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IMPACTS OF BIO-INVASION BY NILE TILAPIA (*Oreochromis niloticus*) IN TELANGANA STATE

Article Id: AL202137

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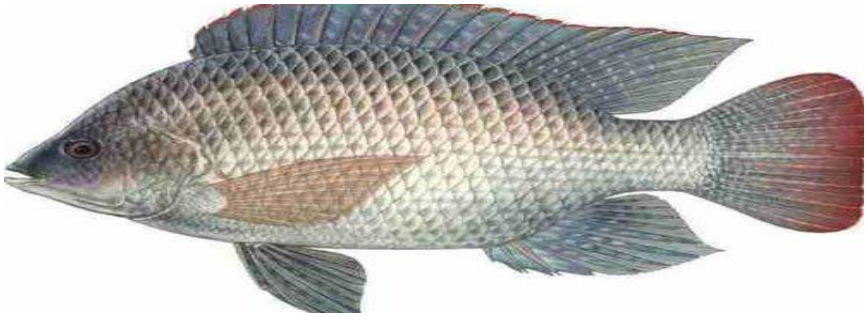
Nowadays, the main environmental concern is Biological invasions. The bio invasions have great impacts on the native flora and fauna, and we are not aware of which introduced species will become invasive (Attayde et al., 2011). Invasion is a process done by human activities either accidentally or intentionally outside of its natural habitat (Kottelat and Whitten, 1996). Nile tilapia is an invasive species all over the world. Nile tilapia is a native species of Africa. From the upper Nile River southwards to the equator and west to the Atlantic coast, Nile tilapia is distributed naturally (Trewavas, 1983).



Oreochromis niloticus (Source: Fishbase.org)

Scientific Classification:

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cichliformes
Family: Cichlidae
Genus: Oreochromis

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Species: O. niloticus

In India, Nile tilapia was introduced in 1987 for the purpose of aquaculture. According to Singh and Lakra, 2006 a total of more than 7.17% is contributed by Nile tilapia to the inland fish production. In the global production of inland fishes, tilapias occupy second place after the carps (Ridha, 2006) and Tilapia is generally known as Aquatic Chicken. Because of its tolerance to the wide environmental conditions, Nile tilapia is a widely cultured species (Tsadik and Bart, 2007). Over the past three decades, the percentage and contribution of Nile tilapia were increased drastically to capture fisheries production and global aquaculture (De Silva et al.,2004).

On the other side, due to the introduction of species like tilapias, indigenous species were affected by poor growth rates and age structure (Sreenivasan, 1967; Dwivedi et al., 2016). Local aquatic biodiversity was degraded by appearance increased invasive alien species (Lakra *et al*., 2008). Local biodiversity (flora and fauna)is highly affected by the population of Nile tilapia, which is competing with other local population for food and shelter. Icthylogical diversity is greatly affected by Nile tilapia because of changing environmental conditions and lack of predation (Leveque, 2002; Vicente et al., 2011).

Habitat and Biology

The optimum temperature for Nile tilapia is from 31 to 36 °C. They used in life in shallow waters. Tilapia is highly tolerant to environmental parameters such as salinity, dissolved oxygen and temperature. Nile tilapia can filter feed by entrapping suspended particles, including phytoplankton and bacteria, on mucous in the buccal cavity, and also periphyton mats are the main source of nutrition. At the age of 5-6 months, it attains Sexual maturity in ponds. The temperature of the water is the main environmental factor in tilapia for spawning (24 °C). Male fish starts the breeding process by digging a crater-like spawning nest. This nest is the spawning place for a ripe female. Then male fish starts fertilization; after the fertilization, female fish carry the eggs into her mouth, and in the mouth, the eggs are incubated (Balarin and Hatton, 1979). There is a positive relationship between fecundity and female fish body mass.

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Adaptive Characters for Invasion of Nile Tilapia

Nile tilapias, in particular, are highly successful invaders due to their environmental tolerance to water quality parameters such as salinity, dissolved oxygen, temperature and successful reproductive strategies and trophic plasticity (Lowe-McConnell, 1958; Leveque, 2002). This tolerance to environmental variability, along with their high fecundity, rapid growth rates and omnivorous feeding habits, further contribute to successful invasions in estuaries as well as freshwater bodies.

Occurrence of Nile tilapia in Telangana

Telangana state is endowed with vast and varied inland water bodies and diverse aquatic resources viz., tanks, canals, ponds, rivers and reservoirs. In Telangana, tilapias are distributed in all water bodies such as reservoirs, canals, ponds and tanks, and *Oreochromis niloticus* is the most occurring species of tilapia. Tilapia is the second most abundant species in the state of Telangana after the major carps. Compared to canals, ponds and tanks, the growth and abundance of tilapia are more in the reservoir due to the availability of food and enough space; also, they get sexual maturity earlier in reservoirs. Tilapia is not a culture species in Telangana, but they occupy the second position because of their prolific breeding nature and easy to acclimatize to changing environmental conditions. Recently, a study stated that 36-49 % of the catch was Nile Tilapia variety in Ameenpur Lake.

Impacts of Bio-Invasion

Each and Every aquatic ecosystem prone to some positive and negative impacts due to the bio invasion of alien species.

Positive Impacts by invasive Nile tilapia on Non-native Aquatic Ecosystem

Nile tilapia greatly reduces the water purification costs by eating aquatic vegetation and detritus matter, and therefore it is used for controlling aquatic weeds. Since the last thirty years, Nile tilapia is cultured as commercial aquaculture species. Generally, in stagnant waters, Chara sp. and Najas marina are a major problem; they could be controlled by introducing tilapia and some aquatic vegetative problems also solved by the invasion of tilapia. Most of the filamentous algae and floating plants are controlled by tilapia, such as

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Lemna species and filamentous algae. Malaria causing mosquitos was greatly controlled by tilapia by eating mosquito eggs and larvae in many countries. The contribution of tilapias to global aquaculture production has increased over the past few years, with the production of 2.6 million tons in 2004 was and continued to rise up to 3.6 million tons in 2008 (FAO, 2010).

Negative Impacts by invasive on Non-native Aquatic Ecosystem

In many ways, tilapia can cause problems with native biodiversity (Indigenous species). They disrupt the ecological balance and negatively affect the local environment by competing for food and shelter with other species, and the intensive production of tilapia leads to Eutrophication of water. They gradually decrease the diversity and density of local plants, which are used for spawning and protection by the local fish species. Tilapia mostly feeds on the eggs of other species, which leads to the extinction of local species. Eating Not only local species but also they spread disease within the aquatic ecosystems. Along with commercial fisheries, recreational fisheries were also greatly affected by the invasion of Nile tilapia. In ponds and lakes, the primary productivity mainly depends on the phytoplankton and zooplankton composition. Production is reduced by the invasion of tilapia by grazing upon them. Phytoplankton and zooplankton number, composition and also biomass in tropical lakes and reservoirs can be reduced by Nile tilapia, but phytoplankton biomass and size-structure influence the magnitude of effects. Singh et al., 2010 stated that local recourses and native species suppressed by the invasion of Nile tilapia.

General Management Strategies

Ecology, morphology, phenology, reproductive biology and physiology are the essential and basic knowledge for the effective management of alien species. We can handle the problem of bio invasion in many ways. Strict quarantine, strictly controlled introductions and checking on imports are major ways to stop and suppress the invasion of new species from other geographical areas. Moreover, one of the best methods to control is preventing the establishment of alien species. The general public can also participate in alien species prevention by educating themselves about this problem.

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Conclusion

As a consequence of its wide environmental tolerance, high reproductive rate, rapid population growth and ease of cultivation, the Nile tilapia has become a model of livestock farming in several countries. However, the same characteristics that make the species attractive for aquaculture render it highly invasive, with considerable potential for becoming a pest in aquatic environments where it is introduced. The risks of tilapia introduction must, therefore, be rigorously evaluated and weighed against the potential socio-economic benefits.

