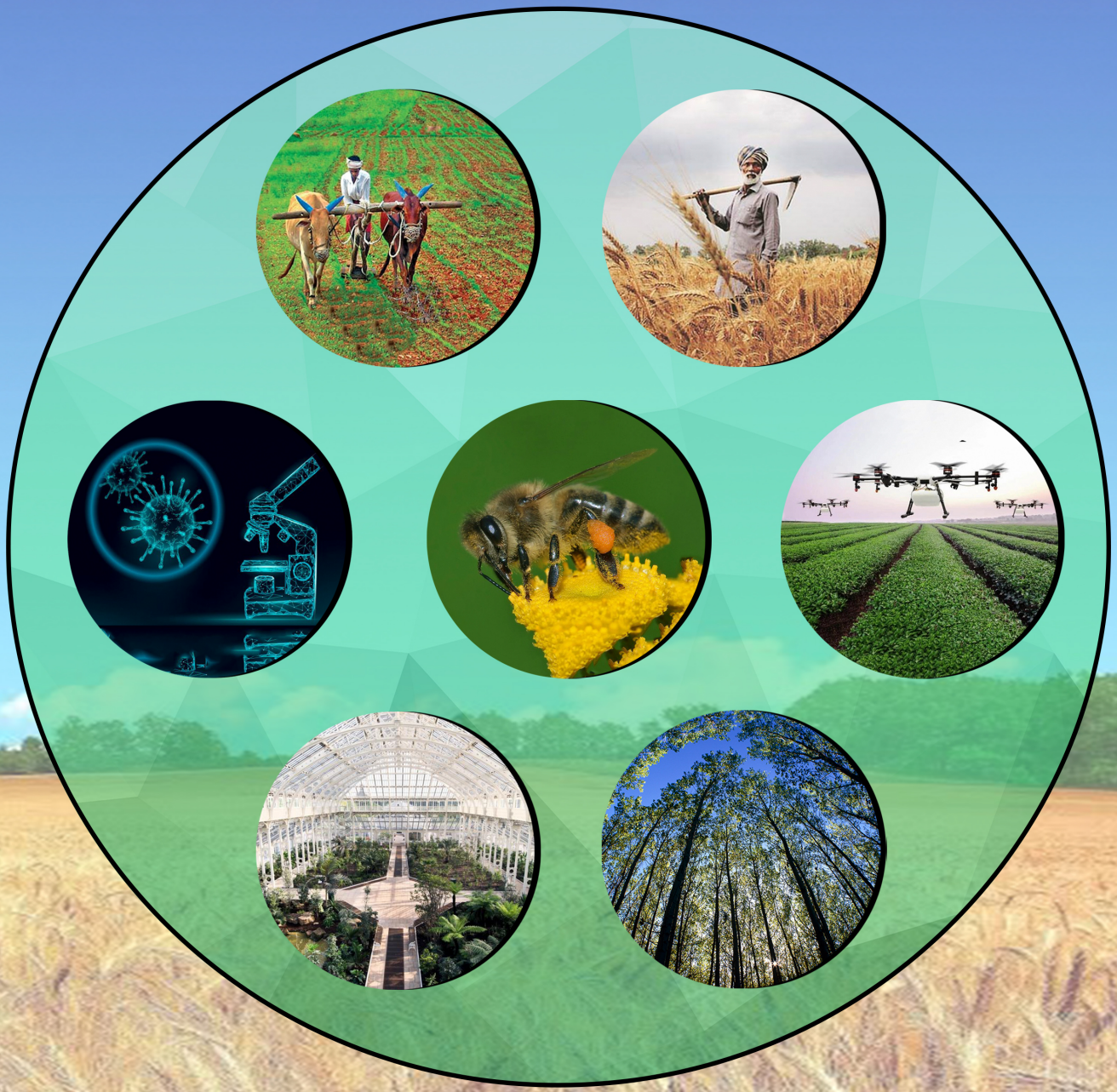

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Utilization of Wild Relatives for Insect Resistance Breeding in Cereals

Anjali Joshi[1], Babita Bhatt[2], Aparna[1] and Charupriya Chauhan[1]

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[1]*Department of Genetics and Plant Breeding, G.B.P.U.A.T, Pantnagar*
[2]*Department of Entomology, G.B.P.U.A.T, Pantnagar*
Corresponding Author: anjali999aj@gmail.com

Introduction

Diseases and insect pests are key biotic constraints leading to low yields in cereal production worldwide. Insect pests in particular destroy approximately 14% of all potential food production, including rice, wheat and sorghum, despite the application of greater than 3,000 million kilograms of pesticides per year (Pimentel, 2007). Losing crops to insect pests constitutes a great limitation to recognition of food security worldwide. Host plant resistance through crop breeding remains the keystone of an integrated pest management strategy to minimize losses and impact on grain quality. Wild relatives on account of being growing under natural conditions without any artificial selection have constantly been exposed to varied stresses in the past and as a result have evolved various resistance genes to tackle them. They therefore possess sufficient variability to act as donor for various insect resistance traits. An in-depth account of wild relatives of important cereals as wheat, rice and sorghum that have been identified and utilized in recent past as donor of resistant traits have been discussed.

Wheat

The species belonging to primary, secondary, and tertiary gene pools of *Triticeae* species (*Aegilops*, *Agropyron*, *Elymus*, *Hordeum*, *Leymus*, *Secale*, *Thinopyrum*, and *Triticum*) are rich source of genes for improvement of traits pertaining to biotic and abiotic stress tolerance and quality improvement. Introgression of alleles from nearly 52 related species have already been done for improvement of wheat for different traits. Wheat crop is affected by various insects during different stages of development causing significant grain yield loss. Beside use of pesticides which not only increases the cost of cultivation but also causes environmental pollution, development of host plant resistance is a sustainable approach to pest management where genes from related wild species can be used to breed tolerance against insect attack. Resistance against insect attack have been found in a number of related species of wheat. A large number of insects causes yield loss in wheat both in field as well as under storage. Few of the most significant amongst them includes green bug (*Schizaphis graminum*), aphids as *Diuraphis noxia, Rhopalosiphum padi L*. and *Sitobion avenae*, Hessian fly (*Mayetiola destructor*), cereal cyst nematode (*Heterodera avenae*) and mite (*Aceria tosichell*). It was found that *Aegilops tauschii* possess Cre3 locus controlling resistance to cereal cyst nematode and resistance genes against Hessian fly infestation while *Aegilops variabilis* serves as donor for nematode resistance genes. *R. padi* resistant twenty-one accession from six *Aegilops* species and one accession from *Triticum araraticum*, a tetraploid

species of wheat where further screened for aphid resistance and it was found that out of all the accession screened, *Aegilops neglecta* accession showed antibiotic effect against colonization by *D. noxia* and *S. avenae*. According to various publications resistance to aphid *R. padi* was conferred by *T. araraticum, A. tauschii* and *Triticum boeoticum*, to *S. graminum* was controlled by genes present in *A. tauschii* and *T. turgidum* and higher level of resistance to *S. avenae* was conferred by *T. araraticum* and *T. dicoccoides*.

Rice

Genus Oryza of the graminae family constitutes a total of 24 species. Out of these 24 species *O. sativa* L. and *O. glaberrima* are the only cultivated species of genus *Oryza* while the remaining 22 are wild species distributed worldwide. Depending on the ease of transfer of genes to their cultivated counterparts, the wild species are divided into three complexes i.e., *O. sativa* complex, *O. officinalis* complex and *O. meyeriana* and *O. ridleyi* complex (Morishima and Oka, 1960). Later these complexes were renamed as the primary, secondary and tertiary gene pool of rice. Wild species of rice are a rich source of economically valuable traits on account of being grown in diverse climate and lack of artificial selection. Brown plant hopper is one of the most devastating insect affecting rice cultivation worldwide. A total of 30 brown plant hopper resistant genes have been identified and out of these more than a dozen are contributed by crop wild relatives. Resistance to brown plant hopper have been conferred by genes present in *O punctata, O. minuta, O. officinalis, O. eichingeri, O. latifolia and O. australiensis*. While *O. officinalis, O. eichingeri* have valuable genes for white backed plant hopper and green leaf hopper resistance. The most distantly related wild species, *O. meyeriana, O. longiglumis, O. granulata, O. coarctata* and *O. ridleyi* have most valuable genes for stem borer. Many valuable genes for brown plant hopper tolerance in rice have been identified and tagged (Jena, 2010) viz., *Bph6, bph11, Bph13, 14, 15* have been identified in *O officinalis* and tagged with suitable markers. While *Bph20, Bph21* identified and tagged in *O minuta*, *Bph12* in *O latifolia* and *Bph10, Bph18* in *O. australiensis*. Tagging of these genes with specific markers makes their transfer into elite lines much easier and will subsequently reduce the problem of linkage drag associated with wide hybridization. Four resistance genes including *Bph14* from *O officinalis* and *bph29* from *O. rufipogon* have already been cloned and introgression of brown plant hopper resistance from wild to elite lines is also being performed simultaneously.

Sorghum

Resistance level to stem borer and sorghum shoot fly is reported to be low to moderate in sorghum germplasm (Sharma et al., 2003). There is therefore an immediate need to look for alternative resistance genes providing high level of resistance in wild relatives. High level of shoot fly resistance has been reported in *Sorghum purpureosericeum* and *S. versicolor*. Sorghum midge (*Stenodiplosis sorghicola*) resistance was reported in some Australian species of sorghum. Odors from the panicles of *S. halepense* were found to be more attractive to the females of sorghum midge compared to the odors from *S. stipoideum, S. angustum, S. brachypodum, S. nitidum, S. macropsermum, S. laxiflorum* and *S. amplum.* The hybrids derived from *S. bicolor* ssp. *Verticilliflorum* race virgatum was found to possess high level of resistance to green bug (*Schizaphis graminum*) and resistance to green bug

(biotype E) was also discovered in S. *halepense.* Another study was conducted in which 17 wild relatives of sorghum were screened for resistance to shoot fly (*Atherigona soccata*) in order to identify alternate resistance genes. Under multi choice conditions in field, Stiposorghum, Parasorghum and Heterosorghum were although preferred for oviposition but they showed low deadheart formation and did not suffered any damage. One accession each of Chaetosorghum (*S. macrospermum*) and Heterosorghum (*S. laxiflorum*) also suffered very low intensity of shoot fly damage. Non preference for oviposition was shown by *S. exstans, S. matarankense* and *S. stipoideum*. Therefore, these wild relatives with different resistance mechanisms can be used as a source of alternate genes to enhance the levels and broaden the basis of resistance to shoot fly, *A. soccata*. Spotted stem borer is yet another destructive pest of sorghum and levels of resistance to this insect is of low to moderate level in sorghum germplasm. Wild relatives of sorghum were screened to identify resistant sources to this pest and also to investigate the mechanism of resistance. High level of resistance against stem borer was displayed by heterosorghum, parasorghum and stiposorghum while Chaetosorghum, *S. halepense* and four wild races of *S. bicolor* subsp. verticilliflorum were found to be susceptible. Although egg laying was observed on all evaluated accession under no choice condition but Stiposorghum and Para□sorghum were less preferred for oviposition when compared to control, IS 2205. Stiposorghum showed no appearance of dead hearts while in Para□sorghum, very few deadhearts were formed. Although *Heterosorghum* was highly preferred for oviposition and showed about 82% dead heart formation, but the recovered larvae died within a month of emergence. Therefore, both antixenosis and antibiosis was reported to be the mechanism of resistance against *C. partellus* in sorghum wild relatives.

Conclusion

It is therefore clear that wild relatives are a gigantic source of insect pest resistance genes. The need of the hour is to tap these genes present in wild relatives by mobilizing them into the adapted germplasm by means of pre breeding activities. Once present in adapted germplasm these genes can help in dealing with enhanced insect susceptibility of modern germplasm one of the most potent problem of commercial plant breeding now a days.

