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Growing seed

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Contents

AGRIALLIS
Science for Agriculture and Allied Sector: A Monthly e Newsletter
Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

EFFICIENCY OF MARIGOLD (*Tagetes* Spp) AS A COMPANION CROP TO DEBAR INSECT PESTS FROM THE BRINJAL ECOSYSTEM

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Pest herbivores debilitates the crops and results in the yield loss to a higher extent. Thus huge agricultural loss results into food scarcity and other socio-economic problems. Although modern crop cultivation science has adopted the biocontrol strategies for the pest killing, yet, when biocontrol fails, there is still reliance on chemical control for crop production and excessive use of chemical sprays result in resistant pest genotypes, phytotoxicity and pesticide residue problems. Injudicious application of broad spectrum pesticides results into toxic molecules entry into the vertebrate food chains and bio-magnification in the ecosystem. Thus alternative pest management strategies are adopted nowadays like use of trap crops or companion crops accompanying the main crop for the pest diversion. Companion planting is a form of intercropping, typically practiced in small-scale gardens and agricultural crop fields in which two or more species of plants are grown near each other for shared benefit. Mixed plantings with companion crops are established to boost crop productivity, diversify options for food and income generation, and improve gardens' resilience under difficult growing conditions.

French marigolds (Tagetes patula) and African marigolds (T. erecta) help to keep the insect pest away from the host plants.. It is thought that this is due to the exudates marigolds produce (thiopene and alpha-terthienyl) to stunt the growth of plants nearby which could be explained as a form of evolutionary competitiveness of marigolds over other plants. Wild marigolds Tagetes sps are highly toxic to the plant parasitic nematodes and are capable of suppressing wide range nematode pests. The plausible mode by which marigolds suppress plant parasitic nematodes is through the biochemical interaction known as allelopathy. The root exudates of marigold known to contain toxic bioactive chemicals having nematicidal, insecticidal, fungicidal, antiviral and cytotoxic activities.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

Reason for using marigold as companion crops

Marigold (*Tagetes* spp) is an excellent plant for the management of root knot nematodes, the bioactive chemicals secreted by the root exudates of marigold could effectively control the nematode population. Thus the use of marigold in nematode in nematode control is an environmentally safer and economically viable method. The roots of marigold were reported to contain flavonoids, di-hydroflavonoids, flavones and flavonones lacking a free OH group. The roots had also been reported to contain chemicals like amines, amides, phenols and ketones. More recently El-Gengaihi et al., (2001) isolated three nematicidal compounds using chloroform from Tagetes erecta, Tagetes patula and Tagetes minuta. These compounds included 5(- ent-1-ol)-2,2-bithienyl, sigma-4, 22-dien-3-beta-ol, and 5-(4- acetoxy-1-butenyl)-2,2-bithienyl. Alpha-terthienyl is heterocyclic sulphur containing compound usually abundant in Tagetes tissue. Gommers and Bakker (1988) proposed that in the absence of light, alpha-therthienyl is activated by root peroxidases synthesized when the plant parasitic nematodes puncture and penetrate the roots. Rotating the cash crop with marigold has been found to have similar effects as growing a non-host crop in reducing plant parasitic nematode population and thus may provide better efficiency than soil fumigant use to suppress nematodes.

Niall J. A. Conboy et al (2019) concluded that planting marigolds next to tomato plants protects the tomatoes from the glasshouse whitefly (Trialeurodes vaporariorum Westwood). If shown to hold true, this technique could be used in larger-scale tomato production, protecting the crop and helping to introduce greater plant diversity into these agro-ecosystems. Root (1973) ‘enemies hypothesis’ in reference explored top-down mechanisms. He proposed that natural enemy populations are greater in polycultures because diverse habitats provide a greater variety of prey and host species that become available at different times. Furthermore, the presence of a greater diversity of prey and host species allows natural enemy populations to stabilize in the companion marigold crops without necessarily debilitating the host population. According to Gupta and Bhandari,1975 , the essential oil of the leaves of Tagetes minuta was reported to contain d-limonene, ocimene, b-myrecene, aromadendrene, l-linalool, linalyl acetate, linalool monoxide, d-carvone, tagetone, 1:8 cineole and salicylaldehyde. However, Sharma et al., 1961 elucidated that the flowers of Tagetes erecta showed the presence of essential oils like d-limonene, ocimene, 1-linalyl acetate, 1-linalool, tagetone and n-nonyl aldehyde. The essential oil of the leaves, flowers and

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

stems of Tagetes patula was reported to contain ocimene, limonene, linalool, linalyl acetate and tagetone (Dhingra and Dhingra, 1956). The terpenes, a-pinene, b-pinene, dipentene, menthol and geraniol were reported in the essential oil of the leaves and flowers of Tagetes erecta (Baslas and Singh, 1980).

Marigold as a companion crop in brinjal ecosystem

Marigold could be grown as a companion crop along with the brinjal as the main crop. It could be seen that the pest population loads in the main crop get reduced due to the marigold companion crops grown around the main crop brinjal. Sucking pests like jassids, whiteflies and coleopteran pests like Epilachna vigintrioctopunctata get diverted to the companion crops from the main crops, as a result the main crop gets protection to a higher degree. However, it could be seen from the companion planting of marigold along with the main brinjal crop that the brinjal shoot and fruit borer Leucinodes orbonalis population (monophagous pest for brijal) also gets reduced due to the odour emitted by the marigold plant. The average percentage shoot infestation in the main crop brinjal during the vegetative stage of brinjal gets lesser when marigold is grown around the main brinjal crop. Also, the average percentage of fruit damage in brinjal by borer pest also seen to be less during the brinjal fruiting stage when brinjal is grown with marigold as a companion crop. Below shows the average pest population per plant of the jassids, epilachna beetle,white fly, % shoot infestation in main crop, % fruit damage in the main crop bronjal in summer brinjal (March 2018 to August 2018) in Gayeshpur, Nadia, West Bengal at twenty days interval

Dates of Observation	Main crop (Brinjal)				
	Jassids	Epilachna	whitefly	% Shoot damage	%Fruit damage
29.03.2018	4.00	2.00	5.00	2%	12%
18.04.2018	3.00	1.00	4.00	3%	15%
08.05.2018	3.00	1.00	6.00	5%	11%
28.05.2018	2.00	2.00	5.00	3%	13%
Dates of Observation	Main crop (Brinjal)				
	Jassids	Epilachna	whitefly	% Shoot damage	%Fruit damage
17.06.2018	3.00	0.00	5.00	4%	15%
06.07.2018	3.00	0.00	6.00	3%	20%
26.07.2018	4.00	1.00	5.00	5%	13%
14.08.2018	2.00	1.00	5.00	10%	17%

Table 1: The data in the tables shows the average population of pests (converted to the nearest whole number)

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

It could be seen from the table that the pest population per plant in the main crop brinjal was comparatively less than the average pest population per plant in the companion crop marigold during the summer brinjal crop. Also the companion crop marigold harbor quite a large number of natural enemy population like spiders, Coccinella beetle and Ants which predates on the insect-pest on the main crop. This experimental research was carried out at the Central Research Farm of the university, Gayeshpur, West Bengal (Geographical location- Latitude 23°N, Longitude 89°E, Altitude 9.75m MSL).

Yield of brinjal when grown with marigold

When brinjal is grown with the companion crop marigold, the high marketable yield of brinjal fruit is obtained. From the experimental research conducted above the marketable yield of brinjal for all the above date of observations revealed the following bar diagram for the summer brinjal crop (March 2018 to August 2018)

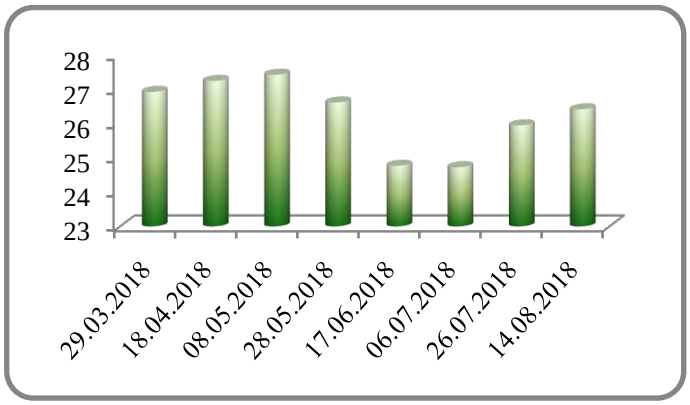

Figure 1: The bar diagram represents the marketable yield of brinjal (tonnes/hectare) on different date of observations.