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STRATEGIES FOR IMPROVING PRODUCTIVITY OF MILLETS/NUTRICEREALS, PULSES AND OILSEEDS

Article Id: AL202138

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Historically, pulses, oilseeds and millets have provided food and subsistence to the Indian population alongside vegetables and fruits naturally available in fields and forest areas. Millets are one of the cheapest sources of energy, higher content of digestive fibres, protein, vitamins and minerals (Kumar *et al*., 2013). The current production of nutricereals is only 17 million tonnes. In order to promote nutricereals as a staple food and enhance their accessibility, it would be necessary to achieve a jump in production to around 34 million tonnes by the end of 2022-23. The productivity target should be raised to an average of 1.6 tons/ha from the current 1.1 tons/ha to achieve the critical production level and enable the integration of nutricereals into the public distribution system (PDS). Besides, the food and nutritional security of India warrants a stable pulse production achievement in the country. The recent interventions have brought about a substantive increase in pulse production to about 23 million tonnes. The projected demand by 2022-23 is 25 million tonnes, and by 2030 it is 32 million tonnes. On the other hand, oilseed production from primary sources should be increased from the current 31 million tonnes to 45 million tonnes by 2022-23, which will help in increasing the edible oil production in India from the present 7.1 million tonnes to a range of 11-14 million tonnes. Different secondary sources and tree-borne oils (TBOs) can contribute additional 3 million tonnes; besides prohibiting the dependency on import to almost 16 million tonnes, that, on the other hand, will be considerably greater by the end of 2022-23.

Millets/nutricereals

- Millets have been neglected to cause a drastic decline in area coverage, but it is the most appropriate crop for rainfed and less endowed ecologies, and also their relevance

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assumes a critical role in view of climate change implications; hence, millets should be promoted as climate-resilient crops, particularly in rainfed regions.

- Millets are an abundant source of different essential nutrients but low in the glycaemic index, which makes the crops superfoods for a healthy living; hence, promote millets as nutri-cereals and as staple crops.
- This will provide a broad base; the cereal consumption basket, currently dominated by wheat and paddy and millets popularized as nutri-cereals will come to acquire a critical mass in the market and support higher production.
- A virtuous cycle between supply and demand will need to be created for a spiralling growth of nutri-cereals.
- There is a need to adopt both approaches to productivity enhancement and area expansion.
- Of nine millets commonly cultivated in India, three major millets, like jowar, bajra and ragi, may be taken up on a priority basis considering the extent of area under cultivation, the quantum of production, scope for higher productivity, and consumer preferences.
- Small millets like kodo, little and barnyard millets have minimum requirements of water and can be successfully grown in the post-*kharif* fallows using residual moisture available in rainfed areas.
- Finger millet has higher nutritional benefits and can be produced.
- Most of the millets are short duration in nature (generally 65-80 days) and can be successfully grown in the post-*kharif* fallows.
- Additional areas should be brought under millets which will significantly increase the cropping intensity in dryland agriculture and contribute to higher output and farm revenues.
- Area under millets has to be substantially increased from the current extent of 16 million ha.
- Use post-*kharif* fallow lands with residual soil moisture in high rainfall regions like central and eastern Indian states which are estimated at 12 million hectares.
- Crop substitution for rice in *kharif* in Indo Gangetic Plains.
- Promote millet based intercropping systems.

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- Development of wastelands, mostly available in central India and bringing them under millets.
- MGNREGA funds can be used to develop these common wastelands into cultivable lands, and an integrated and target oriented strategy may be drawn up for this purpose.
- One of the prerequisites for promoting millets is the establishment of primary processing facilities at the farm gate/village level; hence, primary processing units should be included under the National Food security Mission (NFSM) and agriculture machinery schemes of the Ministry of Agriculture.
- In order to strengthen and sustain the production of millets, adopt a market-led approach.
- Advocate and promote awareness about nutri-cereals among consumers across the country to create demand; therefore, the year 2018 was declared as the 'Year of Millets' by the Government of India for reorienting research, policy advocacy and demand creation by adopting an aggressive and comprehensive public outreach programme.
- Millets like sorghum are a good fodder source; as a result, integration of nutri-rich millet fodder with existing millet supply chain models in beneficial to contribute to enhanced farmers' income.

Pulses

- The components of a comprehensive strategy for self-sufficiency in pulses include enhancement in yields (from the current average of 0.7 t/ha to 1.4 t/ha), area expansion through intercropping, use of post-*kharif* rice fallows and increased cropping intensity.
- Focus on enhancing the farmers' access to an adequate quantity of quality seeds.
- The existing seed replacement rate (SRR) under pulses is only 15-20 per cent; in order to achieve high yield from good seed, ensure that SRR increases to 42 per cent (by 2022-23), taking care of varietal replacement rate (VRR) concurrently.
- In order to take care of SRR and VRR, the seed production system needs to be diligently planned though the chain consisting of breeder seeds, foundation seeds and certified seeds.
- The ratio of requirement from one stage to the other must be ensured.

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- Support decentralized seed production system by establishing seed processing plants at Gram Panchayat levels and institutes like KVKs/SAUs and ICAR centres.
- Pulses are generally cultivated under rainfed conditions and less endowed farming systems; therefore, it is necessary to create small irrigation structures combined with micro irrigation systems to offer protective or life saving irrigation, particularly at the critical crop growth stages.
- Integrated pest management (IPM) practices should be adopted as pulse crops are vulnerable to pests and diseases during growth stages as well as storage conditions.
- To incentivize the farmers to continue with pulse production, a favourable intercrop comparison with competing crops like cereals, cotton will have to be ensured.
- The maximum scope for area expansion under pulses comes from post *kharif* fallow lands, which is estimated at about 12 million ha, largely in central and eastern India, where residual soil moisture is good due to higher annual precipitation.
- An important intervention of securing the cultivated area from open grazing of cattle and the promotion of green fencing should be advisable.

Oilseeds

- To enhance oilseed production, the focus should be on increasing the oilseed productivity, in addition to bringing more area under their cultivation.

- Target an area increase under primary sources of edible oils from 26 million hectares in 2015-16 to 31 million hectares by 2022-23; and production from 25 million tonnes to 45 million tonnes. In consonance, productivity should increase from 968 kg/ha to 1500 kg/ha in the same period.
- Among nine seasonal oilseeds, rapeseed and mustard can become the core focus, as it offers major scope in terms of area coverage, productivity and oil conversion factor.
- Soybean and groundnut are two others that can help in scaling up the output.
- **Rapeseed and mustard**

✓ Timely sowing, seed treatment and maintenance of plant population
✓ Application of boron and zinc-based on soil test values
✓ Intercropping with chickpea or lentil, irrigation management and foliar spray
✓ Management of aphids

- **Soybean**

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- ✓ Varietal cafeteria approach using zone specific varieties
- ✓ Seed treatment and use of bio-fertilizers
- ✓ Broad bed and furrow (BBF) system of planting
- ✓ Balanced nutrient management and irrigation at the seed filling stage
- ✓ Intercropping with pigeon pea, maize etc.