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Banana Pseudo-Stem Fibre: Processing and Applications

P. Karthika[1], A. Varalakshimi[1] and S. Babu[2]

Article ID: 22

[1]*Undergraduate Students, VIT School of Agricultural Innovations and Advanced Learning, Vellore Institute of Technology, Vellore 632014.*

[2]*Professor and Dean, VIT School of Agricultural Innovations and Advanced Learning, Vellore Institute of Technology, Vellore 632014.*

Corresponding Author: babu.s@vit.ac.in

Introduction

Banana is basically a fruit crop cultivated in all the tropical and sub-tropical countries. The fruits are consumed in almost all the countries of the world. Banana plants are known for the usage of all plant parts–ripe and unripe fruits, flowers, pith are edible; leaves, sap, pseudo-stem fibre are used either as such for non-edible purposes or as value added products for other applications. The fibres obtained from pseudo-stem contain cellulose, hemicellulose, lignin and ash, the composition of which varies with different species. Compared to the pseudo-stem fibres, hemicellulose content is high in leaf fibres. Depending on the plant part used (leaves or leaf sheaths of pseudo-stem) and the extraction methods followed the physical and chemical properties of the banana fibres vary. The market value of banana fibres is several folds higher than the fibres obtained from flax and hemp. Hence, at the end of crop season, after harvest of banana fruits, the pseudo-stem which is considered to be an agricultural waste can provide additional income to the farmers, if the pre-processing of fibres are done at the farm level.

Banana Pseudo-Stem Fibre

For every ton of banana fruit produced, four tons of biomass waste (leaves, pseudo-stem, rotten fruit, peel, rhizome etc.) is produced, of which the bulky waste is pseudo-stem. Pseudo-stem is the trunk part of the plant which consists of a central core (pith) wrapped by leaf sheaths. The central core contributes to 10-15% of the pseudo-stem. Out of the remaining 85-90%, fibre is 1.5-2% and the rest is non-fibrous material. About 30-40% of the non-fibrous material is sap and 60-70% is scutcher. The central pith is directly used as vegetable or indirectly used to prepare value added food products like pickle, soft drink and candy. The sap is used to make organic liquid fertilizer and to prepare mordant for the paint industry. Scutcher material is useful as manure after composting or as raw material for the preparation of vermicompost. A normal banana plant has 15-18 leaf sheaths making the pseudo-stem. The outer sheaths are composed of course fibres and the soft fibres are obtained from inner sheath. Each leaf sheath in cross section has three layers – the outer epidermis, water conducting tissue and inner soft layer of cells.

Extraction of Banana Fibres

Manual extraction process involves separation of leaf sheaths, rolling them to remove excess moisture, making of crude fibres by combing which also removes impurities and pigments. The fibre shreds are then cleaned and dried. For industrial applications, specialized machines are available and the banana fibres can be extracted automatically. The machine consists of horizontal beams, a carriage and comb like structure. Banana sheaths are fed through a fixed platform and the resulting fibres are dried at 200°C for three hours. There are various types of banana fibre extraction machines that are custom designed. In some places, the fibre is extracted by separating the ribbon like layers of pulp. These are called tuxies which are then used to remove residual pulp with the help of a knife. The fibres are then spun into twines. A decorticator machine containing a drum mounted on a shaft was designed and found to be successful (Subagyo and Chafidz, 2018). The blades mounted on the circumference of the drum create a beating action on the drum when rotated. The pseudo-stem of banana is fed into the drum by a feeding roller. Due to crushing, beating and pulling, the pulpy material is removed. This machine can handle two tons of dry fibre per day. Fibreboards prepared from banana fibres use steam explosion at high temperature and pressure which rearranges the lignin to give the strength. Extracted long fibres are also cut into small pieces and treated with enzymes like pectinase for six hours to produce textile grade fibres (Ortega et al., 2016). These fibres are found to be suitable for production of yarns. Polygalacturonase producing bacteria such as *Streptomyces lydicus* are also used to process textile purpose fibres from the raw material.

Applications of Banana Pseudo-Stem Fibre

With increasing demand on eco-friendly materials, banana fibres are now used to make garments, ropes, mats, carpets, cushions, cushion covers, bags, baskets, table cloths, curtains, rugs, matresses, pillows, wallets, wallets, yoga mats, sausage casings, tea bags, vacuum bags, cigarette papers, fishing nets, packaging sheets, base material for growing of mushrooms, cardboards, string threads, socks etc. It is used to make currency papers, bond papers, envelopes, tissue papers, filter papers, decorative papers and writing papers. Banana fibre is an alternative for wood pulp in paper industry due to its high cellulose content. In composite materials, banana fibres can be used as alternative to fibre glass and thus it finds application in automobile industry. Due to the high resistance to salt water, banana fibres are the most preferred ones in making marine ropes that are used in boats and ships (Vigneswaran et al., 2015).

Fibre industries have been exploring alternate materials that can replace the synthetic fibres and the demand for usage of wooden trees. Synthetic fibres are toxic, non-degradable and energy consuming during the manufacturing process. Among the biodegradable natural fibres such as coir, jute and palm, banana fibres exhibit better tensile strength. Banana fibres can be blended easily with other natural fibres like cotton or synthetic fibres in textile industries. Due to the high absorbent properties, banana fibres are useful in absorbing oil spills in the oil refineries and also to remove the dye in textile industry effluents. Cellulosic banana fibres are eco-friendly reinforcing materials for the production of green polymers.

Use of cloths based on banana fibres originated in Japan during 13th century. Since water is absorbed and released quickly, fabrics made from banana fibres are considered as comfortable summer wear. Banana fabrics are beautiful and similar to silk. Although the raw fibres are not as soft as silk, it is possible to create silk like fabric from these fibres. Use of non-woody raw materials for paper production will reduce the need for timbers and thus the environmental issues like deforestation can be reduced. Pseudo-stem of Cavendish varieties of banana is useful for paper making. Papers made from banana fibres are known to have resistance to water and also stronger than the wood pulp-based paper (Jacob and Prema, 2008).

Conclusions

In many agricultural farms, the pseudo-stem of banana plants after harvest are disposed as landfill waste or burnt after drying. There exists a high potential for converting this waste into wealth. One metric ton of the pseudo-stem (contributed by 50 plants approximately) can yield about 15-20 kg of banana fibres. Compared to other natural fibres, production of banana fibres is less expensive since the raw material is cheap and abundantly available in banana growing regions. Although many products based on banana fibres are available in the market, banana fibres are not yet explored completely. Cellulose nano-crystals obtained from banana fibres is an emerging field which has a greater potential to find additional applications for banana fibres. Low cost fibre extraction machines established at the village level can not only help in recycling this banana biomass into fibres but also provide employment opportunities to the rural poor and additional income to the farmers.

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Role of Entomopathogenic Fungi in Insect Pests Control of Field Crops

S. J. Chaudhari

Article ID: 23

Department of Entomology, C. P. College of Agriculture,
Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar
Corresponding Author: siddhavc@gmail.com

Introduction

In recent years, crop protection based on biological control of crop pests particularly with microbial pathogens like viruses, bacteria, fungi and nematodes has been recognized as a valuable tool in pest management. Among them entomopathogenic fungi have a potential role to play in development of future integrated pest management strategies. They are effective, ecofriendly, biodegradable and do not leave any harmful residue on environment so it is used widely. *Agostino Bassi* in 1835, first time used the white muscardine, fungus on the silk worm that was the named in his honour as *Beauveria bassiana*. Pesticides have done a lot of good for the world food supply but their unilateral utilization has created many problems *viz.,* development of resistant, resurgence, outbreak of pest and pesticide residues.

In this context, use of entomopathogenic fungi has come into vogue, having target selectivity environmental compatability, economic variability, novel mode of action, safer to environment and beneficial organisms as well as rational approach at a long run.

Why do we need Entomopathogenic fungi?

- The conventional use of chemical pesticides has not only enhanced the food production, but also adversely affected the environment and non-target organisms.
- Increasing cases of insects developing resistance, e.g., *Helicoverpa* has become resistant to most of the insecticides.
- Due to the side-effects of chemical pesticides, also to demand the sustainable crop production through eco-friendly pest management is essentially in recent scenario.
- So, alternative methods of insect management offer adequate levels of pest control and pose fewer hazards.

Symptoms of fungal infection

- Loss of appetite, irritability and paralyses
- Discoloured patches on integuments and increased acidity in blood
- The body hardens and covered by dense white and green mycelial mat
- Mummified larvae comply to leaves, stem and fruiting body with upright position on its prolegs at the time of death
- Death occurs with 3-6 days depending on host insect and environmental condition.

Mode of infection

Spore of fungus come in contact with the cuticle (skin) of insects, they germinate and penetrate in cuticle either by germ tube or by infection pegs from appresoria and grow directly through the cuticle to the inner body of their host. The fungus proliferates throughout insect's body, producing toxin and draining the insect nutrients, eventually kiliing it. Death is caused by tissue destruction and occasionally by toxins produced. Once fungus has killed its host, it grows back out through the softer portion of cuticle, covering the insect with a fungal growth.

- When spores of the fungus come in contact with cuticle of insects, they germinate and penetrate the cuticle by germ tube form appresoria and grow directly throught the cuticle.
- Fungus proliferates throughout the insect's body, producing toxins and draining the insect of nutrients, eventually killing it.
- Death caused by tissue damage and toxin produced by fungus.

General characteristics of Entomopathogenic fungi

- It occurs naturally in soils throughout the world
- It reproduces sexually and asexually
- It has usually definite cell wall
- Growth rate moderately rapid
- Colony reaches a diameter of 3 cm
- Incubation time seven day
- Produces creamy white colour growth

Effect on Field crops

Beauveria bassiana Vuillemin

- Karkar *et al.* (2014) found that the most effective dose (3.5 g/l) of *B. basiana* against third instar larvae of *Helicoverpa armigera* Hubner in pigeonpea.
- Chandrayudu *et al.* (2015) evaluated the efficacy of botanical and microbial insecticides against *S. litura* infesting groundnut and reported that *B. bassiana* (1.5 x 10^{13} spore/ml) was significantly effective in reducing larval population. Combination of chloropyriphos @ 0.125% + *B. bassiana* @ 1 x 10^{7} cfu/g caused 86.27 per cent mortality of rice hispa. (Puzari *et al.,* 2015).
- Kankale *et al.* (2015) found that spraying of *B. bassiana* (1.0 x 10^{4} spore/ml) with neem soap @ 0.5% recorded minimum population of *H. armigera* and pod damage on chickpea.
- Lower per cent of rosette flowers per plant was recorded in treatment of *B. bassiana* 1.15 WP @ 0.009% and was statistically at par with chlorantraniliprole 18.5 SC @ 0.006% and spinosad 45 SC @ 0.014% against pink bollworm in cotton. (Anonymous, 2016[a]).

- Annamalai *et al.* (2016) reported that *B. bassiana* (1 x 10^{13} spore/ml) can be play an effective role in eco-friendly management of *Thrips tabaci,* higher mortality at 7 DAT was observed in cotton. Higher larval mortality (50 per cent) of fall army worm on maize crop was observed by spraying of *B. bassiana* 1.15 WP (1 x 10^{8} cfu/g) 40 gm and neem oil (10000 ppm) 20 ml/10 liter water. (Anonymous, 2018)

***Lecanicillium lecanii* Zimmerman viegas**

- Patil *et al.* (2012) found that the higher dose of *Verticillium lecanii* @ 7.50 kg/ha proved to be the effective against thrips, leaf hopper and aphid in cotton. Mer *et al.* (2016) observed that after one day insecticidal spray of *V. lecanii* @ 1.25 kg/ha + thiomethoxan 25 SG @ 0.05% was found most effective, showed 41.11 per cent mortality of groundnut jassid.
- Patel *et al.* (2019) studied the effect of different entomopathogenic fungi against mustard aphid and reported that *L. lecanii* @ 60 g and *B. bassiana* @ 60 g/ 10 liter of water proved most effective against aphid.

***Metarhizium anisopliae* Metchnikoff**

- Manisegaran *et al.,* (2011) evaluated *M. anisopliae* @ 4 x 10^{9} conidia/ha recorded significantly lower population of whitegrub in sugarcane. Rana and Kachhawa (2014) reported that *M. anisopliae* @ 1 kg enriched with FYM @ 1 t/ha found lower plant mortality due to termite in maize.
- Soil application of *M. anisopliae* @ 5 kg with 250 kg/ha FYM was found most effective against sugarcane whitegrub. **(**Anonymous, 2016[b]).
- Application of *M. anisopliae* @ 2 kg enriched with vermicompost @ 1 t/ha and *M. anisopliae* @ 2 kg enriched with castor cake @ 1 t/ha were found lower plant mortality of groundnut at 80 days after germination with less population of whitegrub/ 1 m row length at harvest. **(**Anonymous, 2019)

***Nomuraea rileyi* Samson**

- Three sprays of *N. rileyi* @ 1 x 10^{8} conidia/ ml were significantly effective in suppressing the larval population of *S. litura* (1.2 larvae/plant) with 62.5 per cent mortality in soybean. (Anonymous, 2012)
- Sharmila and Manjula (2015) revealed that groundnut oil based formulation of *N. rileyi* recorded significantly higher reduction in larval population of *S. litura* in groundnut.