The Figure-1 represents the marketable yield of brinjal (tonnes/hectare) on a different date of observations when grown with the companion crops marigold during the summer brinjal crop(March 2018 to August 2018). From the Figure-1 it could be revealed that on 29th March 2018, the total marketable yield of brinjal was 26.93 tonnes/hectare. The marketable yield of brinjal gradually increased till 8th May 2018 when it recorded highest marketable fruit yield of brinjal to the tune of 27.43 tonnes/hectare. Gradually the fruit yield of brinjal decrease thereafter when the least marketable fruit yield was recorded to be 24.73 tonnes/hectare on 6th July 2018. Then again the total marketable yield of brinjal fruits increased at on the last date of harvesting i.e. on 14th August 2018, the marketable yield of brinjal was recorded to be 26.42 tonnes/hectare.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

Conclusion

Many studies have reported a wide variety of companion plants to contain repellent properties. Companion plants have also been reported to alter the chemical profile of the targeted ecosystem. For example, certain companion plants can directly affect adjacent plants by chemicals taken up through its root. African marigolds (Tagetes spp.) produce root exudates which can be absorbed by neighbouring plants and may help to explain the reports of African marigold reducing pest numbers. African marigolds also release thiopene, which acts as a repellent to a plethora of nematodes. Similarly, empirical studies of the marigold as a companion plant along with the main crop brinjal in field situation revealed that the pest populations from the main crop got diverted due to marigold repellents in the leaves and flowers. While the companion crops(marigold) in the marigold+brinjal ecosystem harbored plethora of natural enemies which essentially fed upon the soft bodied pests, thus, volatile interactions between odors of host and non-host plants and even single species with different cultivars can affect the behavior of pest insects.

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AGRIALLIS
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Volume 2 – Issue 7
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www.agriallis.com

ON FARM PRODUCTION OF BIO INPUTS BY FARMERS GROUP – A GROUP APPROACH

Article Id: AL202077

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Erode District is located in the Western zone of Tamil Nadu. Agriculture and its allied activities like Livestock management and poultry farming play a vital role in sustaining the income of the farming community. The climatic conditions prevailing in the district is suitable for cultivating various crops like cereals, millets, pulses, groundnut, cotton, sugarcane, Banana, Turmeric, Tapioca, flowers and vegetable crops. The total cropped area constitutes about 39% of the geographical area. Nearly 25 percent of the rural populations are directly involved in agriculture, and others are poor, and the landless labourers. Though agriculture is providing income to the farming community, it heavily depends on the successful onset of monsoons.

Moreover, in the present scenario, farmers are using exorbitant usage of chemical pesticide, intensive cultivation practices and so on which declines the population beneficial microorganisms and deteriorate the soil microbes also and reduces in the organic carbon which in turn gives poor yield in crops and lowers the income of the farming community. Keeping the view, ICAR – Krishi Vigyan Kendra, MYRADA in coordination with National Institute of Plant Health Management (NIPHM) Hyderabad have conducted a demonstration on Ecological Engineering for Pest Management in Paddy Ecosystem (ICAR MYRADA KVK, 2014) covering 50 farmers of Kallipatti in T.N. Palayam Block and Andipalayam in Bhavani Block of Erode District in the year 2014 - 15. As part of the demonstration, training on production of bio-inoculants, predators, parasitoids and spiders have organized in the respective villages. The effort resulted in the establishment of on-farm production of bio-inputs by the farmers club in their region.

Cropping System in Andipalayam

Paddy is cultivated in area of 150 ha, Banana 140 ha, Sugarcane 230 ha and Turmeric 175 ha and they have border crops coconut and arecanut plantation. The total area under

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

cultivation is 695 ha. In these crops, pests and disease occurred are blast in Paddy, leaf spot in Banana and Turmeric, Rhizome Rot in turmeric and Smut in Sugarcane. The non-availability of quality bio-inoculants in their area made yield loss and increase in the cost of cultivation in every season of cropping. Through the intervention of ICAR KVK MYRADA, Erode District have able to learn the techniques of "on farm production of bio-inoculants" have made them to start the biocontrol laboratory to serve the farming community on self help basis.

In order to enhance their knowledge and skills on bio input production, a group of 30 farmers from *Pasumai Ulavar Mandaram* of Andipalayam village had exposed to NIPHM, Hyderabad during March 2015 and learned the production technology of the bio-inoculants (NIPHM 2014 and 2019) followed to this two persons identified once again to NIPHM Hyderabad, during May 2015 to get expertise in the production aspects.


The farmers group Pasumai Ulavar Mandaram at Andipalayam village had established the decentralized bio-input production laboratory in the year 2015 and producing the bio inoculants like *Pseudomonas fluorescens* and *Trichoderma viride* for the benefit of the farming community in their region (NIPHM Video link)


Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

Production of Bio inoculants

Type of Bio inoculants	Quantity of Bio inputs Production					No. of farmers benefitted	% of Yield increase in crop production		Area covered (ha)
	2015-16	2016-17	2017-18	2018-19	2019-20		Crop	% of yield increase	537 ha
Pseudomonas floresecence	350 litre	550 litre	675 litre	1000 litre	1000 litre	322	Sugarcane Banana Turmeric	65% 70% 70%	
Trichoderma viride	400 litres	600 litre	500 litre	750 litre	1000 litre	268	Turmeric Sugarcane Banana	60% 50% 45%	

Economics of Production

Sl. No.	Bio inoculants	Quantity	Gross cost (Rs.)	Gross Return (Rs.)	Net Return (Rs.)
1.	*Pseudomonas floresecence*	3,575 litres	Rs. 1,50,000.00	Rs. 3,57,500.00	Rs. 2,07,500.00
2.	*Trichoderma viride*	3,250 litres	Rs. 1,30,000.00	Rs. 3,25,000.00	Rs. 1,95,000.00

Outcome

- Quality input and easily assessable to the farmers
- Reduction in the cost of input in crop production due to non-application of chemical pesticide/fungicide.
- Additional income to the farmer group by production of bio-inoculants in their farm level
- Knowledge improvement on Bio input production technology at farm level by the farmers

The farmers' groups have good linkages with ICAR-KVK MYRADA, NABARD, Pondicherry KVK, TNAU and Department of Agriculture and Horticulture Erode. With regard to quality check-up, the liquid broth have been tested in Pondicherry KVK on every batch of Production from the unit to ensure its quality.

Conclusion

By adopting these on farm production of bio inoculants the production cost will decrease the cost of cultivation of crops. By this quality inputs is easily accessible to farming

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

communities in nearby villages in time. Moreover by adopting this group approach farmers, rural youth can get employment opportunities to run the enterprise and sustain their livelihood which will turn benefits the farmers

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AGRIALLIS
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IMPACT OF GLOBAL COVID-19 PANDEMIC IN LIVESTOCK SECTOR

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In the current global COVID-19 pandemic situation, the entire human race is fighting for their lives, kept themselves indoor amid nation wise lockdown, maintaining the prevention strategies as implemented by the government. The novel COVID-19 corona virus, although originated from a wholesale food market in Wuhan city of China (as per retrospective investigation) crossed the international border swiftly and infected peoples from almost all countries across the globe (Shereen *et al.*, 2020). Now we stand in such a situation where the world has seen around 7 million COVID-19 positive cases with a death toll over four lakhs. Apart from huge life loss, the effect of global lockdown has resulted in the severe economic breakdown, job insecurity, poverty and will seriously affect industrial growth. In the livestock sector, the impact of COVID-19 oriented loss may not be quantifiable in real time, but observing the recent scenario, some possibilities can be assumed, which will be presented in the subsequent sections.

Constraints arising due to COVID-19 pandemic in livestock sectors

Although the source of COVID-19 virus is of animal origin, there is lack of strong evidence stating that animal plays a significant role in transmitting the virus to humans. The infection is highly contagious among human and mode of transmission is by respiratory droplets containing virus particles which is being released during coughing, sneezing, talking and by touching contaminated surfaces (Phan *et al.*, 2020; Li *et al.*, 2020; Kampf *et al.*, 2020). But at this point, studies failed to prove such mode of transmission among animals or from animals to humans. Therefore, with the limited information available, it is said that risk of this disease transmission from animals to human is low.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

1. **Shortage of animal feeds**

Due to global lockdown and physical distancing strategies, shortage of labour, as well as supply of raw materials, has been drastically reduced. Due to movement restrictions and transportation difficulties, animal feed companies have reduced total feed production, which could seriously affect the trade flow in the global marketing system. This breakage in the animal feed supply chain could hamper the general health of the animals resulting in reduced efficiency of livestock production.