- **Groundnut**

- ✓ Broad bed and furrow (BBF) system of planting in kharif and crisscross planting in rabi season
- ✓ Protective irrigations at flowering and pod formation stages
- ✓ Application of zinc, seed treatment and use of bio-fertilizers

- Extend oilseed cultivation to non-traditional areas and non-traditional seasons.
- Harvest the advantage of castor productivity and promote its cultivation by assessing domestic demand and export potential.
- The country's non-edible oil demand is also growing, and there exists greater scope for the use of castor oil in the industry.
- In order to promote domestic production of second and third-generation derivatives, having higher economic value, adopt a suitable policy framework for castor to help the farmers to reap higher farm revenues or incomes.
- The area under mustard can be enhanced by substituting it with wheat in Punjab, Haryana and Western Uttar Pradesh by 5-10 per cent.
- Mustard may also be promoted in unconventional areas, including northeastern states.
- Promote oil palm cultivation by addressing some constraints like long gestation of oil palm tree through intercropping to support better income flow, fluctuation in global prices of crude palm oil, etc.
- One of the important area expansion strategies includes utilizing an estimated 12 million hectares of post *kharif* fallows for promoting oilseeds besides pulses and nutri-cereals.

Conclusion

One of the most significant means for addressing developmental challenges in the Indian context is an achievement of self-sufficiency in food production and ensuring nutritional security for all. India's massive vegetarian diet based population, food access

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issues encountered across states and escalating sustainability detriments in agriculture make it important to have policies for promoting the production of pulses, oilseeds and millets due to their higher compatible nature and also to guarantee improved accessibility and delivery at affordable prices. Another vital challenge is the inactivity of the Government in procuring and distributing millets, pulses and oilseeds especially through the public distribution system. Additionally, pulses' and millets' procurement continues to be a deficit arena depriving the growers to enjoy full advantages of minimum support price. In order to achieve the aim of doubling farmers' income by 2022, there are requirements of viable strategies encompassing major elements such as *the* introduction of millets-based pulses and oilseeds cultivation to minimize risks; capacity building with R&D along with input supply in single-window mode; promotion of value addition and creating market demands through collective actions like the formation of FPOs and SHGs; and policy support for buy back arrangements with MSP; crop insurance; inclusion in MDM and PDS system; infrastructure for farm gate processing and warehouses.

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BIOFORTIFICATION THE KEY TO ADDRESS MALNUTRITION

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Malnutrition affects more than two billion individuals, Africa and Asia being the most affected regions Grew *et al.*, (2018). "Biofortification" is defined as the production of nutritionally enhanced food crops using modern biotechnological techniques, conventional plant breeding, and agronomic practices Garg *et al*., (2018). Traditionally the prime focus of our agricultural system is increasing grain yield and crop productivity, leading to the rapid rise in micronutrient deficiency in food grains followed by among the consumers. Recent trends shows a shift in the focus to the production of nutrient-rich food crops in sufficient quantity Khush *et al*., (2012).

Need For Biofortification Research

The primary source of nutrients is agricultural products, especially for those living in developing countries Graham *et al*., (2001). The diet includes rice, wheat, maize, cassava which are insufficient in nutrients like vitamin A, iron, zinc, calcium, copper, magnesium etc. These nutrient deficiencies cannot support a healthy life, thus resulting in poor health, stunted growth, reduced socio-economic development Chizuru *et al*., (2003). Globally, 38% of pregnant women and 43% of pre-school children are affected by malnutrition. Biofortification can enhance the desired nutrition in the edible portion of the crop plant and help in lowering the statistics. Moreover, biofortifying the crops consumed by the poor population around the world can be a targeted approach for improving the amount of nutrient consumed by the population Brinch *et al*., (2007).

Transgenic Approach For Biofortification

Transgenic methods are useful where there is limited or no genetic variation among the plant varieties related to nutrient content Brinch *et al*., (2007). Hence, when a particular nutrient is not present naturally in the crop, the transgenic approach is the only way to fortify

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this crop with the nutrient Perez *et al*., (2013). The transgenic approach helps in the incorporation of the genes that help in increasing micronutrient level, reduce the presence of antinutrient elements. The development of crops through these approaches need a substantial amount of time, investment, effort, but it is a cost-effective and sustainable approach Das *et al*., (2013). In wheat, provitamin A content is enhanced by expressing bacterial PSY and carotene desaturase genes [CrtB, CrtI] Wang *et al*., (2014). Iron content enhanced by expression of ferritin gene from soybean Xiaoyan *et al*., (2012) and wheat [TaFer1-A] Borg *et al*., (2012). Protein content enhanced by using Amaranthus albumin gene [ama1] Tamas *et al*., (2009).

Agronomic Approach for Biofortification

The agronomic method needs the physical application of nutrients for improving temporarily the nutritional and health status of crops followed by the nutritional status of consumers Cakmak *et al*., (2017). Micronutrients like iron, zinc, copper, magnesium etc., are found in different proportion in edible parts of the plant, which are generally absorbed from the soil. Thus, increasing the soil nutrient status can lead to reduced malnutrition in the population Cakmak *et al*., (2008). This approach is simple and inexpensive but requires extra attention to application methods, source of nutrients and environmental effect. Soil microorganisms like *Azotobacter*, *Bacillus*, *Rhizobium*, *Pseudomonas*, etc., can also be used to increase the Phyto-availability of nutrients Smith *et al*., (2007). Foliar application of urea with iron inclusion has a positive correlation with high iron accumulation Aciksoz *et al*., (2011). Foliar application of zinc reduces the amount of antinutrient element (phytic acid) and reduce zinc deficiency in the consumer population Yang *et al*., (2011). Moreover, mycorrhizal fungi, along with fertilizers, are used extensively for biofortification Nooria*et al*., (2014). zinc biofortification was also achieved by using *Bacillus aryabhattai* Ramesh *et al*., (2014).

Conventional Breeding Approach for Biofortification

This is the most acceptable approach for biofortification and is a sustainable, cost effective alternative to the transgenic and agronomic approach. Sufficient genotypic variation is needed to make this approach feasible. Here, the parent lines with high nutrient contents are crossed with the lines with desirable agronomic traits for many generations to obtain plants with desired nutrient and agronomic traits. Sometimes distant relatives can also be

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used in the crosses. Mutagenesis can be an alternative method to introduce variation Garg *et al*., (2018). Closely related wild relatives of wheat with wide variation in grain iron and zinc concentration can be used for exploitation of modern elite cultivars Monasterio*et al*., (2000). Six high zinc wheat varieties released in India (2014)- BHU 1, BHU 3, BHU 5, BHU 6, BHU 7, and BHU 18. In Pakistan (2015)-NR 419, 42, 421, and Zincol. WB2 is high in iron and zinc content developed by the Indian Institute of Wheat and Barley Research. High provitamin A durum wheat variety (HI 8627) has been released by the Indian Agricultural Research Institute (IARI), India, in 2005. Black grain wheat in China rich in protein and selenium Li *et al*., (2006). The purple wheat cultivar (Indigo) released in Austria in 2006 Eticha *et al*., (2011).

Limitations

Agronomic approach- The success rates are highly variable due to difference in mineral mobility, soil composition in specific geographical areas, mineral accumulation in plant species Ismail *et al*., (2007). It is less cost effective and labour intensive, demands continuous input of micronutrients on a regular basis. Many times it's not possible to target the edible portion of the plant for nutrient accumulation. For example- in Turkey, the cereals absorbed a high amount of zinc from the soil, but the accumulation of the zinc was not in the grain Cakmak *et al*., (1999).Accumulation of antinutrient elements (phytic acid) is one of the limitations Frossard *et al*., (2000). Moreover, the accumulation of such fertilizers in soil and water also posses a setback Waters *et al*., (2011).

Conventional breeding approach- The major limitation is the availability of genetic variation. It is a time taking process. Sometimes it may be impossible to breed for specific traits by conventional means. Example- improving Se concentration in wheat grains Lyons *et al*., (2005).

Transgenic approach- The major limitation is the low acceptance among the masses. Another major limitation is different countries have adopted different regulatory processes for the acceptance and commercialization of these transgenic crops Inaba *et al*., (2004). The regulatory process is very expensive and time-consuming Watanabe *et al*., (2005)—example- the case of Bt-brinjal.