Compatibility with insecticides

- Bagwan *et al.,* (2012) showed that azardirachtin 1000 ppm, carbosulfan 25 EC and fenvalerate 10 EC did not significantly reduce the spore germination of *M. anisopliae* and *B. bassiana.* Barad *et al.,* (2014) evaluated the compatibility of *N. rileyi* with insecticides and concluded that azadirachtin @ 0.0075% and spinosad @ 0.009% were found compatible.
- Lily (2016) evaluated the compatibility of *B. bassiana* and *N. rileyi* with different insecticides and observed that spinosad 45 SC @ 0.02% and imidacloprid 17.8 SL @ 0.04% were compatible.

- Reddy (2016) observed that fipronil 40 + imidacloprid 40 WG @ 0.04% and monocrotophos 36 SL @ 0.036% were not significantly reduce the spore germination of *M. anisopliae, L. lecaanii* and *B. bassiana,* respectively.
- Kachot *et al.,* (2018) evaluated the compatibility of *B. bassiana* with insecticides and found diamethoate 30 EC @ 0.015%, dianotefuran 20 SG @ 0.005% and spinosad 45 SC @ 0.007% were not significantly reduce the spore germination of *B. bassiana.*

Advantages

- The Major advantage of exploiting microorganisms for pest control is their environmental safety primarily due to the host specificity of these pathogen.
- Microorganisms have natural capability of causing disease at epizootic levels due to their persistence in soil and efficient transmission.
- There is minimum effects on non-target organism.
- The cost of development and registration of microbial insecticides is much less than chemical insecticides.
- Their application is relatively easy and inexpensive in most cases.
- Generally, resistance in insect to pathogens is not developed as compared to other insecticides**.**

Conclusion

- The entomopathogenic fungi control many insect pests *viz*; sucking (aphids, jassids, thrips, *etc*.), foliage feeders (pod borer, leaf eating caterpillar, semi looper, *etc*.) and soil borne insects (whitegrub and termite).
- Entomopathogenic fungi are safe for non-target organism, good compatibility with adjuvant, insecticides (azardirachtin, spinosad, imidacloprid and dianotefuran) and considered as natural mortality agent in insect pest management programmes.
- Use of entomopathogenic fungi should be emerged as promising alternative to chemical pesticides.
- Commercial products of entomopathogenic fungi are available in market that can be utilized as one of the component of IPM.

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Indigenous Chickens of India and Their Performance Characteristics

J. Subhashini[1] and R. Vinoth[2]

Article ID: 24

[1 & 2]*Teaching Assistant, Institute of Agriculture, Kumulur*

Corresponding Author: subhabvsc@gmail.com

Introduction

Indigenous chickens play an important role in the rural economy of the most of the developing countries. These indigenous chickens are well known for their climatic adaptability, disease resistance. They are comparatively hardier and needs less health care than exotic breeds. Some of the indigenous breeds of chicken are Aseel, Kadaknath, Naked neck, Frizzle, Nicobari, Ghagus, Busra, Chittagong, Miri and Brown desi etc.

Aseel

Aseel is the indigenous chicken breed of India which is well known for its hardiness, high stamina, majestic gait and fighting qualities. The breed is the native of Andhra Pradesh. The word Aseel means pure. The remarkable endurance of this breed is even during the most critical stages of fight the bird prefers death to dishonour. The Aseel is therefore known to all game lovers all over the world due to its specific characteristics. The Aseel has short, broad breast, straight back and close-set strong tail root. The important feature of this bird is the thick and long neck, long and slender face (without feathers), short beak, short and small comb, ear lobes and the absence of wattles. The legs of this breed are long, strong and straight. The Aseel cock comes in many colours like red (known as Dega), golden and red spotted plumage (known as Reza), blue black (known as Mazzara),spotted (known as Poola Mazzara), white and black spots (known as Savala), pure black (known as Kaki), hen like colouring (known as Petta maru) and white colour (Settuva). The average weight of two-year-old full-sized adult male varies between 5 to 8 kg. The average weight of a hen varies between 3 to 4 kg.

The bird Aseel is large built with noble looking and dignified appearance. The wattles are rudimentary. Pea comb is mostly found. The beak is short and well curved. The face is long and not covered with any feathers. Eyes are compact, well set and has bold look. The neck is long uniformly thick not fleshy. The general feathering is close, scanty and almost absent in the breast. The plumage has no fluff and the feathers are tough. The tail is small and legs are strong, straight, clean and set well apart. The birds have been traditionally bred for meat quality. They are not prolific layer with 36 to 60 eggs laid per year.

Performance characteristics

- Body weight at 20 weeks of age: 1.2 kg
- Age at sexual maturity: 196 days
- Annual egg production: 92 numbers
- Egg weight at 40 weeks: 50 g
- Fertility: 66 %
- Hatchability: 63 %

Kadaknath

The bird Kadaknath is known as "Karuknozhi" in Tamil as the bird is having black flesh. The home tract of this bird is districts of Madhya Pradesh and adjoining districts of rajasthan and Gujarat where the breed is popularly known as "Kalamasi". These breeds are mostly reared by tribals and rural poor people in olden days, but now the breed is reared most of the people due its medicinal properties. The bird is considered to be sacred bird and offered as sacrifice to goddess after diwali.

Day old chicks are bluish to blackish in colour with irregular stripes on its back. The adult plumage varies from silver to gold beads to blue black without any beading. The skin, beak, shank, toes and soles of feet of males and females are dark grey colour. Even the comb, wattles and tongue also show as purplish blue. The specific feature is the shining blue tinge of ear lobes. The peculiarity of this breed is that the majority of the internal organs show the characteristic black pigmentation. The varying degree of blackish colouration is also found in the skeletal muscles, tendons, nerves, meninges, brain and bone marrow. The black colour of muscles and tissues is due to the deposition of melanin pigment a condition known as "fibromelanosis".

The flesh of this breed though black and unattractive to look at, it is considered not only as delicacy but also of medicinal value. The Kadaknath blood is used in the treatment of chronic heart disease in human beings. The meat and eggs are richest source of protein and iron.

Performance characteristics

- Body weight at 20 weeks of age: 0.9 kg
- Age at sexual maturity: 180 days
- Annual egg production: 105 numbers
- Egg weight at 40 weeks: 49 g
- Fertility: 55 %
- Hatchability: 52 %

Naked Neck

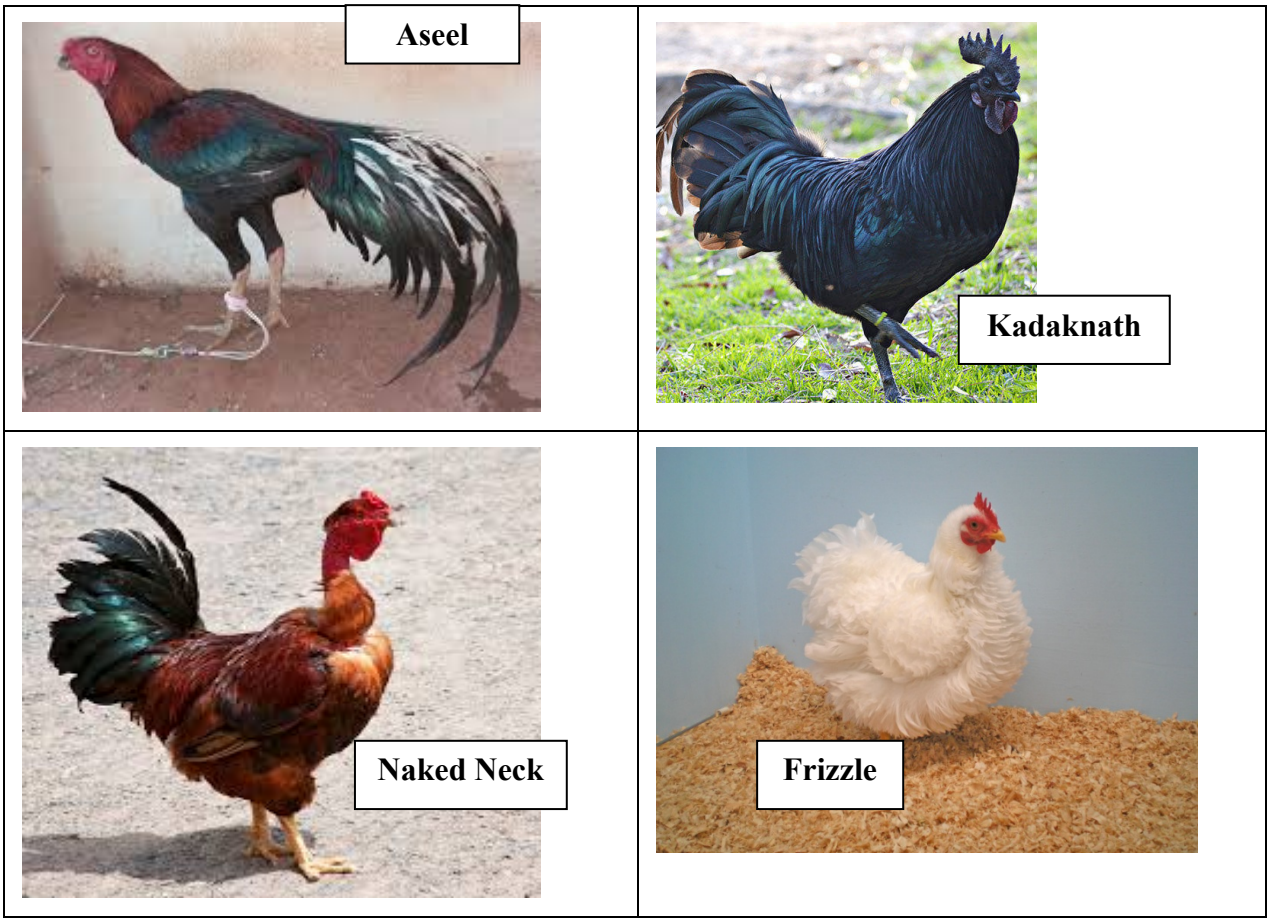
Naked neck is comparatively larger in built with long cylindrical neck. The home tract of this breed is Trivandrum region of Kerala but the breed is also available through hot and humid coastal area including Andaman and Nicobar Island and north eastern states of India. Peoples of those regions have greater affinity for naked neck birds thanks to their better adaptability to the recent and humid climatic condition also as for better taste and flavour of meat.

As the name indicates the neck of birds is fully naked or only a tuft of feathers is seen on the front of the neck above crop. The resulting bare skin becomes reddish particularly in males as they attain sexual maturity. General body feathering is also reduced. Various types of comb such as pea, rose, walnut and single combs are seen. The beak is short and well curved. The face is long and not covered with any feathers. The eyes are compact and well set. The skin is thin and pinkish in colour. Main plumage colours are brown, black, white and

mixture of brown and black. Due to reduced feathering the birds are able to tolerate the tropical stress. Among all the Indian native breeds of chicken it lays the largest size eggs.

Performance characteristics

- Body weight at 20 weeks of age: 1.0 kg
- Age at sexual maturity: 201 days
- Annual egg production: 99 numbers
- Egg weight at 40 weeks: 54 g
- Fertility: 66 %
- Hatchability: 71 %



Frizzle

Frizzle birds are found all over the hot and humid coastal areas including Andaman and Nicobar Islands. Good numbers f these birds are also available on high altitudes hilly tracts of North eastern states. It is said that these birds have better adaptability to hot and humid climatic regions.

Frizzle birds have oval body with well-developed comb and wattles. The skin of the birds is thin and pale pink in colour. The beak and shanks have no relation with plumage colour and are creamish pale in colour. The birds have single comb and ear lobes are well

developed with white spots on them. The eyes are bright and well developed. Plumage colour varies among birds but the most common colours are white, brown, black and mixed colour.