2. **Difficulty in marketing livestock origin products**

The immediate effect upon global lockdown was the marketing of livestock products in local, national as well as international market. The serious breakdown of marketing chain was a cumulative effect of labour shortage, partial or complete restriction of transport leading to dumping of the food products, increased production cost and the modified demands of goods by the customers.

The worst affected groups are the small-scale livestock farmers whose daily household income has solely relied upon the currency generated by selling meat, milk or other livestock origin products. Due to less access to the market and less customer support, the poor owners bearing a huge economic loss which is a matter of great concern and needed immediate action to alleviate their problem.

3. **Modified customer demand**

We are now living in a world where we prefer to purchase a decorated product from a reputed e-commerce company rather than buying the same available in the local market. This scenario became evident amid COVID-19 global lockdown where we felt more secure to purchase any item through e-commerce service while neglecting the local market due to the fear in our subconscious mind of getting exposure from the goods produced marketed in the local area. Despite the fact of maintaining cleanliness, personal hygiene and maintaining the quality production of goods, less demand by the customers has seriously affected the local marketing system. For example, the practice of door step supply of milk has been drastically reduced due to customers fear of contracting the disease while consumption of milk (which is not true as studies could not find any relationship between livestock product or byproduct

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

consumption and disease occurrence) increasing cost of production with minimal return of the small scale livestock farmers.

Adoptive strategies amid global COVID-19 pandemic scenario

- For nonstop delivery of required raw materials, special permits to be issued from higher authority and dedicated drivers for supplying the goods to be employed.
- Local sourcing and production of animal feed could be a better alternative.
- Local markets to be remained open by maintaining proper social distancing and hygienic measure.
- Local food producers should strictly follow quality measures in the production line.
- Customers should consume and support the locally made food products which will eventually strengthen the economy of small scale and medium scale enterprises.
- Livestock enterprises should be encouraged to start producing products with long shelf lives for long term storage.
- Creating awareness among poor livestock farmers regarding personal hygiene, physical distancing, sanitizations per WHO guidelines.
- Strict biosecurity measures and routine screening of animals for disease identification is a must as the nature of COVID-19 virus has not been fully elucidated and the risk of transmission from human to animals or vice versa cannot be fully neglected.

Conclusions

The global pandemic situation brought by the novel COVID-19 virus has been spreading like fire with no tendency to limit its fatality. World Health Organization and many experts have declared that "The world must learn to live with it". With no scope for developing an effective vaccine in the near future, we have to come up with some novel strategies that not only will help us in safeguarding human health but also will ensure nations economic growth. By maintaining social distancing and WHO guidelines, we can effectively engage in income generation activities and also can help the needy people, including small scale livestock farmers to support their daily household. This is the fight for our lives, and together we can win against our common enemy COVID- 19.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

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AGRIALLIS
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Volume 2 – Issue 7
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www.agriallis.com

BRASSICAS: THE MOST POTENTIAL WARRIOR IN CONTROLLING SOIL PATHOGENS BY BIOFUMGATION

Article Id: AL202079

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Soil pathogens are very toughest micro-organism with huge diversity and very hard to control. Different chemicals used for controlling soil pathogens but their negative impact on the ecosystem and accumulation of chemical traces in the food chain through plant system is creating a great threat. As an alternative to chemical fumigation, Biofumigation has to become a new opportunity. It is mainly an agronomic practice, but it has an immense role as plant protector from different soil pathogen. The term 'biofumigation' was originally coined by J.A. Kirkegaard. Biofumigation is a mainly an agronomic practice that consists of the process of growing, macerating / incorporating certain with the interest of not only adding biomass and addition of organic nutrient by the decomposition but also suppression of soil pathogen by the use of released secondary metabolite that secreted by the plant cultivated as biofumigation. Mainly Brassica or related cruciferous species releases isothiocyanates compounds (ITCs) through the hydrolysis of glucosinolate (GSL) compounds contained in the plant tissues (Kirkegaard et al., 1993). Basically, Glucosinolatesare sulfur-containing carbohydrate compounds, whose degradation in the presence of the myrosinase enzyme releases substances that have biocidal properties and help limit the proliferation of certain pathogens. (Manici et al., 1997).

The mood of action and successful utilization of the bio fumigation

Plants such as broccoli, cauliflower, mustard, rapeseed, and horseradish contain organic compounds called glucosinolates. When the tissues of these plants are damaged, biologically active chemicals are produced as secondary metabolite. One of the most important compounds that are released is isothiocyanate (ITC). Generally, the pungency taste of mustard is caused by ITCs released when the tissues are macerated. At higher concentrations, ITCs are generally behaving as biocides that behave much like commercial pesticides. The isothiocyanate that is produced by mustard is called "Allyl isothiocyanate"

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

(AITC). This AITC compound is very similar to the compound that is contained in the commercial fumigant like Vapam. The affect of AITC can be based on the allelopathic effect where the allelochemicals like AITC can suppress the growth of pathogens and can kill them. Morra and Kirkegarrd (2002) conducted experiments to determine the concentration and pattern of ITCs released from GSLs in Brassicaceous residues like rapeseed and Indian mustard. A rapid release of ITCs occurred immediately after tissue incorporation into the soil because cell membranes were broken during plough down. ITCs have a wide range of biocidal characteristics and are acutely toxic to a variety of pests and pathogens (Chew, 1987). Other than the direct biocidal effect these brassicas have some other indirect effect on soil pathogen control like

- Bio fumigant crops rotation can improve overall efficiency and productivity of the soil. The benefits of correctly incorporating biofumigant crops result in adding the well amount of organic matters that lead to improvements in soil health, plant health and a reduction in farm inputs cost.
- This Bio fumigant crops act as break crops between two susceptible host crop that disrupt the lifecycle of the different pathogen as they can kill the pathogens survival structure like sclerotia, spores and other hyphal and mycelial body *etc.*
- Suppression of pathogen can also be achieved by the changes in the soil fauna and microbial community of beneficial micro-organisms, including mycorrhizal fungi that have been found to increase after biofumigant crops.

Many Researchers has already studied about the successful inhibition of different pathogen by intercropping many crucifers plant, including brassicae. Some of them has been mentioned below:-

- *Aphanomyceseuteiches f. sp. Pisi* Causing Root rot of Pea (Muehlchen and Parke .1990).
- *Fusuriumoxysporum. f. sp. cumini*causing Wilt of Cumin (Israel *et al*. 2005)
- *F. o. f. sp. spinacia*causing Wilt of Spinach (Mowlick *et al*. 2013)
- *F. o. f. sp. niveum*causing Wilt of Watermelon (Njoroge *et al*. 2008)
- *Pythium ultimum*causing Damping-off of Tomato/pepper (Handiseni *et al.*2012)

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

The factors related to effective biofumigation

The efficiency of *brassicae* as biofumigator plant depends on different factors. The ideal combination of all the factors leads to successful management of different soil pathogens. They are mainly-

1. Choosing of right plant sp. that have higher glucosinolate (GSL)like mustard has higher efficiency for biofumigation.

2. The crop identification as biofumigator should be based on the flexibility or adjustment of cultivation in the fellow period, they should be quick growing and need less attention.

3. The amount of glucosinolate in *brassicae* plant depends on the sulphur present on the soil. So, after testing sulphur should be used in soil with an adequate amount so that the production of glucosinolate should not be hampered.

4. Timing of incorporatrion of *brassicae* plant with soil is also an important factor. For maximum biofumigant activity, the plants need to be chopped and incorporated into moist soil when the tissue remains green. The glucosinolates are highest in the leaf tissue, but glucosinolate activity occurred in leaves and roots too. Plants should be chopped and incorporated in mid blooming stage for best glucosinolate production.

5. Soil moisture has immense role in rapid degradation of *brassica* residue and the release of ITC in soil.

Conclusion

There is also still a lack of information and practical knowledge on some of the agronomical practices *i.e* associated with growing biofumigant crops having maximum GSL production such as biofumigant crop selection, seed rate, proper fertilizer applications, sowing dates, incorporation with soil etc.So, there is a huge chance for researches to gather more and more knowledge regarding bio fumigants and its advantages and drawbacks if any. Moreover, the knowledge sharing and more and more practical implementation of knowledge can bring a biofumigant crop into the limelight and can also start an era that is far away of synthesized plant protection chemical and very close to mother nature.