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Conclusion

Biofortification is a promising, cost effective strategy for combating malnutrition in the population throughout the world. The generation of biofortified crops with enhanced nutrition especially increased content of iron, zinc, provitamin A etc., can provide a sufficient level of these and other micronutrients that are frequently lacking in the diets of developing and developed countries. Many international initiatives, like Harvest Plus programs and national programs, act as a pillar to achieve the target. Traditional breeding approaches are widely accepted rather than transgenic approach. Transgenically fortified crop plants have to face difficulties due to acceptance constraints among consumers and different expensive and time-consuming regulatory approval processes adopted by different countries. Biofortified crops have a bright future and have the capacity to reduce malnutrition cases in developing countries.

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BROWN MANURING

Article Id: AL202140

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Brown manuring is simply a 'no-till' version of green manuring, using a selective herbicide to desiccate the crop before flowering instead of using cultivation. According to this technique, green manure crops are grown along with the crop and killing them with the help of herbicide. The plant residues are left standing in the field along with the main crop without incorporation/in-situ ploughing until its residue decomposes itself in the soil. It helps to add organic manure besides weed suppression by its shade effect. The post-emergence herbicide spray on green manure leaves resulting in loss of chlorophyll in leaves showing brown in colour is referred to as brown manuring.

Crops Suitable for Brown Manuring (Chauhan and Rahevar, 2021)

Non-leguminous crops: The non-leguminous crops which provide only organic matter to the soil are used to a limited extent. Example: Niger, Wild indigo *etc*.

Leguminous crops: Crops provide organic matter along with nitrogen to the soils. The legumes are preferably used, and they can fix atmospheric nitrogen with the help of its nodule bacteria. Example: Sun hemp, Dhaincha, Mung, Cowpea, Lentil *etc*.

Generally, brown manuring in rice is the practice of growing *Sesbania spp*. and rice together, and when these dhaincha plants overtake the rice plants in height at about 25 days of co-culture, a weedicide 2, 4-D is applied to kill these *Sesbania* plants. After 4-5 days of spraying, *Sesbania* plants will appear brown and then start dying; leaves will fall on the ground and form mulch and help in smothering of weeds. As it is a selective herbicide, it kills only *Sesbania* plants and not the rice plants. This is called the down knocking effect.

Sesbania is a live cover that offers interference (at pre-killing period) with weed and later as a dead residue mulch offers stimulation by addition of organic matter (at post-killing period). As brown manure crops are grown between the lines of the major crop, so planting

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density in the field was high, due to which there would be no free space available for weed for its spread resulting in a minimum weed population. In brown manuring, knocking down of *Sesbania* by 2,4 D application fasten the decomposition and release of nutrient present in *Sesbania* as compared to in-situ incorporation. *Sesbania* could add C and N into the soil, which facilitates favourable microbial action (Behera and Das, 2019). Also, during the decomposition of *Sesbania*, certain organic acids, allelochemicals are released, which might offer some depressive effect on the weed seed bank. Enhanced soil fertility as well as lesser weed competition under brown manuring treatment, leads to higher productivity of crops.

Benefits of Brown Manuring

- Soil organic carbon content is increased by brown manuring, thereby supplying the required nitrogen for the rice plants. Thus, a part of nitrogenous fertilizer (upto 25%) can be replaced by brown manuring.
- It also increases the crop yield
- Biomass of green manure conserves moisture
- It also improves the soil health parameters like organic carbon content and earthworm population of the soil.
- Brown manuring improves the physicochemical and biological properties of the soil.
- Brown manuring reduces the weed population in the early stage due to its high growth rate and competition with the weeds.
- Brown manuring increasing soil organic matter, which decreases the bulk density of the soil and acts as a buffer preventing or lessening the transmission of compaction to subsoil from external loads acting on the topsoil

Conclusion

As brown manuring is eco-friendly and helps to suppress weeds as well as add nutrition to the soil, it can be used as a good approach for higher production of crop and thereby leading to benefit for the farmers. It should thus be widely advocated by the extension agencies to realize its benefits for the farming community of the nation.

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ALLELOPATHY IN AGRICULTURE

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Allelopathy is a biological phenomenon by which an organism produces one or more biochemical that influences the germination, growth, survival, and reproduction of other organisms. Allelochemicals, which are the secondary metabolites of plant, algae, bacteria and fungi, are responsible for allelopathy. The crop having allelopathic property can be used for nutrient management, weed control, disease, pest management and abiotic stress management in field crops. The allelochemicals also enhance and regulates crop growth. Allelochemicals produced by microorganisms, insects, higher animals and plants could provide new strategies for maintaining and increasing forest and agricultural production in the future. The application of allelopathic substances in the crop field reduces the utilization of agrochemicals, which have a detrimental effect on the environment and human life.

Allelopathy in weed management

Allelochemicals have the potential to be used as a herbicide. Allelopathy may help in weed management through the inhibition of weed seed germination and seedling growth. Weed-suppressing ability in several crops is either due to the exudation of allelochemical compounds released from living plant parts or from decomposing residue. As these are free from all the problems associated with present herbicides, they could be used directly as herbicides, and their chemistry can also be used to develop new herbicides. A lot of secondary compounds are produced by plants and microorganisms, and many of these are phytotoxic to weeds, thus having the potential to be used as herbicides. Glufosinate –AM, a synthetic analogue of bialaphos (microbial toxin/allelochemical is found in bacterium *Streptomyces hygroscopicus*) is extensively used for weed control in cropped and non-cropped situations. AAL toxin is a metabolite produced by *Alternaria alternate* f.sp. *Lycopersici* used as a natural herbicide. Many crops have been reported with their alleged

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allelopathic effect. For *e.g.*, Barley produces phenolic compounds and two alkaloids *viz.*, gramine and hordenine. Gramine inhibited the growth of chickweed, even in small concentrations. In *Sinapis alba*, root length and vigour of root tips decreased due to both hordenine and gramine. Radicle tips exposed to hordenine and gramine of *Sinapis alba* showed damage to cell walls, increase in both size and number of vacuoles, autophagy, and disorganization of organelles. Rye residues have been used to control weeds in fruit orchards (Narwal and Haouala, 2013)

Allelopathy and crop nutrition

Allelochemicals play a significant role in plant nutrition. These allelochemicals released into the rhizosphere, produced by plant, algae, bacteria and fungi, regulate solubilization, mobilization, release and chelation of mineral nutrients. Allelopathy can help to improve Nitrogen use efficiency (NUE). To improve N use efficiency (NUE) in agricultural systems, the nitrification rate in soil should be decreased, which is an important strategy to minimize N losses. Allelopathy offers an attractive and natural option to decrease nitrification for improving NUE in agricultural systems (Jabran *et al.* 2013)

Allelopathy in insect pest management

Extensive use of synthetic insecticides usually have a negative effect on the environment, human and animal health, and most critically, develops resistance against insects. Scientists are therefore turning towards the discovery and use of natural insect suppressants. Azadirachtin, an allelochemical from neem plant, effectively inhibit insect cicadellid, whitefly and *Ashbya gossypii*. Neem seed oil is reported to exhibit antifeedant properties against nymph and adult strawberry aphids. Eucalyptus contains a volatile oil which severely effects post-embryonic development and adult emergence of rice moth when sprayed during the larval period of rice moth. Common rue plant contains allelochemicals, coumarin and flavonoids, which have the potentiality to suppress Mediterranean fruit fly and mosquitoes. Ethanol produced from California pepper tree's leaf extract imparts insecticidal effect on elm leaf beetle. *Ambrosia trifida, Ageratum conyzoides,* and *Lantana camara* have allelopathic activity against insect and other pests (Farooq *et al.* 2011)

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Allelopathy in disease management