Performance characteristics

- Body weight at 20 weeks of age: 1.0 kg
- Age at sexual maturity: 185 days
- Annual egg production: 110 numbers
- Egg weight at 40 weeks: 53 g
- Fertility: 61 %
- Hatchability: 71 %

Conclusion

Despite of the drastic increase in the import of high yielding strains from across the world the local birds still retain preference in its native environment. Indigenous chickens still enjoy the favour of the local people mainly due to its special capabilities such as adaptability to unfavourable environments and resistance to tropical diseases.

Potassium Solubilizing Bacteria (KSB)

Varsha Pandey
Article ID: 25
Ph.D. Scholar, Department of Soil Science, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar
Corresponding Author: varshapandey.p93@gmail.com

Introduction

The population of India is increasing at an alarming rate and in order to feed this growing population there is a need to produce more from the present arable land. To increase the agricultural food production, various organic and inorganic source of nutrients are used in order to increase soil fertility and to increase the crop yield. One of the major inputs used is fertilizers. But, the application of chemical fertilizers has a considerably negative impact on environmental sustainability thus causing a negative effect on agricultural sustainability.

Among the three essentials nutrients required by plants, one of them is potassium. Potassium(K) is the third important essential major plant nutrient with numerous functions. It plays a vital role in enzyme activation, water relations (osmotic regulation), opening and closing of stomata, starch synthesis, protein synthesis and water nutrient transport. K represents 2.6% of the weight of the earth's crust. The soluble forms of K are present in approximately 2% and insoluble forms of K are present 98% in form of minerals like biotite, feldspar, mica, muscovite and vermiculite and most of this K is unavailable for plant uptake. Common potassium containing minerals are sylvite, carnallite, kainite, langbeinite, schoenite and polyhalite.

Soil microorganisms affect the soil fertility because of its influence on soil processes like decomposition, mineralization and immobilization. Soil microbes have been reported to play an important role in the natural K cycle and therefore, potassium solubilizing bacteria (KSB) present in the soil could provide an alternative means to make potassium available for uptake by plants. KSB can solubilize K-bearing minerals and convert the insoluble K to soluble form of K.

Example of KSB are-

- *Pseudomonas*
- *Acidothiobacillus ferrooxidans*
- *Bacillus mucilaginosus*
- *Bacillus edaphicus*
- *Bacillus circulans*
- *Paenibacillus* spp.

K solubilizing mechanisms

- **Acidolysis** – Production of protons by bacteria is one of the mechanisms which is able to convert the insoluble K (mica, muscovite, and biotite feldspar) to soluble forms of K which can be easily taking up by the plant.

- **Organic acid production** – Different types of organic acids such as oxalic acid, tartaric acids, gluconic acid, 2-ketogluconic acid, citric acid, malic acid, succinic acid, lactic acid, propionic acid, glycolic acid, malonic acid and fumaric acid have been reported in KSB. These acids which are effective in releasing K from K bearing minerals.
- **Chelation -** Organic ligands, extracellular enzymes and chelates produced by KSB are capable of chelating or forming complex with Si^{4+}, Al^{3+}, Fe^{2+}, and Ca^{2+} ions associated with K minerals. This results in conversion of mineral form of potassium to the form which is easily available for plant uptake.
- **Biofilm formation -** KSB also synthesizes biofilms which creates a microenvironment around the microbial cells for weathering. Biofilm formation increases the residence time of water on aluminosilicate as compared to the residence time at the bare rock or mineral surface and enhances the mineral weathering.
- **Lowering of soil pH**
- **Polysaccharides secretion –** Polysaccharides and proteins production by microbes can serve as an attachment structure to the mineral surfaces. This can cause release of K from K bearing minerals for plant uptake.

Screening of KSB

- KSB are isolated by serial dilution plate method using modified Aleksandrov medium containing 5.0 g glucose, 0.5 g $MgSO_4.7H_2O$, 0.1 g $CaCO_3$, 0.006 g $FeCl_3$, 2.0 g $Ca_3(PO_4)_2$, 3.0 g potassium aluminium silicate and 20.0 g agar in 1 l of deionized sterile water. The pH of this medium is adjusted to 7.2 by adding 1 N NaOH.
- A solubilization zone is formed in the medium after incubation for 3-4 days. The diameter of the solubilization zone is calculated in mm using following Khandeparkar's selection (Prajapati, 2012):

Ratio = Diameter of zone of clearance / Diameter of growth

- Rajawat *et al*. (2016) suggested a modified plate assay for rapid screening of KSB. In this method, an acid-base indicator dye (bromothymol blue, BTB) is used to modify the Aleksandrov medium. As a result, halo zone formation occurs around the colonies and it causes improved visualization.

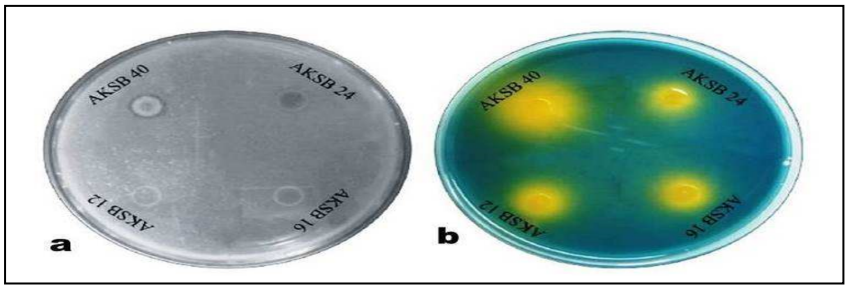


Fig.1: Comparison of K solubilization on (a) Aleksandrov agar plate and (b) modified agar medium plate after 72 h of incubation (Rajawat et al., 2016).

Conclusion

Since, potassium is one of the macronutrient for plant, therefore it is very important to meet the plant's K requirement. Overuse of K fertilizers causes increase in the cost of input and can also cause environmental problems. Therefore, use of microbial inoculants

containing KSB can serve as an environmental friendly approach which can further aid in K nutrition of plants and ultimately meeting the plant's nutritional needs.

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Concept and Approaches of Nano Technology

Bheru Lal Kumhar

Article ID: 26

Ph.D. Scholar, Department of Agronomy, College of Agriculture, Jabalpur
Jawaharlal Nehru Krishi Vishava Vidyalaya, Jabalpur 482004
Corresponding Author: prajapatiagro09@gmail.com

Introduction

Nanotechnology is the manipulation or self-assembly of individual atoms, molecules, or molecular clusters into structures to create materials and devices with new or vastly different properties. It is the science and technology that focuses on special properties of a material which emerge from nanometer size is becoming one of the most promising scientific fields of research in decades. It is enabling scientists to better understand better the relationships between macroscopic properties and molecular structure, degree of order, and intermolecular forces in synthetic materials and biological materials of plant and animal origin. The word nanotechnology is generally used for materials having size range between 1 and 100 nm however it is also inherent that these materials should display different properties from their micro or macro scale in terms of their physical strength, chemical reactivity, electrical conductance, malleability, ductibility, magnetism and optical effects (Huang et al. 2007). Nanotechnologies involve the understanding and control of matter at the nanoscale, namely, at dimensions between approximately 1–100 nm, where unique phenomena such as improved physical, chemical, and biological properties may enable novel applications.

Concept and term

The term ‘nanotechnology’ was not used until 1974, when Norio Taniguchi, a researcher at the University of Tokyo, Japan used it to refer to the ability to engineer materials precisely at the nanometer level (Taniguchi 1974). “Nano-technology” mainly consists of the processing of, separation, consolidation, and deformation of materials by one atom or by one molecule. The prefix ‘nano’ is derived from the Greek word for dwarf. A nanometer (nm) is one billionth of a meter, or 10^{-9} m or one-millionth of a millimeter pico Newtons (pN = 10^{-12} N), and Angstrom (A = 10^{-10} m). Nanotechnology are the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale. Nanoscience is the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale. However, as the term ‘nanotechnology’ encompasses such a wide range of tools, techniques and potential applications, we have found it more appropriate to refer to ‘nanotechnologies’. The first term of reference of this study was to define what is meant by nanoscience and nanotechnology. These new materials are manufactured to have unique physical or chemical properties, which arise from their small size, shape, surface area, conductivity, or surface chemistry, and have been applied in numerous ways in fields such as textiles, electronics, engineering, and medicine (Smith et al. 2007). The concept of a ‘‘nanometer’’ was first proposed by Richard Zsigmondy, the 1925 Nobel Prize Laureate in chemistry. He coined the term nanometer explicitly for

characterizing particle size and he was the first to measure the size of particles such as gold colloids using a microscope. Modern nanotechnology was the brain child of Richard Feynman, the 1965 Nobel Prize Laureate in physics, at an American Physical Society meeting at California Institute of Technology on December 29, 1959, presented a lecture titled, ‘‘There’s Plenty of Room at the Bottom’’, in which he introduced the concept of manipulating matter at the atomic level. This novel idea demonstrated new ways of thinking and Feynman’s hypotheses have since been proven correct. It is for these reasons that he is considered the father of modern nanotechnology. (Hulla et al., 2015). In the 1980s the basic idea of this definition was explored in much more depth by Dr. K. Eric Drexler, who promoted the technological significance of nanoscale phenomena and devices through speeches and the books Engines of Creation. It is the manipulation of individual atoms and molecules into structures to create new products. Nano particles can be made by top down approach by reducing the size of the smallest structures to the nanoscale and the bottom up which involves manipulating individual atoms and molecules into nanostructures. The current challenges of sustainability, food security and climate change are engaging researchers in exploring the field of nanotechnology as new source of key improvements for the agricultural sector.

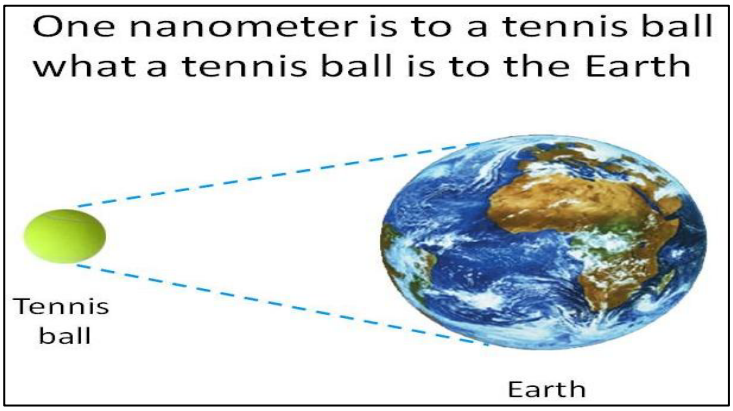

Fig. 1: Pictorial assumption of size of nano particles

Approaches of nano technology

Nanotechnology is usually represented by two different approaches, ‘top-down’ and ‘bottom-up’. ‘Top-down’ refers to making nanoscale structures from smallest structures by machining, templating and lithographic techniques, for example photonics applications in nanoelectronics and Nano engineering. Whereas ‘bottom-up’, or molecular nanotechnology, applies to building organic and inorganic materials into defined structures, atom by atom or molecule by molecule, often by self-assembly or self-organization, which are applicable in several biological processes. Biologists and chemists are actively engaged in the synthesis of inorganic, organic, hybrid and metal nanomaterial including different kinds of nanoparticles having unusual properties like optical, physical, biological, etc. Due to these properties, nanoparticles have enormous applications in many fields like electronic, medicine, pharmaceuticals, engineering and agriculture (Salata, 2004).