Volume 2 – Issue 7
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www.agriallis.com

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UN INTERNATIONAL YEAR OF PLANT HEALTH: 2020

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Plants are essential to our daily lives. They not only produce 98% of the oxygen we breathe, but they also make up 80% of our food. Plants are, however, under constant and increasing threat from pests and diseases. According to the Food and Agriculture Organization (FAO), pests and diseases account for up to 40% of the world's food crops lost. This leaves millions of people facing poverty and seriously destroys agriculture, which is the primary source of income for many countries around the world. As in human health, it is much more cost-effective to protect plants from pests and diseases than coping in full-blown plant health emergencies. In reality, plant pests are often difficult to eliminate once they have established themselves and are time consuming and costly to handle. Prevention is critical to avoiding the devastating impact on agriculture, livelihoods and food security of pests and diseases. For these and more factors the UN General Assembly has called 2020 the "International Year of Plant Health (IYPH)".

UN International Year of Plant Health History (IYPH) for 2020

The Food and Agriculture Organization (FAO) launched the UN International Year of Plant Health (IYPH) for 2020 at the UN Agency Council meeting on 2 December 2019, with the aim of raising global awareness on how plant health protection can help end hunger, reduce poverty, protect the environment and boost economic development.

The key objectives of the year are;

- Awareness raising of the value of safe plants in achieving the Sustainable Development Agenda 2030
- Stressing the impact of plant health on food safety and ecosystem functions
- Sharing best practices on preserving safe plants while protecting the environment

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

Why would you worry about Plant Health?

Plants are the source of the air that we breathe and much of the food we consume, and we still don't care about keeping them safe. That can result in devastating results.

- From plants, air and food we get two main life-essentials
- Plant safety is becoming ever more endangered
- Climate change and human actions are rapidly changing the landscape, growing biodiversity and developing new invasive species niches and habitats
- International commerce and travel help to spread disease
- Prevention is often easier than cure when it comes to plants and diseases
- Plant health policies and activities are necessary if sustainable development goals are to be achieved

What can we do to support Plant Health?

A common man

We must all respect plant health regulations put in place to protect agriculture, forestry and the environment. Pay attention to moving plants and plant products (e.g. seeds, vegetables, cut flowers) across boundaries, even when buying from online outlets. As well as reducing your environmental footprint, protecting natural resources and spreading the word, everyday actions include.

- Be careful when taking plants and plant products with you when you travel, as plant pests and diseases may spread. Beforehand, contact the national plant health authority to ensure that you do not infringe plant safety laws
- Be vigilant as small packages can easily bypass normal phytosanitary controls when purchasing plants and plant items online or via postal services
- Spread the word #PlantHealth during 2020 and beyond on social media and in your culture.
- Take regular steps to reduce the environmental impact and actively participate in conservation and natural resource management programs

A farmer or worker in agribusiness

You can have a direct influence on plants, and the management of natural resources. Women and men who work in agriculture play a vital role in protecting plant health.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

- Prevent the spread of pests by using only certified pest-free seeds and seedlings
- Regularly monitor and report the occurrence of pests on your farms
- Adopt environmentally friendly pest-management practices – including those based on biological approaches that do not kill pollinators, and beneficial insects and organisms
- Use modern digital technology, mobile apps and software to access information on how to prevent and manage pests and diseases in plants, and report outbreaks

Governments

The government can, in many ways protect plant health, thus enhancing food security, protecting the environment and facilitating commerce.

- Promoting public awareness campaigns on the importance of plant health and what plant protection can do for everyone
- Invest in plant safety organizations, and ensure sufficient human and financial resources are available
- Invest more in plant health research and innovative practices and technologies, and provide incentives for both the private sector and farmers to do so
- Ensure that phytosanitary import requirements are based on IPPC standards and are technically justified, consistent with the pest risk involved, constitute the least restrictive measures available and result in minimum impediments to the international movement of persons, commodities and transports
- Implement plant health standards and enhance plant protection capacity, including through a Phytosanitary Capacity Assessment (PCE) in collaboration with the IPPC Secretariat
- Improve control and early warning systems for plant and plant health protection
- Align policies and actions with sustainable plant health development goals, in particular, those designed to eliminate hunger and malnutrition and reduce poverty and environmental threats

Private sector

Businesses in the private sector play a vital role in plant safety, as they can contribute to and help enforce global plant health standards. The private sector is also a driver of plant-health innovation and a major player in the food and food nutrient development and safety.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

- Encourage environmentally sustainable pest control and management goods and practices;
- Make trading and transportation safer for plants and plant products by meeting international plant health standards and legislation
- Inform customers that transportation of plants and plant products may spread pests and diseases – sometimes with devastating consequences
- Sustain innovative plant health practices and use of new technologies to facilitate market access according to international standards

Conclusion

This year, efforts to provide disease resistance to many crops around the world should be underlined. Many vulnerable crops are cultivated in regions of the world where underdeveloped plant science. We can both avoid and combat plant pests and diseases in environmentally sustainable ways-by, for example, integrated pest control. This approach to the ecosystems incorporates different management approaches and practices to grow safe crops while reducing pesticide use. Healthy plants are the foundation of all life, the functions of ecosystems and food safety. Plant pests and diseases damage crops, diminishing food availability and increasing their cost. Sustainable plant health protects the atmosphere, forests and biodiversity from plant pests, tackles the impact of climate change and promotes efforts to end hunger, malnutrition and poverty.

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GYPSUM IN AGRICULTURE: A BRIEF DISCUSSION

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It's been a long time since calcium sulphate otherwise popularly known as gypsum is being used as a "tool of multiple-use" in agriculture around the globe. Full availability, relatively lower price; that is what makes it an excellent agronomic and environmental tool to improve soil physical and chemical property. In this regard, most of the research came out with conclusive results; however, the three-way interaction among local condition, plants response and environmental implications are remained significantly untouched. The primary utility of gypsum is a means to overcome the physicochemical problem in sodic soils as well as a nutrient source of calcium and sulphur to the plants (Shainberg*et al.*,1989). The most recent scientific trends are also suggesting a just opposite turn, i.e., using it to reduce the high level of soil acidity as well as soil dispersion problems. Along with reclaiming sodic soils; the other most common utilities of gypsum are reducing soil crusting in arid and semi areas where it can increase infiltration rate despite scarce rainfall and improving seed germination. In high aluminium- rich soil, gypsum can suppress the Al ions from damaging the root system by replacing it with Ca ions thus helps to establish a sound root system (Ritchey *et al.*, 1995).

On the strict sense of plant nutritional point of view; it might seem unnecessary to apply gypsum as a source of calcium in low rainfall areas where the calcium is already present in the soil in plentiful quantity to suppress Phyto- toxic aluminium ions; however; the problem lies somewhere else. The high rate of ammonia-based fertiliser often responsible for the localised or even widespread soil acidification, which causes a sharp increase of Al^{3+} ions

Volume 2 – Issue 7
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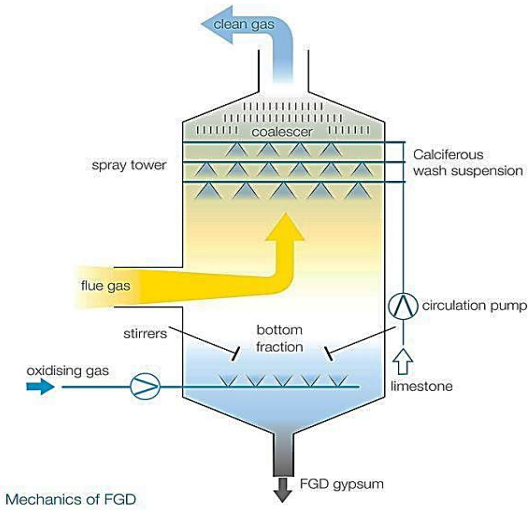
in the rootzone. Of Couse, a general lime application can seem to be an easy way out. However, the effectiveness of the lime application is limited to the depth of its incorporation which often results inthe formation of a shallow and deep acid subsoil especially in zero tillage situation where lime can only reduce acidity of the middle layer; the layer of lime incorporation. In this scenario, Gypsum has some advantages over lime such as higher rate of ion mobility, solubility and replacing the Al^{3+} from the exchange medium with calcium and sulphate (Kost*et al*.,2014).

Gypsum: where and howit comes from?