Plant disease is a serious issue causing damage to many crops. The soil-born pathogen causes substantial losses to crop production as it disturbs the crop stand and lowers the quality of production. Although cultural practices such as burning infected plant debris and using resistant cultivar have long been used, diseases still cause abundant losses in crop yields. Chemical disease control is not very effective and also very harmful to the environment. Another approach for the suppression of plant-pathogen is by using allelopathic crops in different ways. For reducing disease intensity, an allelopathic crop can be intercropped with the main crop, which creates a microclimate congenial for disease suppression. Intercropping of tomato with Chinese chive (*Allium tuberosum*) inhibit the multiplication of bacterial wilt (*Pseudomonus solanacearum*) without any negative effect on tomato. Marigold, when intercropped with tomato, suppress early blight of tomato caused by *Alternaria solani*. Neem leaves or neem cake applied to soil have a long term effect on the management of root node nematodes. Dried cabbage (Brassica oleracea L. var. capitata) incorporated into the soil significantly reduced the yellow cabbage pathogen (F. oxysporum sp. conglutinan) population and produced near disease-free cabbage plants. Methanethiol, dimethyl sulfide and dimethyl disulfide from the residues were suggested to have contributed to disease suppression (Ramirez Villapudua and Munneche1988).

Allelochemical as growth regulator

In modern agriculture, the role of plant growth regulators is very important. These are the substances which are known to control the plant's physiological and biochemical processes at low concentration. The growth-promoting effects of allelopathy can be used in different ways. Foliar application of plants extracts which having promotive effects can be beneficial for other crops. At higher concentration, the allelochemicals have an inhibitory effect, and at low concentration, the allelochemicals have a promotive effect, *i.e.* concentration of allelochemicals is inversely related to the promotive effect of the plant. Moringa water extracts contain a growth hormone *i.e.* Zeatin, which is the source of cytokinin, has been widely used for growth promotion in agronomic and horticultural crops. It increases yields by 25%-30% for a number of crops such as soyabean, maize and coffee. So, the juice from fresh Moringa leaves can be used to produce an effective plant growth hormone. (Maishanu *et al.* 2017)

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Allelochemicals in abiotic stress management

The abiotic stresses, increase in daily mean temperature, changed patterns of precipitation, increase in episodes of drought, and floods may pose threats to crop production and food security in the future. Plants have evolved several mechanisms to cope with abiotic stresses. Production and release of secondary metabolites among organisms induce tolerance mechanism against abiotic stresses in ecosystems. Production of allelochemicals at higher rates induces resistance in plants against stresses and helps them grow vigorously under such conditions. The production of allelochemicals is influenced by the age of the plant, type of stress, the intensity of stress and surroundings. For example, when drought-resistant plants are exposed to drought condition, cyanogenic glucoside synthesis is enhanced. Biosynthesis of ferulic acid is increased under drought condition in wheat. Cucumber, when exposed to dry conditions, produces more phenolics and flavonoids. Similarly, temperature fluctuations also cause a change in the production rate of allelochemicals. Plants have to make necessary metabolic and structural adjustments to cope with the stress conditions. Stress-induced changes in plant metabolism and development can often be attributed to altered patterns of gene expression. In response to stress, some genes are expressed more intensively, whereas others are repressed. The protein products of stress-induced genes, named stress proteins, are helping plants to survive under stress conditions and minimizing the effectiveness of the stress agents. (Pedrol *et al*. 2006)

Conclusion

The term ‘allelopathy’ is mainly viewed negatively, but if correctly managed, this phenomenon may be exploited for enhancing crop productivity. There are a number of reports indicating the improvement in crop production due to allelopathic interactions. This manipulation can be achieved through weed, disease, pest and nutrient management *etc*. For sustainable agriculture, allelopathy has achieved great success in weed management. The utilization of allelopathic crop combined with reduced doses of herbicides can be a promising strategy for sustainable weed management, enhancing environmental health. The allelopathic potential of the crop can be exploited directly by using allelopathic interactions or indirectly by utilizing allelochemicals as a biopesticide.

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ENVIRONMENTAL IMPACTS ON EXOTIC FISHES INTRODUCTION IN INDIA

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Introduction of exotic species has the extinction of native species in aquatic ecosystems. Major concerns over the introduction of exotic fish are prolific breeding, predation or competition of introduced species affecting indigenous biodiversity. While much of the recent attention has been mainly focused on the adverse impact of exotic species introduction.

Why are they Introduced?

1) Improving local fishery potential,
2) Sport fishing,
3) For aquarium keeping,
4) Improving aquaculture productivity,
5) Controlling unwanted(mosquitoes) organisms.

* These all are only focused on short-time benefits of fisherman and fisheries sectors. But did not consider long term adverse effect on the biodiversity of the aquatic ecosystem.

Exotic Fishes Transplanted in India

1) Game fishes

* Brown trout- Salmo trutta fario(1863-1900)
* Rainbow trout -Salmo gairdner (1907)
* Atlantic salmon- Salmo salar (1968)

2) Food fishes

* Tilapia- Oreochromis mossambicus (1952)
* Common carp- Cyprinus carpio (1957)
* Grass carp - Ctenopahryngodon idella (1957)

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* Silver carp - Hypophthalmichthys molitrix (1959)

3) Larvicidal fishes

* Guppy - Pocilia reticulata (1908)
* Top monnow (mosquito fish)- Gumbusia affinis (1928)

4) Ornamental fishes

* Live bearers (27 species)
* Egg layers (261 species)

Impact on biodiversity

1) Genetic impacts

The genetic impact can be classified into two categories.
A) Reduction of effective population size by the ecological, biological & genetic of introduction.
B) Alteration/extinction of gene pools of the species/crossbreeding or hybridization & backcrossing.

Extinction due to hybridization

Hybridization between exotics & Native species has not only brought in genetic contamination but even resulted in species extinction in some cases.

Loss of traits

It's leading to economic value decline takes place in uncontrolled hybridization between exotic and native species.

Hybridization between bighead carp (Aristichthys mobiles) and silver carp (Hypophthalmichthys molitrix) should beneficial properties in terms of growth, food conversion and disease resistances.

But in further uncontrolled hybridization of these fishes in later generation, the offspring lost the acquired beneficial traits.

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Genetic Bottleneck

A genetic bottleneck is a sudden and drastic decline in numbers. It effectively samples a few individuals from a larger gene pool. Resulting in a remnants population with a less overall variation. Loss of variation has two components like reduction in the variance of qualitative traits and loss of specific and usually rare alles.

Inbreeding Depression

It is probably the most serious and nebulous problem in small population of endangered fishes. It is the mating of individuals related by common ancestry that share common genes due to descent than individual randomly selected from the population. Fitness characters with low heritability are generally effected in consanguineous mating.

2) Ecological impacts

Competition of exotic fishes with the native species for living space with same niche preference for food with fishes of similar types of feeding habits, predation on native fishes, spreading parasites and pathogens, thereby are some common ecological concerns.

Predation-Prey Interaction

Top carnivorous are often viewed as the most important significant threat as introduced fishes. Predation directly reduces the size of the prey species in the ecosystem.

Competition

Competition can occur between exotic and native species for food, habitat, mates and other essential resources. In recent days reported for inland water bodies, Tilapia Mozambique is considered to be a threat to native diversity.

3) Disease impact

The spread of pathogen along with species transported or traded in aquaculture is a serious concern with several international agencies such as, FAO, WHO, WTO and OIE.

4) Habitat impact

Many species of freshwater animals greatly modify aquatic habitat when placed into new areas. For eg. Crayfish, common carp, grass carp etc..

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5) Socio-economic impact

Since the exotic fishes never fetch a higher price than native varieties and also the decline of the native fish population is observed in the presence of exotic species in natural waters, the total economic returns declined for the stakeholders of the capture fisheries.