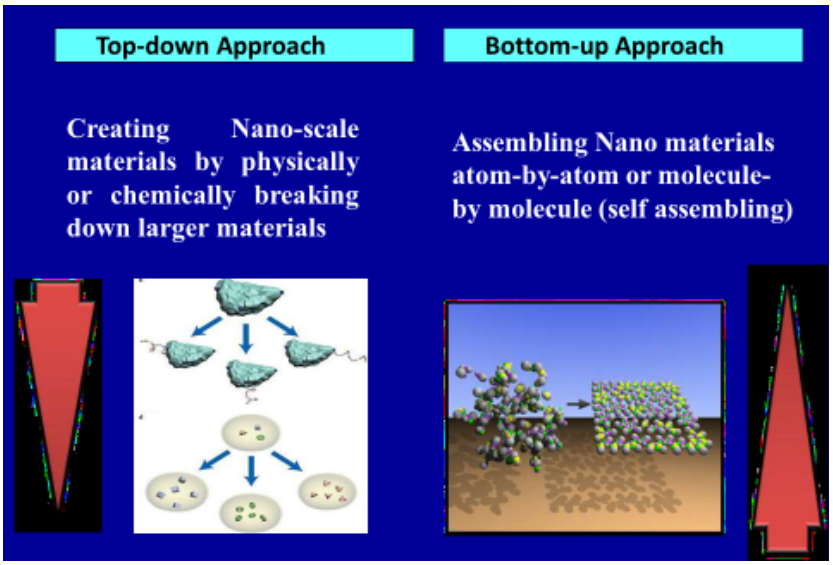

Fig. 2: Different approaches of nano technology

Need of nano technology

Nanotechnology has the potential to revolutionize the existing technologies used in various sectors including agriculture. Nanotechnology may have concrete solutions against many agriculture-related problems like insect pest management using traditional methods, adverse effects of chemical pesticides, development of improved crop varieties, *etc.* Nano materials in different forms can be used for efficient management of insect pests and formulations of potential insecticides and pesticides. Nanoparticle-mediated gene transfer would be useful for the development of new insect resistant varieties. Therefore, it can also be concluded that nanotechnology can provide green and eco-friendly alternatives for insect pest management without harming the nature.

One application of nanotechnologies in agriculture addresses low use efficiency of inputs. Nano sensors are devices that respond to environmental conditions converting them to a useful form of information. They are capable of detecting very small amounts of contaminants, pests, nutrients and even stress caused by nutrient deficiencies, drought, and temperature or pathogen presence. This detection engages nano delivery systems that deliver, with high precision, drugs or nutrients to crops and animals (Johnston, 2010).

Function of nanotechnologies

Nanotechnologies will fundamentally change the understanding and conditions of mankind and create new development opportunities for physics, chemistry, materials, biology, medical science, and other fields. Nanotechnologies can be used to operate genes freely, to produce plant and animal species with its excellent properties, and nanoparticles can be used as vectors for treating various diseases. When nano biology develops to a certain level, nanotechnologies can be used to produce nano biological cells with recognition ability and can absorb biological medicine which can inhibit cancer cells, which may then be injected into the human body to directly destroy cancer cells.

Nanotechnologies hold great potential for creating new materials with enhanced properties. A number of nanotech based products are finding applications in industries such as medical devices, imaging, sports, bio sensing, electronics, drugs, environmental cleanup, cosmetics and sunscreens, agriculture, textiles, food, etc. In the future, the global economy will be increasingly influenced by nanotechnologies, as more products containing nanotechnologies move from research and development into production and commerce (Sastry et al., 2011).

Conclusion and future research

Nanoparticle concentrations for application needs to be standardized for further improvement in crop growth and nutritional status. Internationally shortage of standard legislation, protocol for manufacture, use, export, import and information regarding fate, behaviour, ecological risk of Nano pesticides

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Climate Based Planning for Smart City Development

Guhan V and N. Kowshika

Article ID: 27

Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore - 641003
Corresponding Author: guhanthiran@gmail.com

Introduction

The urbanization is one the important factor for changing climatic conditions. Rapid climate change under strong convective extreme weather makes the city so extreme panic stricken, the rising sea level, city level turbulence, waterlogging, cold heat, precipitation mutation and storm and so on become a city's unbearable.

India is ranked sixth among the ten most affected countries in the world as per the Global Climate Risk Index 2016, and accounts for about seven per cent of the global Greenhouse Gas (GHG) emissions. It is therefore a crucial actor when it comes to dealing with climate change related issues.

Although the temperature rise has a long time background, but other climate factors on the prediction of climate change trajectory, the climate of the city cannot change traditional wisdom to deal with regulatory capacity, city development is facing all kinds of new difficulties, adapt to the bearing capacity of the same generation change, in order to breaking the predicament, the construction of climate change, can adapt to climate change and self-adjustment, sustainable development of smart city is the best choice of smart city, construction and development planning of the smart city.

The support for the smart city planning from the smart meteorology

With the global smart city's construction and development planning push forward steadily, the intelligence meteorological service smart city development research has become a hot spot. Meteorological development planning, clearly clarify the development of ideas like wisdom weather, put forward to promote the integration of meteorological and smart city, intelligent transportation, smart agriculture and other fields by information technology, make the meteorological modernization to a higher level, for the society and city development, public management and decision making the production and livelihood of the people, with fine, professional, personalized inclusive meteorological domestic policies and actions to address climate change, climate change related issues research topics and hot issues, which provides a strategy reference for climate change to the wisdom of the city development planning.

Blakely suggest that "research on the natural risk of climate change and the relationship between urban design must be applied to the research area such as the geographical position, the development scale and the assessment of new natural risks in residential communities that are threatened with climate change. Each urban area must estimate its potential risk type to formulate the corresponding urban design policy. All over the word, in an effort to improve the meteorological intelligence level, the development of

high resolution and fine weather service user location and prediction based on requests, improve the weather forecast service targeted, accuracy, response to climate change to meet the city disaster prevention and reduction of the city planning and development needs and other needs of the public.

Green paper on climate change suggest that local government of urban construction management has paid great attention to the trend of climate and its consequences in urban construction and planning city planning at the national and provincial meteorological data meteorological intelligence internet service, the local meteorological historical data, real-time data using cloud computing data analysis of climate change and its use of data to draw the actual climate and its variability data, to guide city development planning.

Smart city planning concept of replying for climate change

Nowadays, the technologic revolution and its application in the city have greatly improved the level of smart city. Smart city planning based on big data, cloud computing and other new generation support has brought great changes to the methods and models of urban governance, and it improves the comprehensive operation efficiency and management level of the city; relying on remote sensing cloud technology to integrate spatial data resources, geological information resources and climate data resources for urban planning, so as to scientifically construct urban three-dimensional planning system.

Smart city planning can use data intelligence to enhance the city's scientific management capacity of smart cities in climate change, implementing effective management of smart cities in climate change. Climate change poses a major problem in urban construction, urban planning and urban management. As far as urban planning is concerned, the past planning awareness, planning experience and planning methods have been unable to cope with all kinds of problems caused by climate change. Urban planning and management department, urban planning agencies and urban planners should plan as a whole with urban's function, urban's environment with the core technology and wisdom of the city with climate change awareness, focus on adapting to climate change the city bearing capacity of disaster prevention and mitigation capacity planning and climate change in the future of city planning.

Climate change and meteorological data has been the attention of scientific research of city planning, but the trend and the consequences of climate change have far more than expected, at present, the city planning is a serious shortage of capacity of climate change, city ecological is very fragile, and it looks weak under bad weather conditions. Smart city planning to dealing with climate change, it must be studied combing and integration of information on climate change, to make judgments in the future climate change trend, In combination with the wisdom of the city's networking, cloud computing, big data, 3S(GIS, GPS, RS) and so on a new generation of communication technology research and scientific and reasonable layout and application to lead the city construction to achieve things and objects, objects and people, people and people interoperability, enhance the intelligent perception of climate change and climate information for comprehensive utilization, realize the city's efficient government management, convenient public services and sustainable industrial development.

Smart city planning to tackle climate change should begins with four main aspects. First, energy saving and emission reduction should be optimized to mitigate climate change; to effectively regulate the use of energy sources and the supply side; to reduce greenhouse gas emissions; to strengthen urban greening level and improve urban carbon sequestration capacity. Second, according to the climate change tendency, the bearing capacity of scientific and predictability of city planning increasingly frequent extreme weather events, including sea level rise, heat, cold, drought, flood, typhoon, dust storms and other kinds of weather disasters. Third, create the future deployment of smart city strategic intelligence meteorological public cloud platform for city disaster prevention and mitigation and adaptation to climate change planning and construction to provide a full range of seamless weather information service for the society and the public. Fourth, make full use of smart city technology and develop smart city technology, build big weather data "incubator", intelligent induction, monitoring climate development and change situation, feeding back the optimization and dynamic adjustment of urban planning.

In the smart city planning, we should treat the planning with universality and particularity differently, and make concrete analysis of the specific problems of different cities. We should have foresight and local conditions to plan the wisdom of different cities. Different city with different geographical climate meet the phenomenon is not the same, basic research must be based on the overall environment and environment of city long time of gas changes, make scientific judgments on the climate phenomenon of current and future trend of climate change, rational planning of new phenomena by climate, incubation of new formats, to avoid adverse climatic factors and the measures of city planning, the formation of facing the future climate change. As far as China's urban planning is concerned, the mountainous areas in Southwest China have large rainfall, high mountains and steep slopes, landslides, debris flows, and changes in the water level of the river bed, all of which are sensitive climate problems and special coping plans; city waterlogging, disaster problems of extreme weather events caused by the southeast coast, is the implementation of drainage tunnel engineering and wind engineering planning; city planning for urban heat island effect, by reducing the density of population, the development of small and medium sized city planning, avoid the problem of population density.

Conclusion

Taking climate research and its results as the center, and with meteorology, environment, economics, ecology, sociology and other disciplines to promote the sustainable development of smart city planning.

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Remodelling of Indian Agriculture to Execute Food Security After COVID19

Jyoti Prakash Sahoo
Article ID: 28
Ph. D Research Scholar, Department of Agricultural Biotechnology, College of Agriculture, OUAT, Bhubaneswar – 751003
Corresponding Author: jyotiprakashsahoo2010@gmail.com

The coronavirus pandemic is a general health crisis with grave ramifications for the number of inhabitants on the planet. India has been unfavourably affected by progressing health emergency, particularly poor people and marginal people. Nonetheless, there is a moderately low comprehension of socio-economic development. This pandemic is a worldwide health emergency and can likewise prompt the food security emergency in India if right measures are not taken. In India, it is basic to limit the unfavourable impact and interruption of vocation of poor people and marginal people. In spite of the fact that provisions of staples, natural products, vegetables, and meats have been sufficient during the COVID-19 episode up until this point, still there are dangers to food security, in the long haul. Limitations on transportation and development of individuals have just prompted some food calculated difficulties. However, the effect of the flare-up will overflow to food handling businesses, which have suspended creation. Flexibly of prepared food remains generally inexhaustible for the present, yet creation might be influenced by a labour crunch and falling interest for agrarian items. As ranchers are as of now battling to collect and exchange perishables because of deficiency of workforce, transportation, restricted market tasks.

The coronavirus pandemic may almost certainly have a broad and long-haul effect on the farming business. It might be hard for the focal just as state organizations to convey any further sponsorship because of constrained financial breathing space, which may additionally diminish because of other financial elements. Albeit no generous information is accessible on the degree of the effect of the present pandemic on the rural segment, yet there is no denying to the way that the current calamity won't extra the Indian Agriculture. Comprehensively the drawn-out effect would essentially be because of a decrease popular in view of financial plunge. It might be hard for the focal just as state organizations to convey any further support because of constrained monetary space, which may additionally decrease because of different financial components.

India needs to make more cooperative energies in food innovation, agribusiness and biotechnology. Organizing and adaption of advancement should go about as primary drivers of efficiency development and improved supportability. The progressing across the nation lockdown should be looked into and supplanted with bunch indicated limitations (as required) in light of epidemiological evaluation, as there is no possible situation of control or disposal in a brief period. An interdisciplinary group of general health authorities and social researchers, alongside grassroots political and social initiatives and volunteers, should keep

bringing issues to light about the COVID-19 methods of transmission and strategies for counteraction in the network.

In the midst of the flow pressures of COVID19, seeds and other inputs must arrive at ranchers in time for kharif season. Robotized machines ought to be presented for the planting of seeds which need just a machine driver for planting and reaping. Indigenous assembling of robotized machines ought to be elevated by the legislature to chop down the general expense. Appropriations ought to be given to the makers of such machines with the goal that ranchers can get them at prudent costs. Encouraging Genetically Modified Organisms (GMOs), utilizing hereditary building is another method of adding to food and nourishment benefits while boosting farming creation other than diminishing a post-reap misfortune.

Updating rural activities is fundamental. Hence, there is a need to comprehend the separate job of government and private division in fortifying agribusiness and encouraging the reception of increasingly percipient practices at the homestead and agro-food firm level. In any case, there is as yet an enormous absence of Research and Development (R&D) in associating spots to discover the solid connection among agriculture and sustainability. Time requests us to put resources into broad R&D for beating hindering, squandering and different types of ailing health. An elevated level of mindfulness is fundamental at all levels. Critical research joining Indian information and situations, needs to build models for India and viable social insurance plans, which will be useful.