The traditional natural source of gypsum is the geologic depositions which are often excavated, collected, and used fora long time. Different derivatives of gypsum such as the hemihydrate (Plaster of Paris, CaSO4,1/2H2O) and anhydrite (CaSO4) are very common, extensively distributed minerals which can be found as sedimentary evaporative deposits(Chen *et al*., 2010).

When brine marine water is evaporated, the first mineral which gets precipitated is gypsum which is often found beneath the rock salt deposit of salt domes (Murray, 1964). If the temperature is higher, (>42°C) anhydrite (Angelite) may precipitate before gypsum, but upon rehydration, it easily converts back to gypsum. Chemically pure gypsum deposits are although naturally possible; but in general, an impurity such as Ca and Mg carbonate and sulphate salts, as well as Fe oxides, are often remaining mixed with gypsum. Majority of the natural gypsum deposits are found in the USA, France, Canada, England, and some parts of the former Soviet Union. Since a long time, these mined-gypsum has been used as cement additive and soil amendments (Hurlbut and Klein, 1971).



Mechanics of FGD

Another source of gypsum is nongeogenic in nature, such as it is a by-product of phosphoric acid production, which is a part of high analysis prophetic fertiliser production. As compared to the natural gypsum, it is much finer in quality and higher purity and termed as "**Phosphogypsym**". One interesting fact is that; the plants which produce gypsum as a

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

byproduct often consider it as disposal nuisance while it can be a useful agricultural tool elsewhere. Another concern associated with this secondary gypsum production is its association with some degree of radioactivity (Guimond and Hardin, 1989).

A relatively new source of gypsum came into existence when different countries took air pollution seriously; the flue gas treatment plants of different industries which still uses coalremoves and retains the sulphur dioxide. This by-product is called 'flue gas desulphurisation gypsum' (FGD-gypsum).

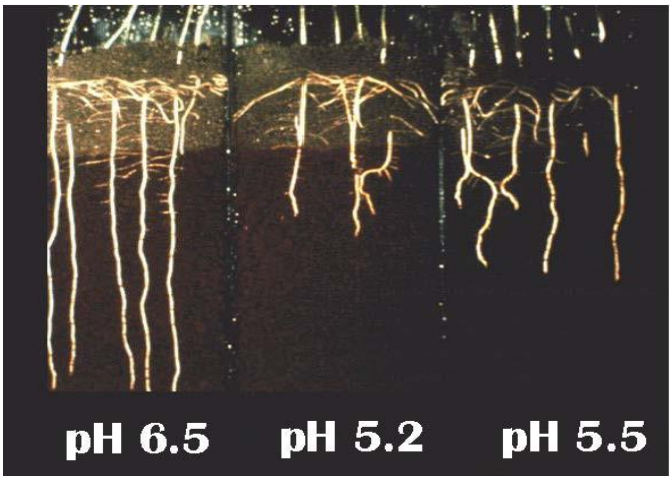


Fig 1: Effect of low pH and Al toxicity on cotton root

The solubility of gypsum

The solubility of pure gypsum in pure water is little, generally 2.5 g L^{-1} (Lide, 2005); however, the solubility increases significantly in complex formation. In case of saline water; the solubility increases based on the presence of other non- Na ions in solution. The other exchangeable ions which can replace the Ca also increase the dissolution of gypsum.

Use of gypsum in Agriculture

Subsoil acidity alleviation

Around the world, a whopping 50% of arable land faces the challenge of soil acidity. The presence of toxic aluminium ions is behind this limitation (Von Uexkull and Mutert, 1995). Soil naturally becomes acidic over time due to removal of base cations, production of organic acids or due to microbial respiration. Crop production hastens the process by increasing all these three factors. When the pH gets below the threshold limit (pH 5.5); the aluminium started becoming available to the plant. The most prominent ill-effect of aluminium is inhibition of the growth of plant roots; even in micromolar concentration! Aluminium does it by inhibiting root cell expansion and elongation (Marschner, 1995). Aluminium tends to interact with multiple sites in the apoplasm and symplasm of root cells as it forms strong bonds with oxygen donor compounds (Martin, 1986). Aluminium also inhibits Ca uptake by blocking Ca^{2+} channels at the plasma membrane.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

Gypsum is often superior to limestone-based materials when it comes to subsoil acidity alleviation because of the higher mobility of gypsum dissolution products. This often becomes more important if the land is under no-till cultivation practice where limestone can not be added. Another important fact is that; the solubility of limestone reduces once the pH approaches the near-neutral value. Hence if the soil top layer has a near-neutral pH while the subsoil is acidic; the limestone does not solve the purpose. However; unlike the carbonate in limestone which directly neutralises the acidity; limestone somewhat alleviates the Al toxicity by shifting the soluble Al to less toxic form. Ultimately; the reduction of subsoil acidity leads to better root growth as well as enhanced water As well as nitrogen use efficiency (Hammel *et al*., 1985).

Impact of gypsum application on overall soil pH

Gypsum is not an acid neutralising or acid-forming agent hence the impact of gypsum on overall soil pH is minimal. It can although slightly change the pH, but that totally depends upon the sophisticated soil mineralogy, CEC, and other competing anions. The range of pH change is often ranged between 0.2-0.3 pH units (Pavan *et al.*, 1982).

Effect on base cations base saturation

Gypsum has a high potential to increase the soil fertility especially in the sub-soil due to high solubility of Ca, and S. Gypsum directly improves base saturation, exchangeable Ca and S content in soil moreover; gypsum also increases the leaching loss of Mg and K due to thermodynamics of ion exchange (Oliveira and Pavan, 1996).

Impact of gypsum application on soil physical properties

Gypsum has a long history of being used as a useful tool of soil amelioration for sodic and heavy clay soils. Gypsum also prevents swelling and dispersion and indirectly potentially increase porosity, hydraulic conductivity, structural stability, and drainage. Na^{+} and Ca^{2+} possess opposite characteristics; while one has a deleterious effect; the other has a favourable effect on soil. However, the threshold level of exchangeable Na in which a non-dispersive soil becomes dispersive is not entirely defined (Shainberg*et al*., 1989). As per The U.S. Salinity Laboratory Staff (1954), the threshold level is 15 ESP. The higher the ESP (exchangeable sodium percentage), the more chances of dispersion and breakdown of

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

structure when wetted. However, a modification made by Bernstein (1974) concluded that soil texture plays a significant role; hence; the critical ESP is 10 for fine-textured soil and 20 for coarse-textured soil. A soil which has ESP value greater than 15 is scarce even in semi-arid and arid condition while low ESP soil (ranging 1-5) is widespread in arid and semi-arid conditions and even humid regions (Shainberg*et al*., 1989). As a result, the dispersive and unstable soils where gypsum potentially can be used are much more significant. The leaching of sodium as an effective method to prevent soil dispersion is not a new concept, as Hilgard (1906) reported it a hundred years back. Gypsum is the most common sodic soil amendment tools due to its high solubility, lower cost, higher availability, and secure handling. Even in non-sodic soils; gypsum improves soil structure by increasing flocculation, aggregate stability, and water infiltration (Malik *et al*., 1991).

Table1: Potential impact of gypsum application on soil

Mechanism	Potential impact
Increase in soil solution ionic strength with divalent ions	Decreases double layer thickness which leads to improve soil structure and drainage, reduce crusting
	Decreases aluminium ion activity
Increase solution calcium Concentrations	Displaces excessive sodium from sodic soils to permit remediation and reductions in exchangeable sodium percentage
	Provides calcium for growing plants
	Displaces magnesium and potassium from soil CEC: leaching of nutrients
	Displaces aluminium and protons from CEC: slight temporary pH reduction
	Increase base saturation and decrease acid saturation
	Decreases phosphorus solubility due to calcium phosphate Precipitation
Increase solution sulphate Concentrations	Provides sulphate for growing plants
	Complex solution Al^{3+} and Mn^{2+}: decrease aluminium and manganese toxicity
	Allows for more profound movement of Ca and other cations into acid subsurface due to high sulphate mobility and electroneutrality of ion leaching
	Ligand exchange with valence unsatisfied terminal hydroxides on variable charge minerals: slight increase in pH

(**Source:**Zoca and Penn, 2017)

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

The response of crop toward gypsum application

Direct improvement of crop yield has been observed, which is a contribution to increased Ca and reduced Al status in soil. Scientists also reported that gypsum induced yield improvement is more prominent in the year when the deficit of rainfall has been observed, Ritchey *et al*. (1995).