In aquaculture, however, it provided immediate gain, in most cases without consideration of the long term ecological consequences.

Conclusion

The global experience and present status of introduction of exotic species in India their ecological, biological and genetic impact analysis in this contribution indicate their generally deleterious effect on autochthonous species. In addition to eco-biological impacts, it has been seen that some fish are even extinct owing to loss of genetic variability and heterozygosity.

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IN-VITRO EFFICACY OF PGPR *Pseudomonas flourescens* AGAINST FUSARIUM WILT IN TOMATO

Article Id: AL202143

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Tomato (*Solanum lycopersicum* L.) is one of the most important, commercial and widely grown vegetable crops in the world. Tomato plays a critical role in nutritional food requirements, income and employment opportunities for the people. However, its production is threatened by the *Fusarium* wilt caused by *Fusarium oxysporum* f. sp. *lycopersici* and productionlossesbetween30 %to40 %. In the present investigation, an attempt has been made to study the *in vitro* efficacy of *Pseudomonas flourescens* against *Fusariumoxysporum* f.sp. *lycopersici*. The antagonistic effect of *Pseudomonas flourescens* was observed by the Dual culture technique under the *in vitro* conditions.

Tomato(*Solanum lycopersicum* L.) is one of the most cultivated and popular vegetable crops across the world (Pastoretal. 2012). It belongs to the *Solanaceae* family, and it is the most important vegetable after Potato. It is used as a fresh vegetable and can also be processed and canned as a paste, juice, sauce, powder or as a whole. Tomato grows well in a relatively cool and dry climate, it is well adapted to all climatic zones around the globe. Tomato is used for consumption due to its high nutritive values, antioxidant and curative properties and it contains Vitamin A, Vitamin C and Vitamin E with 95.3% of Water, 0.07% Calcium and Niacin, which have great importance in metabolic activities of humans (Sahu et al. 2013). In 2018 the number of Tomatoes produced worldwide stood at 188 million tonnes, rising by 3.5% against the previous year. India occupies the second position in the world with respect to area, but occupiesonly fifth place in terms of production. Total area under tomato cultivation in Indiais 7.97 lakh ha with a production of 207.08 lakh tonnes (Anonymous 2018). Tomato plants are susceptible to various diseases caused by different agents such as Bacteria, Viruses, Nematode, Fungi and Abiotic factors. Among the fungal diseases,

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Fusarium wilt is caused by *Fusarium oxysporum* f.sp. *lycopersici*, and it causes economic loss of tomato production in worldwide. *F. oxysporum* f.sp. *lycopersici* is a soil-borne pathogen, persists in soil for about 8-10 years in the form of chlamydospores as resting structure. The fungus *F. oxysporum* f.sp. *lycopersici* is exerting pressure on productionlossesbetween30to40%andmay even raise upto80%if so; climatic conditions favour the growth of the fungus. The PGPR having the ideal potential to combat various pathogen has been used in different forms of application. PGPR playing a vital role and capable of colonizing the plant's root system and improve the growth and yield. Plant growth-promoting rhizobacteria with biocontrol traits can be considered as an alternative to the high doses of pesticides applied on crops to deter pathogens and reduce the disease severity (Mahendra Prasad et al. 2019). Mechanisms used by PGPR are involved in biocontrol, such as direct antagonism via the production of Antibiotics, Siderophores, HCN, Hydrolytic enzymes or indirect mechanisms in which the biocontrol organisms act as a probiotic by competing with the pathogen for a niche. *P. fluorescens* are the most exploited bacteria for biological control of soil-borne and foliar plant pathogens. In the past three decades, numerous strains of *P. fluorescens* have been isolated from the rhizosphere soil, and plant roots by several workers and their biocontrol activity against soil-borne and foliar pathogens are reported.

Yield Losses

Fusarium wilt is one of the most important constraints to tomato (*Solanum lycopersicum* L.*) production in major tomato growing areas in the world. That results were* reported 10-90% losses in yield of tomato in the temperate region. *Fusarium* wilt causes 90% of crop losses with repeated infections, especially in the same growing season in greenhouses. Sustainable losses in the yield of tomato is due to vascular wilt and early blight caused by the fungi *F.oxysporum* f.sp. *lycopersici* and *A.solani*, respectively. Nirmaladevi (2016) reported that among the diseases of tomato, the Fusariosis caused by the fungus *F. oxysporum* f.sp. *lycopersici*, bringing up production losses between 30 and 40 per cent and may even reach up to 80 per cent if climatic conditions favour the growth of the fungus.

Epidemiology

F. oxysporum occurs, survives and grown in all the type of soil, but sandy soils are most favourable for growth and development. Infection and disease development in *Fusarium*

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wilt is favoured by warm soil temperature and low soil moisture. The disease tends to be most severe in sandy soil and generally less in heavier clay soil. This disease affects the tomato grown at warm temperature (28°C) in both greenhouse and field condition (Debbi et al. 2018). Disease development is favoured by warm temperatures (27–28°C), dry weather, and acidic soil (pH 5–5.6). Rapidly growing, highly succulent tomato plants exposed to fertilization with Ammonium nitrate are especially susceptible to the disease. The fungus can be disseminated by infected seeds or by transplants grown in infested soil. The fungus can be introduced into a field on contaminated equipment, training stakes, packing crates or shoes. Soil particles from infested fields may be blown into disease-free fields.

Symptoms

Fusarium oxysporum f.sp. *lycopersici* is a soil-borne pathogen that invades the plants mostly through the wounds in the cortical tissues of roots and also through the wounds on adventitious roots produced on the stem. The symptoms of Fusariosis begin with foliar chlorosis in a region of the plant, and as the disease is established, the yellowing is observed in the majority of the plant, causing the wilt and later the death of the plant, without producing fruit or the fruit production is scarce. The earliest symptoms appear within 48 h after the entry of the pathogens. In the infected plants, the leaves become yellow, followed by dropping of leaves which occurs may be on one side of the plant or on both the sides of the shoot.

The fungus blocks the xylem vessels by invading the vascular tissues and reduces the movement of water, and causes severe wilting. Lengthwise brown streaks or vascular discolouration may be seen when the infected stem is cut open. This is the characteristic symptom and used for the identification of disease (Mui-Yun 2003). This discolouration often extends far up the stem and is especially noticeable in a petiole scar. *Fusarium* disease occurs in two forms, also called syndromes.

Antagonistic Effect of *Pseudomonas Flourescens*

The use of plant growth-promoting rhizobacteria (PGPR) in agriculture is effective in integrated pest management due to improved nutrient cycling to the crop and protection of crop from phytopathogens. *P. fluorescens* has been extensively used against different soil-borne pathogens in several crops (Gopi et al. 2016). The PGPR colonize the plant rhizosphere

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and influence plant growth by secreting essential phytohormones for growth and development, increasing nutrient uptake due to production of siderophores, increasing mineral and nitrogen availability in the soil. The PGPR are antagonistic against phytopathogenic microorganisms by producing siderophores, antibiotics, chitinase, β-1, 3 glucanase and Hydrogen cyanide (HCN). These bacteria are involved in the solubilization of phosphate, inducing systematic resistance in the host system to fight against a wide range of phytopathogens, and withstanding abiotic stresses.

Vascular discoloration

Yellowing of leaves

Fluorescent Pseudomonads are non-pathogenic rhizobacteria that suppress the soil-borne pathogens through rhizosphere colonization, antibiosis, iron chelation by siderophore production and ISR. The studies on the mechanism of growth promotion indicate that PGPR promotes plant growth directly by production of plant growth regulators or indirectly by stimulating nutrient uptake by producing siderophores or antibiotics to protect plants from soil-borne pathogens or deleterious rhizosphere organisms. *Pseudomonas* sp. may increase plant growth by producing Gibberellins like substances, mineralizing phosphates or by other mechanisms which are not clearly understood.