Hydroponics – An Innovative Approach of Green Fodder Cultivation

E. Sujitha
Article ID: 29
Institute of Agriculture, Tamil Nadu Agriculture University, Kumulur, Trichy
Corresponding Author: sujitha047@gmail.com

Introduction

Green fodder feeding to livestock ensures optimization of productivity. Though India is the top producer of milk in the world insufficient livestock feed, fodder is one of the constraints affecting growth, health, production and reproduction potential of livestock. Green fodder is essential to feed livestock but the reduced availability of land, lack of water and more labour requirement. It is become difficult to produce required quantity green fodder throughout the year also; the lack of quality fodder hampers the growth production and reproduction of livestock. Novel approach called Hydroponic fodder would be the best solution for the fix. In this technology green fodders produced by growing seeds without soil, and with very little water, within six-seven days the seeds are sprouted the seedlings will be up to 30-35 cm tall and provide a highly nutritious feed.

What is hydroponics?

The word hydroponics has been derived from the Greek word 'water working'. Hydro means water' and ponic means 'working' and it is a technology of growing plants without soil, but in water or nutrient rich solution for a short duration in an environmentally controlled houses or machine.

What are the requirements for hydroponic fodder production?

- 45 square meter area for production of 1000 kg of green fodder daily
- Hydroponic machine
- Uninterrupted power supply
- Clean water
- Seeds with good germination capacity
- Good sanitation
- Two labours

Construction of Hydroponic fodder system

Temperature and humidity are the two important parameters to produce good quality fodder. The fodder easily grows in semi-controlled environmental conditions with the temperature range of 15-32 °C and relative humidity of 80-85%. However, light also plays an important role in production, therefore light can be control through construction of small shed net or a low-cost greenhouse. Shade netting or gunny bags also used as covering material for the structure.

Construction

- According to demand, size of hydroponics system can be desired. Mostly 10 ft x 10 ft shade net were used and it is better to choose near to the livestock shade for easy operation.
- Ventilation is to avail for easy maintenance of the temperature and humidity.
- Tray of about 1.5 x 3 ft with perforation is needed, must be made up of good plastic and strong enough to hold the weight of the fodder.
- The shed can be made up of bamboo rack, plastic rack or metal rack to hold the trays and limited to four layers.
- Maintain enough space between the layers with slight slope for easy drain of water

Hydroponic fodder production process

Good quality seeds should be used for germination. Seeds such as maize, pulses, wheat, and horse gram can be produce through hydroponic fodder system except pearl millet and sorghum seeds because these sprouted leaves harmful for livestock. In cold regions wheat and oats seed are good, while in hot regions maize where suitable for hydroponic fodder production.

Process

- Add a 5-7 liters warm water in a bucket which has seeds and remove the floated seeds and other impurities.
- After that add 50 -100 gm salt and make it dissolved in water which will helps to minimize chance on fungus production on sprouted seed.
- Remain the seeds in soaked condition for around 12 hours. Then drain the water and wash with clean water.
- Transfer the washed seed in a gunny bag and allow them to sprout. In a cold climate, it will take more than 24 hours to germinate while in a hot climate the seed will take about 24 hours to get sprout.
- Wash the trays properly and check for blockages of holes.
- Evenly spread the transfer sprouted seeds from the gunny bags to trays and place the trays on the rack in the shade net or greenhouse.
- Sprinkle the water to the sprouted seeds every day. In hot weather conditions sprinkling to be done at every two hours, and in cold weather condition for every 4 hours it helps to maintain moisture.

Maintenance

- Periodically clean the shed and avoid the chance of fungus and moulds development
- Do not disturb the sprouted seeds in the trays until the harvest because it will influence the growth of the fodder.
- Within a week can harvest eight kilograms of fodder from 1 kilogram of seed. Therefore, arrange the tray based on the demand. Because well planning would not disturb the system.

Feeding of Hydroponic Green Fodder

- Take out fodder slabs form the tray after six to seven days and make into small pieces before feeding it to the livestock, so it will reduce the wastage
- Avoid remain the fodder for more than nine days in the trays because the nutrient value of fodder starts to decrease slowly and fibre start to develop.
- It can also be feed along with the other food.

Advantages of hydroponic fodder

1) *Nutrient Value*

Hydroponics fodder has more nutrient than traditional fodder. It contains high carbohydrate, minerals, and vitamins.

2) Time to grow

Compared to traditional fodder which often needs up to two months to grow you can grow hydroponic fodder in just one week

3) Less water requirement

Only 3 to 4 litters of water is necessary to grow one kilogram of hydroponic fodder on other for traditional fodder approximate 15 -20 litter water required.

4) Easy daily production

Hydroponic fodder can be produced on a regular basis throughout the year even when there is a water crisis.

5) Chemicals or pesticides

It does not require any Chemicals or pesticides to produce

6) Less workforce and Transport cost

It needs only less workforce and transport cost.

Conclusion

For the sustainable dairy farming, quality green fodder should be a fed regularly. Hydroponic fodder is a good option in front of the farmer because it grows fast, it contains a high nutrient value, and the most important thing is animals keen to have.

Spodoptera frugiperda: An Emerging Pest of Maize

Babita Bhatt[1] and Anjali Joshi[2]

Article ID: 30

[1]*Department of Entomology, GBPUA&T, Pantnagar*
[2]*Department of Genetics and Plant Breeding, GBPUA&T, Pantnagar*
Corresponding Author: babitabhatt91@gmail.com

Introduction

Maize (*Zea mays* L.) being monoecious in nature is the third most widely cultivated crops in the world after wheat and rice. It is also known as queen of cereals. In Indian context maize is grown throughout the year but is predominantly a *kharif* crop covering 85% of the total area under cultivation in this season. Owing to its higher adaptability it is capable of being grown under diverse environments including tropics, sub tropics and temperate regions. Though highly adaptable to diverse agro climatic zones, maize is frequently affected by a number of biotic and abiotic stresses which are responsible for markedly affecting its quality and quantity. Among biotic stresses insect pests are the major factors affecting the quality of maize crop. The crop is attacked by various insect pests at different crop growth stages. *Chilo partellus, Sesamia inferens, Helicoverpa armigera, Aherigona orientalis, Calocoris angustatus, Myllocerus spp., Pyrilla perpusilla, Rhopalosiphum maidis* and *Peregrinus maidis* are some insect pests attacking maize crop.

Besides, all these insect pests, *Spodoptera frugiperda,* fall armyworm (Noctuidae: Lepidoptera) is a newly introduced insect pest attacking maize crop throughout the country. It is a native of North America. A study revealed the Southwest monsoon winds and the strong flight capacity of this pest to be responsible for its spread from African continent to Indian continent every year from June to September. Thus, this pest was reported from India in June, 2018 in the maize growing fields of Karnataka. Further in the month of August this pest was reported from 15 districts of Maharashtra. It has also been reported from the sugarcane growing fields of Tamil Nadu. Presently, this notorious pest is seen attacking various crops in almost all the states and union territories of country thereby, assuming the status of major pest of corn throughout India.

Host Range

Spodoptera frugiperda (fall armyworm) is a polyphagous pest attacking more than 300 plant species including cereals, forage grasses, ornamental and vegetable crops. The most preferable host are the crops belonging to Gramineae/Poaceae family including sweetcorn, maize, sorghum, millets, sugarcane, wheat, rice etc. These larvae acquire an armyworm habit when they are large in numbers thereby consuming all the vegetation in their path. Several weed plants such as *Digitaria spp*., *Agrostis spp.*, *Sorghum halepense*, *Cyperus spp.* etc. are also the host crop of this insect pest.

Identification

The pest completes several generations in its life cycle depending upon the climatic conditions. At a temperature of 15^0C to 30^0C a single female moth lays dome shaped eggs on the underside of leaf or on the inner side of the leaf whorl in maize crop. These eggs are loosely covered with pale yellow coloured hairs. After egg hatching (usually 2 to 10 days) initial larval instars of fall armyworm larva are green in colour with black head. At latter stages the dorsal surface of larvae develops brown colour and lateral white lines are formed. It also has an inverted Y-shaped mark on its head and four dark spots that form a square towards the end of its body on 8^{th} and 9^{th} abdominal segments. The larval body lacks microspines giving it a smooth appearance when it is touched. This pest usually has six larval instars while occasionally it may have five also. The larva enters into pupation in the soil by burrowing about 2-8 cm soil surface. The fully formed male moth is brown with triangular white spots at the tip and near centre of the wing. In female moths the forewings are less distinctly marked. The adult moths are nocturnal and they live for about 12-14 days.

Nature of damage

The young larvae feed gregariously and damage the leaves by scrapping the epidermal layer of leaves leaving behind a silvery transparent membrane. Older larvae cause an extensive damage by feeding on the leaves and leaving behind only the midrib and stalks of the plant. The larvae reduces the growth potential of plant by burrowing the growing point such as buds, whorls etc. of the host plant. The fall armyworm larvae may also burrow through the husk on the side of the ear of corn plant and feed on kernels. Cannibalistic nature has been observed in second and third instar larvae therefore, usually one or two larvae are present per whorl.

An attack by this pest at an early stage of plant may result in high plant mortality leading to huge yield loss. In Africa, this pest in the year 2017-18 resulted in the monetary loss of US $2 billion putting the food security at risk in this continent. In India in the year 2019, outbreak of *Spodoptera frugiperda* in maize field of 122 villages in Mizoram lead to a loss of Rs 20 crores. This pest is considered as a threat to global food security in India since this notorious pest is expanding its host range from maize to sugarcane.

Management

Ploughing the field exposes the larvae and pupae thereby making them vulnerable to adverse environmental conditions and causing their mortality. Intercropping with suitable crops such as legume crops (beans, soybean and groundnut), habitat manipulation and maintaining or restoring the soil organic carbon content can also be adopted. Mechanical methods include hand picking of the egg masses and caterpillars. Neem, cymbopogon and pyrethrum are some of the botanicals that are effective in managing this insect pest population. Entomopathogenic fungi such as *Beauvaria bassiana* and *Metarhizium anisopliae* are effective against egg and second larval instar of fall armyworm. Virus based insecticides mainly belonging to Baculovirus group such as multiple nucleopolyhedrovirus (SfMNPV), entomopathogenic nematodes (*Steinernema feltiae, S. carpocapsae* and *S. riobravis*) parasitizes the larval instars and have a high potential for managing this pest. Chemical

protectants such as cypermethrin, permethrin, lambda cyahalothrin, emmamectin benzoate and malathion have recommended to manage this pest. However, these insecticides produce several adverse effects on environment, soil and non-target organisms (humans and natural enemies) therefore it is desirable to use ecological control (cultural, mechanical, botanicals, biopesticides) to manage this insect pest.

Conclusion

Enormous loss both in terms of quality and quantity have been reported by this insect pest throughout the World. High host range of this insect pest raises the concern to manage it at an early stage by adopting suitable Integrated Pest Management programme for maize crops. Future concern should be on working at Host Plant Resistance aspect of insect pest (*Spodoptera frugiperda*) management so as to develop a greater number of resistant varieties against this polyphagous pest and minimize the loss caused by it.

Carbon Sequestration Via Agricultural Management Practices: An Extenuation Strategy to Climate Change

Sunil Kumar[1] and Rewangini Ranjha[2]

Article ID: 31

[1]*Department of Soil Science & Water Management, YSP UHF Nauni, Solan, H.P*
[2]*Dr. Khem Singh Gill Akal College of Agriculture, Eternal University, Baru Sahib, Rajgarh, H.P*
Corresponding Author: dukegarhwal@gmail.com

Introduction

Agriculture plays a very crucial role in the increase in global warming due to its great contribution to the emission of greenhouse gases and conversion of non-agricultural land such as forest areas and grasslands into agricultural land. There are drastic changes in the environment and the temperature has increased rapidly in a few years. The average surface temperature of Earth has been increased 1.3 degrees Fahrenheit over the past century and is predicted by the Intergovernmental Panel on Climate Change to increase by an additional 3.2 to 7.2 degrees over the 21st century (IPCC, 2007). There is 13-15% of global emissions due to direct farming activities only whereas 18-32% of global emissions is due to both direct farming activities + land-use change (Source: US EPA, 2006; FAO, 2006; Bellarby et al., 2008). The main contributor to global warming is CO2 gas and agriculture acts as both sources as well as a sink for carbon dioxide. Carbon quantity in the soil has a positive impact on the growth of plant, environment as well as on soil health. But increases quantity in the atmosphere has a negative effect on the whole planet. So, it becomes very important to fix the maximum quantity of carbon dioxide in the soil and the process through which the atmosphere carbon dioxide is removed and stored for a long term in the soil reservoir is known as carbon sequestration.