The environmental footprint of gypsum

Gypsum potentially can be used to increase water infiltration hence reducing runoff of water and nutrients. Gypsum is also used as phosphorus absorbing material. A higher dose application of high analysis phosphatic fertiliser or dumping off manure often leads to eutrophication. This is especially problematic in the case of poultry manure. Application of gypsum along with compost leads to up to 61% less runoff loss of soluble phosphorus (Endale*et al*., 2014). Another critical environmental benefit of gypsum is that it can be used to trap pollutant heavy metals like mercury and lead.

Determinants of gypsum application rate

The agronomic criterion under which gypsum should be applied are given below:

- When the subsurface layer is significantly high in aluminium and low in calcium which inhibiting the root growth
- When there is a high chance of periodic drought occurrence causing water stress to the plant.
- When magnesium level higher than usual and should be reduced.

There are few robust as well as not so robust criteria for gypsum application rate determination based on all available literature. However; there is no single conclusive solution yet which fits all situations. In Brazil; the researchers recommended that gypsum should be used when the subsurface (20-40 or 30-60cm depth)has less than 0.4 $cmol_c$ $dm^{-3}$of exchangeable Ca (measured by resin extraction) and/or more than 0.5 cmolc $dm^{-3}$of exchangeable Al, and/or more than 30% Al saturation. In a single sentenced suggestion recommended by Dematte (1992) is soils which have the highest possible for a retort to gypsum are acid soils with low CEC which includes oxisols, oxidic ultisols, and low-CEC acid entisols and *inceptisols*.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

When it comes to predictive gypsum requirement dose; the most satisfactory result has been observed while using the following equation:

[GR (kg S ha^{-1})= -114+82.773A_S – 2.739A_s^2]

Where A_S is sorbed/S in solution, after 2 g of soil was equilibrated with 20 mL of 0.75 m*M*CaSO4. H2O solution for 18 hours. In case if there is no lab facility; the gypsum requirement can be calculated from the formula which is totally based on the clay content of the soil is:

[GR (kg S ha^{-1}) = 17+6.508 CLAY-PCT (r^2= 0.79)]

Where, CLAY-PCT= percentage of clay present in soil passing a 2-mm sieve.

Conclusion

Gypsum has a long history to be used for agricultural purpose; however, often in real-world scenario crumpled due to not having a proper user manual. A gypsum is a handy tool when it comes to improving soil chemical, and physical conditions and the production of gypsum as a by-product is also increasing day by day. The requirement of the time is a concise meta-analysis-based manual which can be used by the farmers.

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Volume 2 – Issue 7
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Volume 2 – Issue 7
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FIGHTING LOCUST CRISIS IN INDIA

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The magnitude of the damage caused by the locusts in India in current times during the time of Corona has been alarming. Locusts belong to the family Acrididae. Being polyphagous feeders, an average small locust swarm can eat as much food in a day as about 10 elephants, 25 camels or 2500 people as per the FAO. Locusts cause damage by devouring the leaves, flowers, fruits, seeds, bark and crops. They have the capacity to break down trees because of their weight settled in mass. Locusts reported in India are desert locust (*Schistocerca gregaria*), migratory locust (*Locusta migratoria*), Bombay locust (*Nomadacris succincta*) and tree locust (*Anacridium sp*.) The locust has three distinct stages - egg, hopper and adult. Swarms of gregarious adults migrate downwind and can cover up to about 150 km/day.

Cause of Locust Crisis

Guaiacol, produces in the gut of desert locusts by the breakdown of plant material and undertaken by the gut bacterium *Pantoea agglomerans*, is the important constituent of pheromones that cause locust swarming (Dillon, Rod J. *et al.*, 2002*)* Climate change is the key factor of the current outbreak. During dry spells, solitary locusts are forced together in the patchy areas of land with remaining vegetation. This sudden crowding releases serotonin in their central nervous systems that make locusts more sociable and promote rapid movements and more varied appetite (Guo *et al.*, 2013). Unusual weather conditions generate strong cyclones and heavy rains in the Arabian Peninsula, triggering higher than normal vegetation growth that create a conducive environment for locusts to feed on and surge. Increasing sea temperatures lead to more extreme rainfall - creating suitable conditions for hatching and breeding.

Volume 2 – Issue 7
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Preventive Control Strategy

The World Bank and the Food and Agriculture Organization are the leading technical global agencies on desert locust control that develop integrated pest management plans and support countries to undertake safe and effective control operations.

1. Control Campaign

All the countries affected by locust generally adopt a preventive control strategy for the management of locust in order to reduce the frequency, duration and intensity of plagues. The direction and speed of the wind determine the distance of adults and swarms. Before they take off, a settled swarm generally warms up in the early morning shortly after sunrise by basking in the sun. Swarms then fly throughout the day until just before sunset when they land and remain settled on the ground throughout the night. Hoppers are active throughout the day and will not move more than about 500m to 1 km in a single day. They can be treated throughout the entire day; whereas, swarms can only be treated in the early morning before take-off or in the late afternoon once they have landed.

A control campaign mounted against hopper bands that resulted from local breeding lasts about 4–6 weeks, and a subsequent campaign against the adults is required for a further four weeks. A control campaign against invading swarms is likely to be very short in duration because the adults quickly mature and lay eggs. As it is not possible to prevent egg-laying completely, a subsequent campaign is required for controlling hopper bands. This strategy consists of regular surveys to provide early warning and contingency planning to allow effective response. Locust Warning Organisation undertakes regular surveys in the scheduled desert area to monitor the presence of desert locust and ecological conditions. During the survey, an assessment is made to determine, if the locust numbers have crossed the economic threshold level (ETL) which is 10,000 adults/ha and 5-6 hoppers/bush that may require control. It is checked if all the Locust Circle Offices are self-sufficient in terms of manpower, vehicles, control equipments, and personal protective equipments.

2. Use of Pesticides

The primary method of controlling desert locust swarms and hopper bands is with organphosphate chemicals applied in small concentrated doses (referred to as ultra-low volume (ULV) formulation) by vehicle-mounted and aerial sprayers, knapsack and hand-held

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

sprayers. Malathion 96% ULV, malathion 5% DP, fenvalrate 0.4% DP and quinalphos 1.5% DP have been approved for desert locust control in India by Central Insecticide Board and Registration Committee. A buffer of minimum 5000 litres of Malathion 96% ULV is maintained at specific Locust Controlling Organisations from where pesticide can be mobilised for immediate requirement. Pesticide manufacturing firms must be able to arrange supply of the required quantity of pesticides on short notice during locust emergency.

3. **Biological Control**

Safe and effective use of biopesticides through aerial and ground spraying is necessary to reduce the propagation and prevention of locusts to new areas. The FAO recommends the use of *Metarhizium anisopliae var. acridium* fungus to kill locusts by growing inside their bodies. It is cheaper, more effective, longer-lasting in the deserts, easier to store and is recommended for use before the nymphs begin to fly. Entomo pathogen such as *Paranosema locustae* is effective against hoppers of locusts. The use of traditional Neem Seed Kernel Extract (NSKE) is found to be a good anti-feedant against desert locusts by the farmers in India. Acoustic devices that produce high-frequency sound have been successfully used in different parts of India to deter large swarms of desert locusts. The endangered Great Indian Bustard, ducks and chicken are effective to control locust infestations. Controlling locusts through drugs targeting the serotonin pathway provides an alternative to chemical pesticides. Cholinesterase test for the staff engaged in locust control to see any adverse effects of pesticides should be conducted. The behavioural control of locusts can be managed using hormone/pheromone technology.

4. Emergency Fund

India’s response to the locust invasion has been limited to spraying of pesticides through vehicle-mounted sprayers, states notifying locust invasion as “mid-season adversity” under the Pradhan Mantri Fasal Bima Yojana (PMFBY) and announcing disaster relief packages for the farmers in the affected states.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

5. Updating of Contingency Plan

The contingency plan is updated to ascertain the requirement and availability of the resources required for locust control e.g. emergency fund, pesticides, communication equipment, vehicles, trained manpower, survey, control equipment, protective clothing, first-aid kits, aircraft etc. It is necessary to create pre-treatment awareness in the bird sanctuaries to avoid any harmful effect of pesticides and post-treatment awareness in the treated areas to the concerned departments. Villagers and nomads should be discouraged to allow grazing of cattle and for other public activities till the harmful effect of pesticide is not evaded.