Efficacy of *Pseudomonas Fluorescens* Against *Fusarium Oxysporum* F.Sp. *Lycopersici* (Dual Culture)

A nine mm culture disc obtained from the periphery of the seven days old culture of *F. oxysporum* f.sp. *lycopersici* was inoculated at 75mm approximately away from the edge of the Petri dish containing 15ml of sterilized and solidified PDA medium. The bacterial antagonist *P. fluorescens* and *B. subtilis* were streamed gently made onto the medium

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using two days old culture just opposite to the pathogenic culture at equidistance. The zone of inhibition (mm) and the mycelial growth of *F. Oxysporum* f.sp. *lycopersici* were recorded. The effective antagonists were selected based on the inhibition of the growth of the pathogen. The per cent inhibition of mycelial growth was calculated, according to Vincent(1927).

$$I = \frac{C - T}{C} \times 100$$

Where, I = Percent inhibition over control

C = Radial growth (mm) in Control

T = Radial growth (mm) in Treatment

In a recent study, Shanmuga Priya *et al.* (2019) reported that the *in vitro* antagonism of ten isolates of *Pseudomonas* sp. against the mycelial growth of *Fusarium* sp. and indicated that the isolate *Ps* Ap was most effective in inhibiting the mycelial growth of virulent isolate of *Fusarium* spp (FI3) to the maximum of 57.77 per cent. Shahzaman *et al.* (2016) reported the bioefficacy of thirty isolates of *P. fluorescens* against the *Fusarium* sp. The antagonist Pf 3 was found most effective, with an inhibition percentage of 93.33 per cent.

Conclusion

PGPR (*Pseudomonas flourescens*) are the encapsulated members of the Rhizosphere and considered to be effective symbionts by protecting the plants from root rot pathogens simantaneously increasing plant growth and imparting plant tolerance to various stress factors.

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EXTENSION EDUCATION: A SCIENCE HAVING GOOD ALLIANCE WITH OTHER SOCIAL SCIENCES

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Extension education is the dynamic & flexible type of the education which serves the people wherever they are and whatever they are. It helps in the development of the individual as well as all categories of the constituents of society. It is practical, field and farmers' problem-oriented education, and it starts with practical and end with basic theoretical understanding. It is a widely accepted and well-recognized education with the aim of brings desirable changes in human behaviour. It is need-based in nature, provides freedom of choice of subject matter to learners and uses local teachers for training and dissemination of knowledge. It has a good relationship with other social sciences, and through that, it helps to develop the society and nation. Here in this article, some good relationships of extension education and other social sciences are below mentioned;

1. Extension education and rural sociology:

This both sciences are very close to each other, that we can't easily distinguish them. Rural sociology deals with the study of relationships amongst the people of rural society and similar way extension education also greatly oriented towards the study of rural life. They are jointed to the causes of each other and reap the advantages of each other's association.

2. Extension education and rural psychology:

Rural psychology deals with the study of human behaviour of people of rural society, and in a similar way, extension education also deals with the behavioural study. These both join hand in making a study of individual behaviour in a social situation, and this shows that both fields overlap each other.

3. Extension education and cultural anthropology:

Cultural anthropology generally deals with how people who share a common cultural system organize and shape the physical and social world around them and are in turn, shaped by those ideas, behaviours, and physical environments. Similar way, extension education also deals with the individual as well as group behaviour of society and cultural aspects too. In

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many anthropological studies, our attention is directed towards many of those problems which extension education has to face.

4. Extension education and ethics:

The ethical norms are framed in relation to society, and how these norms affect the behaviour of an individual is of great interest in extension education.

5. Extension education and economics:

Extension education and economics both work closely together with reference to understand and improve the economic conditions of people and their wellbeing of them. Many of the problems of economics are also problems of extension education. In both the sciences, primary and secondary data are an important source of information, research and analysis.

6. Extension education and political science:

In both of the sciences, dealing with human behaviour is common. At the time of exit poll of any election, the survey is conducted for prediction of results. A similar way in extension education survey method is used for getting the primary data and on that basis results of research work are got.

7. Extension education and abnormal psychology:

The study of abnormal psychology is helpful in understanding the anti-social behaviour of people. Extension education gets help in understanding those abnormalities of individual behaviour which have a social, economic or political origin.

8. Extension education and home science:

Home science is the science of a home, also deals with education through which desirable changes are brought about in family living. Extension education, which works with almost every institution and all individuals who come from these families or home fronts, has a very happy relationship with the home science discipline. In all the KVKs of our country, the post of home scientists is there, and they work as extension personnel and do various kind of extension activities like arrangement of FLDs, provide training, organizing field days, and provide various seeds or plant materials to the farming communities with a view to the development of them.

9. Extension education and farm journalism:

Farm journalism is one of the subjects of extension education. They both have a common aim to disseminate farm related information. With the combine efforts of both these discipline, the best outcome can be taken.

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10. Extension education and business:

For the establishment and successful running of any business, it is necessary to understand market research, market survey, the behaviour of consumer and the condition of the market. Similar kind of activities i.e. survey and behavioural studies, are carried out in extension education.

11. Extension education and social welfare:

In the process of social welfare, extension education helps social workers to plan socially-oriented and educational activities. Even in the field of medicine, law and police, human nature and its mental aspects are kept in mind. As a preventive measure and as a cure of all, the above fields take the help of principles, practices and methods extension education. In a country like India, the programme of family planning and extension education are associated with each other, and there exists a great demand for extension educators to help and boost up the family planning programme.

Conclusion

On the basis of above mentioned all relationships, it can be concluded that extension education has a good alliance with other social sciences, and it is interlinked with others. On the basis of extension education's good alliance, one can get its benefit for the process of development of a nation.

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SOIL HEALTH MANAGEMENT AND PRACTICES KEY FACTOR FOR CROP PRODUCTIVITY

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Suitable crop management practices can increase the productivity of the crop, out of which soil fertility and health management play a vital role in crop production. Due to the extensive cultivation of crops, nutrients in the soil get degraded. In order to fulfil the crop nutrient requirement, an integrated approach to nutrient management is necessary. Nutrients to the crop are supplied through organic manures, biofertilizers, green manuring, chemical fertilizers, and Nano fertilizers. Effective utilization of all these components surely fulfils the crop requirement without affecting soil health and fertility. So that better crop yield can be expected from healthy soil in a sustainable way.

India produces 281.4 million tonnes of food grains in the year 2018, from a net cultivated area of 143 million hectares. But the population of our country is increasing in geometric progression, but food production is increased in arithmetic progression. In order to meet food requirement and maintain self-sufficiency in food grains like oilseeds, pulses, cereals, an adaptation of sequential cropping is essential. Up adopting a sequential cropping system and extensive use of soil for cultivation causes overexploitation of soil nutrients, and excessive use of only chemical fertilizers as nutrients reduces the interaction between useful soil microbes and crop plants and makes the soil less productive. Hence it is necessary to maintain the balance between crop productivity and soil nutrient providing capacity, and to get higher productivity, better crop and soil management is essential. And all 17 nutrients are essential at the optimum concentration for a crop to complete its life cycle and to give higher production.

In order to provide all major and micronutrient in optimum dosage, an approach called integrated nutrient management should be followed where organic, inorganic and biological amendments are combined used as nutrient sources. This helps to increase nutrient use efficiency, soil health and prevent nutrient losses, and they're by sustainable crop production

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can be achieved. The main principle of integrated nutrient management includes the use of all possible source of nutrient to optimize their inputs, match soil nutrient supply with crop demand spatially and temporally, reduce nutrient loss while improving crop yield.