Sources of CO_2 Emission in Agriculture

There are three main sources which results in CO_2 emission in agriculture: land-use changes and soil degradation that have direct influence on soil carbon reserves; direct use of fossil fuel in the farm for tillage, grain drying, harvesting, farm machineries like tractor and CO_2 on-farm transportation; indirect emission due to use of fossil fuel for manufacturing of fertilizers, pesticides, etc.

Soil as a Sink for Carbon / Soil Carbon Sequestration

Soil is considered as the largest carbon reservoir of the terrestrial carbon cycle. Soil contains approximately ten times (0.3%) of carbon than the atmosphere (0.003%). The carbon is naturally restored by the plants from the atmosphere through photosynthesis. Besides, the natural growth of plants, other carbon sequesters are vegetation cover, forest, land management practices, etc.

Carbon Cycle

The land which is not disturbed for a very long period of time such as forest has stable carbon cycle. This means that there is a balance between the amount of carbon captured by the soil and the release of carbon into the atmosphere. But when the forest area is converted into the cultivated land large amount of organic carbon is converted and released into the atmosphere as CO_2 gas.

In the farm system, CO_2 is absorbed by the plants through the atmosphere by the process known as photosynthesis. Some amount of carbon in the plant is converted into sugar, carbohydrates, cellulose as an energy source and rest of carbon remains in the plant which is removed from the system when the crop is harvested. Besides this, some of the carbon ends up in the soil which is again converted into CO_2 with the help of microbes and released in the atmosphere by the process known as soil respiration. This cycle is the same for all the crops but only the quantity of carbon varies. This is because there are numerous factors which affect carbon quantity such as climate, type of soil and crop.

This cycle became complex when there is the adoption of mixed farming by the farmers. In mixed farming, farmer cultivates the crop along with livestock. Therefore, there are two main sources of carbon emission i.e. by the crops and through livestock. The crop residues which are also the source of carbon emission are used for mulching and as a feed. With the passage of time, there is the decomposition of the organic mulches results in CO_2 gas emission. The livestock also releases CO_2 through respiration and some through their products like meat and the significant amount of carbonates returned to the soil through manure application.

When there is a change in the farming practices to increase the amount of organic carbon in the soil then a large amount of carbon is fixed by the soil with the help of plants. That means soil stores more carbon than it emits and this process is known as “carbon sequestration” and such agricultural soil is known as “carbon sink”.

Carbon Farming

It is the technique of implementing those approaches in agriculture which are believed to rally the capacity of soil to restore the carbon and minimize the rate of carbon emission through agriculture practices. There are almost 32 carbon farm practices which help in carbon sequestration and few of them are Crop Residue (Mulching) and Tillage Management, Compost application, No-Till/Strip-Till/Direct Seed, Anaerobic Digester, Multi-Story Cropping, Windbreak/Shelterbelt Establishment, Forage and Biomass Planting, Nutrient Management, Tree/Shrub Establishment, Contour Buffer Strips, Vegetative Barrier, Windbreak/Shelterbelt Renovation, Alley Cropping, Wetland Restoration, etc.

Effect of crop residue (mulching) and tillage management on carbon sequestration

The process of covering the soil surface with crop residues, grasses and plastic material is known as Mulching. Crop residue or Mulching is the best agriculture practice to conserve soil moisture and soil organic carbon, maintain soil temperature and improve soil

quality. The crop residue management helps in soil organic carbon sequestration and maintain soil structure which is directly controlled by the use of crop residue's quantity, quality, type, soil properties like soil type, slope gradient, water holding capacity, amount and type of microorganisms to decompose crop residues (earthworm, bacteria and fungi), tillage practices and environmental factors. The tillage practices have a more direct effect on the soil structure than the application of crop residues also studied by Sharratt (1996).

The long-term application of crop residues along with tillage practices such as minimum tillage, zero tillage or no-tillage helps in carbon sequestration and reduces soil erosion. The intensive use of tillage practices breaks soil structure and reduce soil carbon sequestration by removal of crop residues from the upper layer of soil surface. The carbon sequestration may be higher at lower depth due to alteration of residues from the upper layer to lower layer by tillage. The conservation tillage improves soil carbon sequestration better than conventional tillage due to covering 30 % of soil surface area with crop residue.

Effect of cropping system on carbon sequestration

The cropping system is cropping pattern or arrangement of different type crops in per unit area with its proper management. The cropping system aims to achieve sustainable production and more profit per unit input. The cropping system helps to restore soil organic carbon, maintain soil nutrient status, reduces erosion. The cropping system has huge potential to reduce carbon dioxide concentration from the atmosphere via plant respiration and carbon stored in the plant which helps to mitigate climate change. The carbon sequestration can be improved by the use of an idyllic cropping system which should produce the maximum amount of biomass or organic carbon. To enhance biomass production, one should use cover crops, intercropping, multi-storeyed cropping, mixed cropping, crop rotations and legume crops.

The biomass production and soil carbon sequestration can be enhanced by Crop rotation. The most beneficial crop rotations are legume crops with non-legume crops as legume crops require less amount of fertilizers as compare to non-legume crops. The Legume crops restore or enhance soil fertility by fixation of free atmospheric nitrogen and more biomass production. If appropriate crop rotation is not used then soil productivity and biomass production will be reduced due to an increase in weeds, diseases, and pest infestation.

Intercropping can increase the crop yield due to higher utilization of sunlight with a sufficient spatial distribution of various type of plant geometry. Different type of Intercropping like row intercropping, strip intercropping, mixed cropping and relay cropping is used according to crop geometric and its requirements for nutrients, water, temperature and space. For example, inter-row cropping of complementary crops such as Jowar + Lobia, Jowar receives nitrogen from Lobia and in return, sorghum provides support to Lobia. So, intercropping provides more biomass than mono-cropping and enhances soil carbon sequestration.

Effect of nutrient management on carbon sequestration

The nutrient management has a direct or indirect impact on agriculture production (biomass and yield), soil fertility and productivity, soil physical, chemical and biological properties. The integrated nutrient management or organic farming plays an important role in soil carbon sequestration and biomass production without degrading soil health. The integrated nutrient management is the combined use of organic and inorganic fertilizers. The use of inorganic fertilizers in agriculture leads to emission of GHGs and decrease microbial activity in soil but also improves growth and productivity of the crop. The INM is better for sustainable crop production and maintains soil fertility. The organic fertilizer increases organic matter in the soil, which acts as the main source of carbon and improves soil physical, chemical and biological activity. The combined application of crop residue and organic fertilizer helps in carbon sequestration, improve labile carbon pool and mitigate climate change.

Effect of improved crop varieties on carbon sequestration

The selection of high yielding or improved varieties of different crops should be done according to nature and characteristic of varieties. This can provide high biomass at both above and below ground level and also improves the soil organic carbon status. Machado et al (2006) stated that crops which have enormous rooting system can improve soil carbon status. Similar results were also reported by Kell (2012) that, the vast roots in agriculture crops can store more soil carbon for a long time. This all specifies that the use of improved crop varieties having wide-ranging root systems and better production can upsurge both yields and soil fertility status.

Effect of agroforestry on carbon sequestration

The cultivation of agriculture and forestry in combination is known as Agroforestry where agricultural crops are grown with perennial trees and bushes. Agroforestry can enhance soil carbon sequestration in croplands. Agroforestry has more potential to store carbon than sole-cultivation of forest and grassland because it grows both agriculture and forest crops together in the same piece of land. The conversion from agriculture land to agroforestry considerably enhanced the carbon stock of 26 %and 40 % at 0–15cm and 0–30cm, respectively. Wang et al (2010) reported that alteration from grassland to agroforestry increases soil organic carbon 9 per cent at 0–30 cm and Conversion of fallow or other lands into agroforestry improved soil carbon 25 per cent at 0–30 cm and decline 23 per cent at 0–60 cm.

Uses of soil carbon sequestration

- It helps in decreasing the emissions of CO_2.
- It helps to reduce the releases of different GHGs.
- It helps to maintain atmospheric temperatures by reduction of GHGs.
- It improves the biotic and ecological environment. So, microorganisms can maintain soil health and productivity by enhancing nutrient availability to plants and reducing soil losses.
- The agriculture sector is the main component for emissions of GHGs but it can sustain the emissions of GHGs by adopting appropriate agronomic practices.

- The agriculture soils are a good sink for carbon sequestration and it helps to reduce the adverse effect of GHGs on climate change because soils have high organic matter and can conserve more CO_2 sequestration.

Summary

Increase in the carbon concentration is an alarming concern for today's world, as it is one of greenhouse gas which results in global warming. One of the best solutions to this situation is carbon sequestration through agriculture. It means that carbon can be restored by the soil more than what it emits and this can be done through land management practices and various carbon farm practices. Hence soil act as both source as well as a sink for the carbon. In terrestrial carbon sequestration, carbon cycle plays a very crucial role and it is similar to all the crops. Only the variation is in quantity of the carbon that is fixed by the soil which is affected by climate, soil and crop type.

Impact of Subsidies on Agriculture Sector in India

Sanjeev Kumar

Article ID: 32

Ph.D. Scholar, Department of Social Sciences, Dr. YSP UHF, Nauni, Solan, Himachal Pradesh, India
Corresponding Author: sharmask93@rediffmail.com

Introduction

Agriculture plays a vital role in India's economy. About 55 per cent of the rural households depend on agriculture as their principal means of livelihood. The share of agriculture and allied sectors is about 18 per cent to the country's GDP (Anonymous, 2019-20). On the eve of independence, the Indian agrarian economy was critical in situation as the country was left with only 69 per cent of land under rice, 65 per cent under wheat and 75 per cent under all cereals to the 82 per cent of total population of undivided India (Chahal, 1999). In view of this, after independence, the Government of India adopted a positive approach and played vital role in development of agricultural sector. Tremendous efforts were made to boost the Indian economy through a well-defined policy of integrated production programmes with defined targets and a proper distribution programme was adopted along with other measures. The new technologies were used which included the use of high yielding varieties, assured irrigation, chemical fertilizers, insecticides, pesticides and machinery to increase the food production ith country. But, in modern technology, the inputs were very costly and Indian farmers being poor are not in a position to buy these expensive inputs. Therefore, on the recommendations of Food Grain Price Committee (Jha Committee, 1964), the Government of India started the scheme of subsidies on the purchase of various agriculture inputs to facilitate the farmers (Singh, 1994). Agricultural input subsidies have long been used to promote smallholder farmers' use of inputs, increase wages, reduce food prices and promote economic growth. Since many years, the Indian government has been providing input subsidies to agriculture sector in direct and indirect form for encouraging agriculture production.

Subsidies

The word subsidy has been derived from the Latin word '*subsidium'* which implies coming to assistance from behind. A subsidy is defined as a form of financial assistance paid to an economic sector (institution, business or individual) in order to achieve certain policy objectives, which means that any monetary exchange which is not directly connected to paying for a service can be defined as a subsidy (Salunkhe and Deshmush, 2014). The subsidies appear on the expenditure side and taxes appear on the revenue side of government budgets. While the taxes reduce disposable income, subsidies inject money into circulation. Any government provides subsidy keeping in view the objectives (1) to create a wedge between consumer prices and producer costs, (2) induce higher consumption/ production, (3) to achieve social policy objectives including redistribution of income, population control, etc. and (4) to promote general welfare (e.g. housing, sustenance). According to Fan *et al*., (2007), subsidies in agricultural sector can play an important role in early phases of agricultural development by addressing market failures and promoting new technologies. In

India, for overall development of agricultural sector, central as well as state governments are providing subsidies on fertilizers, irrigation (canal water), electricity and other subsidies to marginal farmers and farmers' cooperative societies in the form of seeds, development of oil seeds, pulses, cotton, rice, maize and crop insurance schemes and price support schemes etc. The Department of Agriculture & Cooperation, Government of India, has been implementing various schemes and programmes under which these subsidies are provided for the benefit of farmers through State Governments. Rashtriya Krishi Vikas Yojana (RKVY 2007), National Mission on Agricultural Extension & Technology (NMAET 2010), National Food Security Mission (NFSM 2007), Mission for Integrated Development of Horticulture (MIDH 2014), National Horticulture Mission (NHM 2005), National Mission on Oilseeds and Oil Palm (NMOOP 2010), Cotton Technology Mission (CTM 2000) are some of the schemes being implemented to help the small and marginal farmers reduce their cost of cultivation, increase profit and encourage diversification among them. The subsidies under various schemes are given in the form of inputs such as seed, fertilizers, plant protection materials, farm machinery, micro-irrigation units and credit.