6. Role of Additional Stakeholders

A holistic approach of various ministries such as Ministry of Agriculture and Farmers Welfare, Home Affairs, External Affairs, Defence, Science and Technology, Civil Aviation, Communication, State departments, Department of Agriculture, Cooperation and Farmers Welfare, Directorate of Plant Protection, Quarantine and Storage, State Department of Health, Pesticides Manufacturing Firms, Aircraft Companies, agriculture start-ups and non-profit organisations is important for needful assistance during a locust emergency. Public awareness must be created through electronic and print media. District and village level committees are formed in consultation with the district collectors and Joint Directors Agriculture, State Department of Agriculture of respective states to monitor progress of the locust control programme under the Directorate of Plant Protection, Quarantine and Storage, Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, Government of India. Indo-Pak Border meetings for the exchange of the current locust situation between the two countries are necessary. The state functionaries, BSF posts, Defence posts and Panchayat Raj Institutions must be advised to inform the nearest LWO office for needful action. A desert locust situation bulletin must be issued at fortnightly intervals to inform all concerned stakeholders about prevailing locust situation in India. Training and sensitisation programmes can be of huge help for the state field functionaries, BSF, Defence and LWO staffs. The Ministry of Home Affairs can advise BSF authorities to extend help and to provide facilities in border surveys, arranging Indo-Pak border meetings and extend help in reporting of locust swarm through BSF staffs. Ministry of

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

Defence can provide wireless sets (High Frequency and Very High Frequency) and trained manpower during locust emergency and coordinate during locust survey in prohibited areas of defence establishments. Ministry of Earth Sciences, Indian Space Research Organisation and Meteorological Department can provide relevant meteorological data. Ministry of Civil Aviation can grant permission from Air Traffic Control (ATC) for flying drones during locust control operations. Ministry of Information and Broadcasting should collaborate with Locust Warning Organization concerning media and news coverage of the locust emergency. Use of satellite imaginary and geographic information system (GIS) from ISRO can be of utmost help. Awareness on Do's and Don't of pre-treatment and post-treatment control operations and promotion of new chemical pesticides with low mammalian toxicity are essential to avoid health risk for human by medical toxicologists of State Department of Health in various states of India. The state agriculture universities can contribute to using the resistant genes from resilient plant species in crop breeding programmes for locust prone areas in India.

Conclusion

The challenge of locusts in India has been further amplified because of the lockdown imposition due to COVID-19 outbreak. At the traditional incursion hotspots, the plant protection teams armed with pesticides are handicapped by the lockdown restrictions. Border closures and delays posed by quarantine measures are imposing restrictions on the movement of personnel and equipment to aid in the locust response. Even in those areas where the government is making locust response an essential activity and allowing teams to move, special care needs to be taken to reduce the threats that aid workers and control officers spread the Corona virus to remote rural locations where locust control operations take place. Where bank programmes are financing responses, measures to protect teams and the communities they engage with are required. Taken together, these two crises have the potential to generate the conditions for famine, disease, starvation and increased poverty. Locusts eat crops that farmers grow for humans. They cause major agricultural damage. If locust attacks of this proportion continue, they will wipe out tonnes of food grains and vegetables meant for human consumption.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

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www.agriallis.com

BLOCKCHAIN MANAGEMENT IN AGRICULTURE AND ALLIED SECTOR AND IT'S FUTURE PROSPECTS

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You've been hearing the term 'blockchain technology' consistently from the last few years, probably regarding cryptocurrencies like Bitcoin. Blockchain was invented in 2008 by a person (or group of people) who used the name or pseudo name Satoshi Nakamoto to serve as the crypto-currency bitcoin's public transaction ledger. In a simple term blockchain is a blockchain that contains information. Blockchain is the central infrastructure applications the bitcoin cryptocurrencies. It is “free, distributed ledger that can efficiently and verifiably and permanently record transactions between two parties”. It has very advantageous features such as strong security, decentralized system and ability to automate etc. Blockchain technology can potentially be used to store data about transfers of assets, stops in a supply chain, and even votes for a candidate. Blockchain 's prime application is Bitcoin, and the entire reason the technology was first developed has helped many people through financial services like digital wallets. Blockchain management reach nowadays is in every sector. This creates transparency between government and peoples, is useful for property register records. It is equally important in the health sector as it is used as a secure platform to store sensitive patient data for the healthcare industry. We may think about what's important in agriculture or the related sector about this lavish term, but the truth Blockchain technology or management is secretly penetrating the agricultural sector, but we don't know. Agriculture is of paramount importance in any area. It is the sector that is responsible for feeding the entire population. In addition, 58 per cent of the Indian population relies directly or indirectly on agriculture for their livelihood. His contribution to Indian GDP, however, is only about 17%. India's premier Mr Narendra Modi urged the youth to use and support Artificial Intelligence (AI) and Blockchain technologies. Prime Minister of India Mr Narendra Modi has been encouraging youths to utilize and promote Artificial Intelligence (AI) and Blockchain technologies. He believes that this particular innovative idea will bring

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

about positivity in the agricultural sector. With real-time monitoring of the supply chain, the technology can bring about transparency in agricultural trade.

What is Blockchain technology?

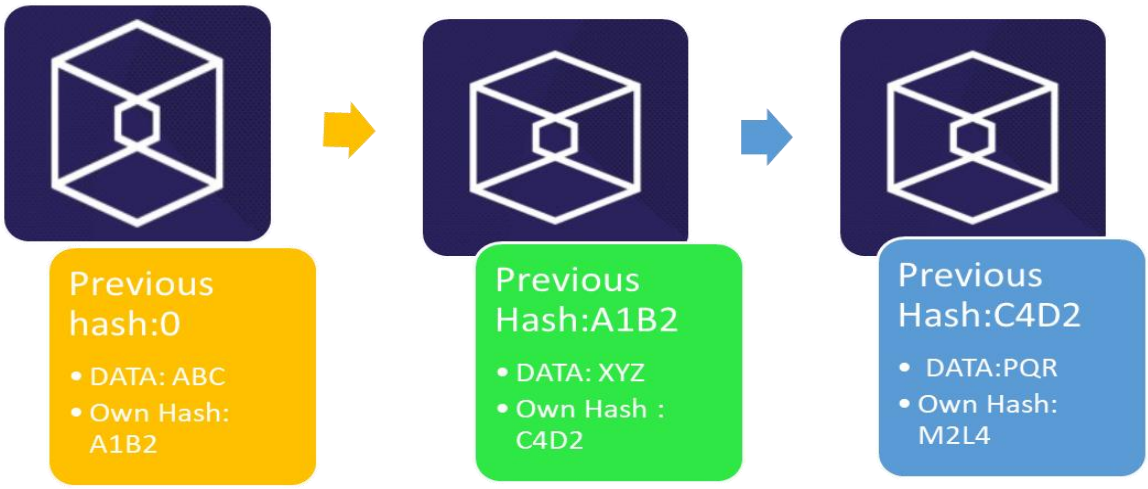
A blockchain is a distributed, public archive that records transactions electronically. Blockchain is a technology that can allow individuals and businesses to make instant network transactions without any intermediary (if decentralized). Transactions made on blockchain are completely secure and are kept as a record of what has happened as a function of blockchain technology. Cryptographic encryption algorithms ensure that no blockchain transaction record can be altered after an event occurs. It's important to remember that the blockchain is still evolving. Blockchain is a decentralized and distributed ledger where blocks containing a set of transactions are linked together by a cryptographic hash. Transactions originating from a node are validated by participating nodes, and a set of transactions is added to the block by the "mining" node. Any mining node with sufficient computes power that solves a cryptographic puzzle can generate and broadcast a new block containing the set of validated transactions.

How Blockchain works?

Before explaining how a blockchain is built, it’s important to understand exactly what makes up the network. Participating computers are called “nodes,” which are simply computers that can store the blockchain’s data, follow the rules of the blockchain’s specific protocol and communicate with the other nodes. Nodes can be physically located anywhere, and for this reason, they’re called “distributed.” Each node follows the same rules and maintains an identical copy of the blockchain data set. Blockchains are a new type of network infrastructure (a new way of organizing how information and value move around on the internet) that creates network 'trust' by introducing distributed verifiability, auditability, and consensus. Blockchains operate as a decentralized database, distributed through large peer-to-peer networks with no single point of failure and no single source of reality. No individual entity may own a blockchain network, and no single entity may arbitrarily alter the data stored on the blockchain without peer consensus. New data can only be added to the blockchain by agreement between the various nodes of the network, a mechanism known as the Distributed Consensus. Each node of the network keeps its own copy of the blockchain data and keeps the other nodes honest — if one node changes its local copy, the other nodes

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

reject it—blockchains record information about a time-stamped chain that extends infinitely forward. New data will be added to the end and will be permanent once added. Older data can not be deleted or changed, since a snapshot of it is stored in the following data blocks. Blockchains uses mathematics and computer science techniques known as cryptography to sign every transaction (e.g. transfer of assets, such as money, from one person to another) with the unique digital signature of the user who initiated the transaction.