Components of integrated nutrient management

All 17 essential nutrients and few beneficial nutrients are supplied to the crops through organic manures, green maturing, chemical fertilizers, biofertilizers, concentrated organic manuals like blood meal, born meal, oil cakes and the use of nano fertilizers play an important role in crop nutrient management.

Organic manures: organic manure is a low analysis fertilizer, and they supply plant nutrients in small quantity and organic matter in large quantity, and hence they are supplied in larger quantity to meet the nutrient requirement of the crops. Ex: FYM, Compost.

Fig 1: Fully decomposed FYM

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Bulky organic manures increase organic matter content and thereby improve the soil physical property. They supply major nutrient along with micronutrient and provide food for beneficial soil microorganisms and increase the suppressive of soil. They have a high residual value, chilling effect and supply the nutrients in a balanced ratio.

Concentrated organic manure contains high plant nutrient and a considerable amount of organic matter. They can influence direct plant growth they contain nitrogen varies from 2.5% - 7.9%, Phosphorus 0.8 to 2.9%, and potash 1.2 to 2.2%. Ex: Groundnut oil cakes, sesame oil cakes, coconut oil cakes, cotton oil cakes.

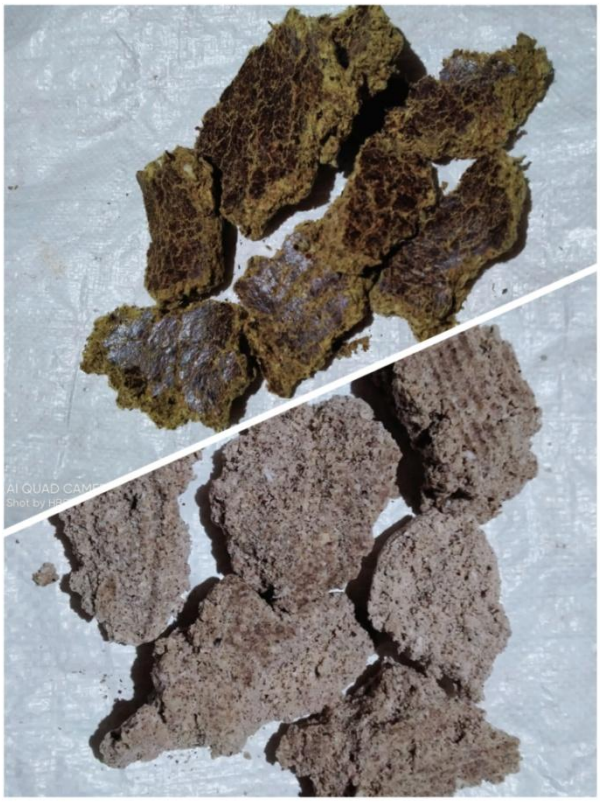

Fig 2: Cotton and coconut oil cakes

A combination of bulky organic manure and concentrated organic manure gives a good quantity of macronutrient and required micronutrient so that crop requirement can be fulfilled.

Green Manuring

The incorporation of green leaf or cover crop, green manuring crop to the soil. Then they become green manure. They are incorporated with a view to improving soil fertility,

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physical property. And cover crop plays a major role in preventing excess moisture evaporation and reduces soil and water loss. Either insitu or excitu can do green manuring.

In insitu green manuring crops are grown and buried in the same field as they are leguminous and succulent in nature and have a lower C:N ratio. Ex: *Crotalaria juncea, Sesbania aculeata, Phaseolus trilobus, Cyamopsis tetragonbia, Indigofera tinctorea, Tephrosia purpurea, Dolichus biflorus. Crotalaria juncea* have good green manuring value with the nutrient composition of 2.3 % of nitrogen, 0.2 % of phosphorus, and 1.4 % of potash with 15 to 30 tons of green leaf per hectare. In Excitu green manuring turning the soil with green leaf, tender twigs of green manuring crops. Ex: *Glyricidia maculata, Leucaena leucocephala, Sesbania rostrata, Pongamia pinnata.*

Fig 3: Excitu green manure plant - *Glyricidia maculata*

Chemical Fertilizers

They are inorganic, high analysis fertilizers that provide a higher quantity of primary nutrients like N, P, K, Mg, S.

Ex: Urea-46% N, Calcium nitrate- 16% N, Rock phosphate, SSP- 16% P, KCl, K_2So_4.

Complex and mixed fertilizers contain two or more major nutrient, DAP-18% nitrogen and 46% phosphorus. They should be applied in the recommended dosage to the crop; variation in the dosage causes an imbalance of nutrients in the crop. In order to prevent nutrient loss, they should be supplied in the required dosage. Here micronutrients can be applied with the chelating agent for slow release.

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Biofertilizers

Biofertilizers are the bio-inoculant and contain living organisms as nitrogen fixers, P solubilizers which are useful for increasing nutrient use efficiency, thereby help in crop production. They fix atmospheric nitrogen both in association with plants and without plants and solubilize insoluble soil phosphate to soluble phosphate. So that fixed phosphorus in the soil can be effectively utilised.

Rhizobium inoculant: They are symbiotic in nature with legumes. They fix 50-100 kg of nitrogen per hectare. They supplement 80-90% of the nitrogen requirement of the crop, and hence they are applied during sowing as a seed treatment.

Azotobacter inoculant: They can be applied to non-leguminous crops like cotton, Tobacco, sugarcane. They are free-living, non-symbiotic; they can reduce the nitrogen application by 10- 20% and increase the yield by 10-15% of the normal crop yield.

Azospirillum inoculant: They are effectively used in cereals like sorghum, wheat, maize. They increase the yield by about 15- 30% and reduce nitrogen application by 20-30 kg/ha.

Azolla: It is effectively used in paddy, fixes atmospheric nitrogen. They are recommended as green manure as they have large biomass and 4-6% of nitrogen, 0.5-0.9% of phosphorus, 2- 6% of potash. It will increase the yield of paddy by 15 to 20%.

VAM: VAM fungi enhance the nutrient uptake of phosphorus, zinc and Sulphur. And enhance water uptake under drought, gives resistance to the root damage. They can be used in forest trees, forage grasses, sorghum, millets and citrus etc. They can substitute 560 kg of fertilizers per hectare for citrus.

Crop Residue Management

Residence of crop gives organic matter to soil and influence on physical, chemical and biological properties and affect soil quality and nutrient cycle. Retention of crop residue on the soil surface will increase the cation exchange capacity of the soil and P content of the top layer of soil. It plays a role in nitrogen availability; legume crops residue will have a low C:N ratio and results in nitrogen mineralization. Cereals will have a higher C:N ratio, which will result in temporary nitrogen immobilization. To fulfil the nitrogen requirement at this time, add 20% extra nitrogen sources to the crop than the recommended dosage.

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Nano fertilizers as source of nutrient in crop production

In order to increase nutrient uptake and use efficiency, Nano fertilizers are used, as normal fertilizers have low nutrient use efficiency. They are manufactured in such a way that they are target-oriented and not easily lost. The utilisation of these nano fertilizers will also influence increasing plant nutrient content; biologically synthesized Nano fertilizers are preferred for agricultural purposes in order to reduce toxicity issues associated with chemically synthesized.

Conclusion

Nutrient requirement of the crop can not be fulfilled by using any one source of nutrient, but it can be fulfilled by integrating all the component of the nutrient like green manuring, biofertilizer, organic manures, chemical fertilizers and effective use of nano fertilizers, a combination of all these as nutrient source maintain the better ecological balance in the soil and helps in maintaining interactions of beneficial microbes and crops in plants. Effective utilisation of all these components increases the suppressiveness of soil. So that effectively biotic stress can be easily managed. Thereby proper nutrient requirement of the crop is satisfied without causing any environmental pollution, and hence better soil health, soil physical-chemical and biological property can be well maintained, which is a prerequisite for crop productivity.

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