Review of Literature

The agriculture subsidies are the integral part of the farmers of India and are very important for the growth of farmers and overall agricultural development in the country. Farm subsidies have the direct effect of transferring income from the general tax payers to farm owners. Many researchers have presented their views on the impact of subsidies on Indian agriculture sector at national and internal national level. Sinha and Prasad (1982) in their study on impact of subsidies on agricultural productivity, income & employment revealed that the cropping intensity on beneficiary farms increased from 154 to 160 per cent after using the subsidy and there was increase in productivity of the farms. Sharma (1990) revealed in his study that subsidies have become unsustainable. In order to release resources for higher investments in the agricultural sector, large scale price and institutional reforms are needed to relieve the pressure of subsidies on the exchequer. Gulati and Sharma (1995) in the analysis of input subsidies in Indian agriculture revealed that subsidies have outlived their aim and have become unsustainable. The author further stated that, in order to release resources for higher investment in the agriculture sector, large scale price and institutional reforms are needed to relieve the pressure of subsidies on the exchequer. Howes (2002) studied the distribution pattern of electricity subsidy in farmers of Karnataka State and concluded that electricity subsidies were regressive because large size category farmers were much more likely to have pump sets than small size category farmers and because large size category farmers with pumps use more electricity than small size category farmers with pumps. The author suggested that electricity subsidy should be given to only small size category farmers. Jain (2006) made an attempt to analyze the existence of disparities in the flow of electricity subsidy between the progressive and backward areas of Punjab and showed that the proportion of farmers having electricity connections in the progressive area was 51 per cent higher than the backward areas. The author also observed that the provision of electricity subsidy has a negative impact on the sustainability of agriculture as it resulted in depletion of underground water. Fan et al. (2007) reviewed the trends in government subsidies and investments in and for Indian agriculture and found that recent years, input

subsidies (including fertilizer, electricity, credit, and irrigation) yielded very low marginal returns in both agricultural growth and poverty reduction, despite their large impact in earlier decades. The author suggested that to sustain long-term growth in agricultural production and therefore provide a long-term solution to poverty reduction, the government should cut subsidies of fertilizer, irrigation, power and credit and increase investments in agricultural research and development, rural, infrastructure and education. Promoting non-farm opportunities are also important. Sharma and Thaker (2009) examined the trends in fertilizer subsidy and revealed that there is existence of fair degree of equity in distribution of fertilizer subsidy among farm sizes. The small and marginal farmers have a larger share in fertilizer subsidy in comparison to their share in cultivated area. A reduction in fertilizer subsidy is, therefore, likely to have adverse impact on farm production and income of small and marginal farmers. Kaur and Sharma (2012) in a study concluded that the central government should adopt some criteria to give away subsidies to states either on the basis of gross cropped area or productivity. The author suggested that the subsidies which have direct relationship on productivity and income like seeds, fertilizers should be given to farmers and on the other hand, the subsidies on electricity can be withdrawn in Punjab to reduce State electricity board's burden and this amount can be used for production of more electricity, reducing the need of purchasing electricity at very high prices, which adds to the deficit of state finance. Sharma (2012) analyze the trends in volume of food subsidy during 1991-92 to 2012-13. The results showed that food subsidies had grown very sharply between 2006-07 and 2011-12, by more than 300 per cent and the subsidy components that are under the control of FCI i.e. administration charges, storage losses, etc. have shown some improvement during the last decade. However, there is further need to improve efficiency in operations of FCI. Salunkhe and Deshmush (2013) revealed that decrement in provision of funds in terms of agriculture subsidies in five years plan and annual budget is responsible for slow growth of agriculture in India and less contribution of GDP in country. Salunkhe and Deshmush (2014) concluded that subsidies play vital role in growth of agriculture sector in the country but due to corruption & ineffective management, it has not reached to the end users i.e. farmers. It was also found that due to illiteracy of farmer regarding agriculture subsidies, he/she can't take benefit in farming & faced financial crisis. Shivashankar and Uma (2014) reported that an ideal subsidy distribution based on the economic levels, size of the holdings, and fertility of the soil was not present. The large farmers were treated on par with the small and marginal farmers causing regression in the sectoral development. Anand (2016) studied the stakeholders' opinion on agricultural subsidies and their impact in Punjab and revealed that very less farmers were aware about the agriculture schemes providing subsidies whereas all the farmers were aware of the subsidies being provided in the areas of seeds, plant protection materials, machinery, micro-irrigation, power and price (MSP). The author concluded that lack of awareness of time of availability of subsidy, delay in release of subsidies and misallocation of the subsidies significantly affected the receipt of subsidy by a farmer. Shilpa and Benni (2017) stated that agricultural subsidies are boon for an agriculture economy whereas a bane to overall economy. They found that fertilizer subsides are relatively more, followed by electricity, irrigation and insurance subsidies.

Conclusions

Subsidies make both positive & negative impact on agriculture sector but without the help of subsidies development of agriculture sector is very difficult. However, the exact measurement of impact of subsidies on agricultural sector is not an easy task as up to which extent subsidies are beneficial to agricultural is a big question. Some researchers suggested that subsidies should be withdrawn in a phased manner, such a step will reduce the fiscal deficit; improve the efficiency of resources use, funds for public investment in agriculture. On the other hand, there is a fear that agriculture production and income of farmers would decline if subsidies are curtailed. Due to corruption & ineffective management in India, subsidies are not reaching to the end users of the country i.e. farmers. All these are very important issues and need serious investigation in future. The central government should adopt some specific criteria to give away subsidies e.g. making subsidy as transparent as possible, framing of farmers' friendly policy in distribution of subsidies, using subsidies for well-defined economic objectives, instituting systems for periodic review of subsidies etc.

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Cyanobacteria: A Potential Adaptability to Improvise the Soil Ecology Enhancing Soil Health

Abhishek Sen

Article ID: 33

PhD Research Scholar, Department of Soil Science and Agricultural Chemistry, U.B.K.V, Pundibari Coochbehar, West Bengal, 736165

Corresponding Author: connectabhishek1@gmail.com

Introduction

Blue green algae (cyanobacteria) are considered as the most primitive photosynthetic prokaryotes, they are supposed to have appeared on this planet during the Precambrian period which is possibly the are first photosynthetic microorganisms persisted over a period of two to three billion years can performing an important role in evolution of higher form. They are very susceptible to sudden physical and chemical alterations of light, salinity, temperature and nutrient composition

Important features of cyanobacteria

- Photosynthetic gram-negative prokaryotes
- It is commonly known as blue green algae conferred the capability to fix atmospheric nitrogen, phosphate solubilisation detoxifies heavy metals
- It decomposes the organic residue and terminate the growth phase of microorganisms in environment to mitigate the biotic and abiotic stress in plants
- It is also improve nutrient uptake and bioavailability to the plants
- These organisms also produce some bio-active compound that function as elicitor molecules which is beneficiaries for plant health and soil fertility by improving physico-chemical conditions of soil to maintain the complexity and diversity of ecosystem
- Enhance the soil methanotrophic diversity and methane sink strength in long term to protect the nature and natural resources
- It is also produce exopolysaccharide which is present in cyanobacterial biomass, can aggregate soil and accumulate organic component which can promote survival and growth

Plant growth promoting and nutrient use efficiency

Cyanobacteria are known to liberate a wide array of extracellular substances, Although, considered as obligate photoautotrophs e.g. plant growth regulators, vitamins, amino acids, sugars and other metabolites that have direct or indirect impact on plant growth and yields also there were a well-established role as nitrogen supplements and tolerance to desiccation that can be key players in carbon sequestration and improving nutrient use efficiency with higher crop yields (Mandal et al., 1999; Prasanna et al., 2008). A number of cyanobacteria that promote plant growth by IAA production which help in colonising the rhizosphere or the root and shoot systems and providing nutrients effectively but some of

them mainly which are phototrophic that grown as biofilms and produce exopolysaccharides which make them environmentally conducive for the growth of not only plants but also other beneficial microfauna and flora that maintain the soil ecology and provide the best fertility sources with higher range of productivity a longer periods.

Bioremediation

Cyanobacteria have been used efficiently as a low-cost method for remediating in various wastewaters by converting the dissolved nutrients into biomass (Lincoln et al., 1996) and for biotreatment (removal) of dissolved inorganic nutrients to allow them to be used as economic and low-maintenance remediation technology for contaminated systems. The beneficial application of cyanobacteria in remediation of contaminated waters in natural aquatic environments or industrial effluents, is still not optimally manipulated whereas like cyanobacterial specie such as *Oscillatoria salina, Plectonema terebrans, Aphanocapsa* sp. and *Synechococcus* sp, have been successfully used in bioremediation of oil spills in different parts of the world (Raghukumar et al., 2001; Radwan and Al-Hasan, 2001; Cohen, 2002). Blue green algae have been shown to be highly effective as accumulators and degraders of different kinds of environmental pollutants including pesticides, crude oil naphthalene, phenol, catechol in effective way to natural system.

Bio-fertilizers

Cyanobacteria fix atmospheric N_2 by forms of free-living and symbiotic associations with partner such as water fern *Azolla, cycads*, *Gunnera*, which are endowed with the specialized cells known as heterocyst–thick-walled modified cells which is considered site of nitrogen fixation by nitrogenise enzyme that is a complex which catalyses the conversion of the molecular N_2 into reduced form like ammonia.

Carbon recycling to improving CO_2 fixation by sequestration strategies

CO_2 from the industries are today's demand in order to reduce the impact of CO_2 on global warming so sequestration strategies adopted so far can be broadly divided into physical and biological mean where the physical means of CO_2 sequestration has disadvantages which having high costs associated with it thereby need to develop the suitable technologies for capturing, transporting and storing CO_2 are also very expensive processes so there for biological method of CO_2 sequestration is an alternative to physical method where the use of algae for CO_2 sequestration has several advantage to mitigating CO_2, the major source of global warming as well as producing biofuels and other interesting secondary metabolite where the one kilogram of algal dry cell weight utilizes around 1.83 kg of CO_2 . Annually around 54.9– 67.7 tonnes of CO_2 can be sequestered from raceway ponds corresponding to annual dry weight biomass production rate of 30–37 tonnes per hectare (Brennan and Owende, 2010). The main mechanism which is a multistep process of photosynthesis plants and algae (green algae and cyanobacteria) fix CO_2 into sugar using light and water as energy and electron source however the metabolic engineering has proven to be effective in rerouting fixed CO_2 from the CB cycle into a desired metabolic pathway, the incorporation of inorganic carbon is still heavily restricted at the initial steps of fixing CO_2 in the CB cycle. Where the availability of inorganic carbon is promoted by the spatial

confinement of CO_2 in the CCM which consists of three key components that hydrates and reduces atmospheric carbon into the CB cycle: RuBisCO, carbonic anhydrase (CA) and the carboxysome.

Soil enzymes activity control towards the soil fertility improvement

Soil enzymes are thought to be largely of microbial origin which are obviously associated with viable cells remain catalytic in cell debris in soil solution or completed with clay or organic colloids whereas the ecological role of cell debris and extracellular complexes enzymes is yet to be completely explored but hypothesized that humic–enzyme complexes may benefit some organisms by hydrolysing substrates are too large or insoluble for microbial uptake. Soils that have been managed to promote soil should have higher biological activity than intensively used soils that is reflected in greater enzyme production and possibly greater potential to stabilize and protect extracellular enzymes to forming soil enzyme complexes. Cyanobacteria, such as *Nostoc muscorum* and *Tolypothrix tenuis* that produce the extracellular enzymes which decompose organic residues (Hussein et al., 1989) are also used as inoculants to increase the polysaccharide content and microbial activity of soil.

Conclusion

It has great potential in soil ecology and fertility improvement strategy that can be modern tools in modern farming system in coming generation to overcome the food security and maintain the soil fertility over longer periods of time and some potential research should be need to conducted to greater applicability of the methods and its mechanism process to increase its efficiency.

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