Diagrammatic representation

Each block contains data and hash of own and also previous block. When hash between two simultaneous blocks match, it forms a chain.

Application of Blockchain Management in Agriculture and allied sector

Blockchain technology is still considered to be in its infancy when compared with traditional global financial systems. But if we lay aside the issue of age, the superior features that blockchain has can potentially disrupt existing solutions not only in industry and commerce but in almost every aspect of our daily lives. Agriculture and food supply chains are well interlinked since agricultural goods are almost often used as inputs in a multi-actor supply chain, where customers are typically end-users. More importantly, there is an increasing number of problems that urgently need to be resolved. There is evidence that blockchain applications began to be used in supply chain management shortly after the technology appeared. The blockchain supply chain management is expected to grow at an annual growth rate of 87%, from $45 million in 2018 to $3314.6 million by 2023.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

Crop and Food production

The population of India was 1,210,193,422 (623.7 million males and 586.4 million females) as of 1 March 2011. They need to be fed anyway, which is why agriculture is the most important sector in India. Addressing the needs of the growing population by growing more food with minimal resources while at the same time reducing the environmental footprint, maximizing customer satisfaction, enabling transparency across the supply chain and ensuring fair income for farmers while dealing with weather vagaries-the agriculture sector has many challenges to overcome, while at the same time improving profits from farmer to manufacturer and grocer, blockchain coupled with IoT is remodelling the food industry. The blockchain is designed to make agriculture a sustainable activity by using a streamlined approach to optimize agricultural resources, including water, labour and fertilizer. IoT sensors may gather important information such as soil temperature, water level, fertilizer details and more and submit it to the blockchain with the aid of smart farming. Smart contracts could trigger and execute specific actions, based on data stored in blockchain. This will help improve both the quality of the farming process and crop production.

Food Supply chain

With rising globalization and intense market pressure, food supply chains have become more and more dynamic than ever before. There are some common problems in food supply chains, such as food traceability, food safety and quality, food trust and inefficiency in the supply chain. From the producer point of view, the use of blockchain technology helps to establish a trust relationship with consumers and to build the reputation of their products by transparently providing individual product information in the blockchain. Enterprises can increase the value of their goods and thus improve their competitiveness. The blockchain makes available accurate and credible knowledge about how food is created and processed from a customer perspective. It helps address consumer concerns about food safety, quality and environmental friendliness). The use of blockchain allows consumers to interact with producers because consumers can understand the food production process more conveniently and in more detail. It encourages consumers by removing barriers to the exchange of goods in order to strengthen their relationship and thus increase consumer confidence and confidence in food safety. From the regulatory agency's viewpoint, blockchain provides them with

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

credible and accurate information to implement knowledgeable and effective regulations. Blockchain can record retail store provenance details from a Brand. This provides a healthy and unchanging way to store data obtained at the start of the supply chain, such as DNA from farm products, food or pesticide residues from vegetables. Any party involved in the supply chain of the product may verify and control such information. Consumers may trackback the supple chain by most significant features.

Controlling Weather Crisis

Farmers usually have to confront unpredictable weather conditions while growing different types of crops. Because of excessive spring rains, many of the crops grown in India cannot tolerate flooding. The level of oxygen concentration reaches zero, making life-sustaining functions such as water uptake, root growth, and respiration difficult for the plants. Moreover, the lack of transparency in the current ecosystems of the food chain can lead to unclear and high price surges. Consumers had no idea when crops were suffering from poor weather and what contributed to higher prices. Because of the ability of blockchain to offer traceability and transparency, farmers and other stakeholders will get a clear understanding of the price differences in the food distribution market. As the weather conditions can be tracked from the blockchain ledger by approved parties, farmers can easily receive claims for crop insurance and livestock insurance through smart contracting.

Improved quality control and food safety

One of the main uses of blockchain is to add greater accountability to the supply chain. It will help us to rid ourselves of inadequate processes and ensure optimal quality assurance conditions. For example, crop failure is a prevalent problem facing farmers around the world. This generally occurs due to unfavourable climatic conditions, including poorly distributed rainfall and unpredictable weather. Similarly, through the agencies concerned the agricultural production could be certified and put on the blockchain system.This would lead not only to a better price for the works of the farmer but also to quality products being obtained by the end consumer. Such systems could lead to a better food ecosystem for sustained country development(Yadav and Singh 2019). Companies like IBM are already investing millions in precision farming to solve this, developing IoT devices that allow farmers to track factors that could affect crops such as soil quality, pests, and irrigation.

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

Land registration

Deployments based on blockchain may offer an incorruptible land registry ledger. Particularly in the case of rural poor, if this is effectively connected to sovereign identification / digital identification, then the safeguarding of land records would not be a problem even in times of natural disasters or war. The United Nations Development Program (UNDP) is working with partners in India to make land registration there more reliable. At a high level, this project will permanently capture and document any transaction throughout the sale of a property.

Effect of Blockchain Technology in Dairy industry

India has enormous potential in the dairy industry, as we are the world's largest producer of milk. Several problems are currently facing the industry, such as the lack of nutrient feed, the lack of storage facilities and, to name a few, the lack of technical support. So, we can see that the organization of the supply chain and logistics are the major challenges facing the dairy industry. The good part is that challenges are nothing but disguised opportunities, and proactive steps need to be taken to educate farmers and provide them with a stronger supply chain to rely on to face this challenge head-on. Currently, due to processing malpractice, milk handling and transportation, market-placed dairy consumption can cause mortal harm to human health. In the Game The recent decades have seen a rise in scandals related to milk happening all over the globe. A study conducted by India's Food Safety and Standard Authority (FSSAI) shows that 68.4 per cent of the country 's milk is not in line with the legal norm (Shingh et al. 2020). The traceability of milk can be defined as the capacity to Trace how milk and milk products are moved from its production through different routes until Its final consumption reaches. Unlike in the past, there has been a decline in the relationship between dairy producers, processors/manufacturers, distributors and consumers, with very little to no information passed on to consumers from previous members of the dairy supply chain. The use of Blockchain technology and the Internet of Things is presented in recent scientific literature as a potential solution for improving traceability in the food supply chain system. Today, consumers are far more discerning, more willing to pay for food protection, quality and ethically generated food. Blockchain technology has great potential for transforming the dairy sector, as it can address various challenges in the dairy supply chain system that prevent transparency and traceability. All the associated members should

Volume 2 – Issue 7
Online ISSN: 2582-368X
www.agriallis.com

be registered in the Blockchain network for this purpose; they will have a unique digital identity and profile in the network.

Conclusion

Blockchain technology is running the crypto-monetary bitcoin. It is a decentralized transaction environment where all transactions are recorded in a public directory that is visible to all. The objective of Blockchain is to provide anonymity, security, privacy and transparency to all its users. However, these attributes set out a number of technical challenges and constraints that need to be addressed. The government has a bull 's eye on the Digital India campaign, and Blockchain technology will make nations dream. India's government has aimed to introduce Blockchain technology in a number of industries, which is why NITI aayog published India's own Blockchain Management strategy earlier this year. India has also vision on creation largest blockchain network in the world, namely IndiaChain. Some Indian originated start-up like KhethiNext, aka plus also started adopting blockchain technology on a pilot basis, and they are also collaborating with large tech giants. Blockchain technology being the new technology, business owners don't know if they get higher payments due to the higher cost of using them. Another big constraint lies in the developing world 's dairy production system, where dairy farming is non-commercial and fragmented. A large number of farmers participate in it, but they have a limited herd size. The integration of these farmers into the Blockchain-based dairy supply chain system presents challenges. For this reason, in order to apply Blockchain technology to the dairy sector, it is necessary to carry out a thorough research on these issues. Like all other technologies, this technology also has some flaws, but we need to look for a positive side and overcome its negative effect. In the end, we can conclude that blockchain management is *"Ensuring performance, trust and accountability from farms to consumers"* in every way.

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Volume 2 – Issue 7
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