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FERTILIZERS, TYPES AND THEIR EFFECTS ON PLANTS: A REVIEW

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ABSTRACT

With fewer resources available, it is more challenging to meet the demands of the expanding population. A decline in agricultural output has been caused by pests, a shortage of fertilizers, and declining soil quality. As a result, fertilizers' contribution to agricultural productivity has grown in significance. The usage of biofertilizers has increased since chemical fertilizers have a significant detrimental effect on soil fertility. These are the substances that could or might not contain germs or latent cells. They add the nutrients and bacteria that the soil needs in order for the plants to grow. They are crucial in preserving the fertility of the soil. They clean out the harmful substances that are the root of plant problems in addition to being helpful for the environment. Two examples of such widely used biofertilizers are *Acetobacter* and *Rhizobium*. Fertilizers boost a plant's defenses to make it more resistant to insect assaults. As a consequence, they are using less pesticides and herbicides, which lead to crops that are ultimately in better shape. Because fewer illnesses are present as a result, the crops have a better aesthetic value. When fertilizers are employed, plants' root systems can be strengthened and made better able to hold water. The plants' stalks and straws get stronger as a result of the fertilizers' high potassium content. Plants that receive phosphorus from fertilizers expand their roots and produce seeds more quickly. Plants may produce seeds with the aid of phosphorus. The presence of nitrogen in fertilizers, which promotes plant development and accounts for the color of plants, results in the hue of green.

KEY WORDS : Soil, Biofertilizers, Fertility, Crop yield.

INTRODUCTION

Agriculture soils must maintain enough levels of quantity and quality to continue providing food, fiber, and energy due to the expanding population and the rising demand for its goods. The soil's nutritional balance, overall health, and water-holding ability must not be harmed in the process. For maintaining a balanced production of nutrients while also boosting crop yields, mineral fertilizers have long been acknowledged as a vital resource (Amanullah *et al.,* 2016; Wang *et al.,* 2020; and Liu *et al.,* 2021).

With the exception of substances used for liming, a substance is regarded as a fertilizer if it is administered to plant or soil tissues with the intention of providing one or more nutrients required for plant development or treating the nutritional deficiency that exists in plants. The present agricultural crop production system, according to Sharma and Chetani, (2017), heavily relies on their application since it replaces soil nutrients and hastens crop growth and yield. Fertilizer either improves the soil's natural fertility or replenishes the chemical elements that previous crops removed.

Types of fertilizer

Based on the complexity of fertilizer

Types	Examples
Straight fertilizer	Are those that provide only one major nutrient for plants (N, P, K) Examples-Urea, Ammonium sulphate, Potassium chloride.
Complex	Include two to three major plant

	nutrients
Fertilizer	Examples-Diammonium phosphate, Nitrophosphates.
Mixed fertilizer	A physical combination of pure fertilizers. Essential plant nutrients are present in them

Based on its effect on changing soil pH

Types	Examples
Acid forming fertilizer	Fertilizer that residues an acidic substance in the soil. Examples-Ammonium nitrate, Sulphur coated urea.
Basic forming fertilizer	Fertilizer that leaves behind alkaline soil residues. Examples-Triple super phosphate, Muriate of potash.

Based on the type of nutrient present

Types	Examples
Macronutrient fertilizer	Two or more micronutrients are present
Micronutrient fertilizer	One or two micronutrients are present

Based on the physical form

Types	Examples
Solid	1.Powder (single phosphate) 2. Crystals (ammonium sulphate) 3. Prills (urea, superphosphate) 4. Granules (Holland granules)
Liquid	Applied with irrigation water or directly.

Based on its nature

Types	Examples
Inorganic Fertilizer	Chilean sodium nitrate, mined rock phosphate, limestone.
Organic Fertilizer	Animal wastes, Plant wastes from agriculture, compost.
Biofertilizer	A Mfungi, N-fixer P-solubilizer and K–solubilizer

1. Natural fertilizer

A. Organic fertilizer: They have a biological basis or are derived from living sources. These fertilizers ensure that the soil will receive nutrients over a longer period of time. The faeces of many animals, such as cows, chickens, goats, and others, can be used as an organic fertilizer. This can be one of the many forms of organic fertilizers available. Young plants, most notably a wide variety of legumes, are used in the production of green manure. Compost that was produced by the decomposition of agricultural waste, such as corn stalks, straw, and other organic materials. According to Solomon *et al.,* (2012), organic fertilizers are often more cost-effective and may be easily obtained from a wider variety of sources in the immediate area.

Results of using organic fertilizer

Organic fertilizers supply nitrogen in a form that plants may use, promoting plant growth without harming the beneficial soil bacteria or damaging plant roots. These issues may be brought on by inorganic fertilizers. By providing plants with the vital nutrients, they need and boosting their disease resistance, organic fertilizers help to avoid plant illnesses. By doing this, a significant source of tension is eliminated from the scenario. They also enhance the quantity of organic matter and carbon in the soil, as well as its capacity to exchange cations and anions.

Organic fertilizer application

According to Dominguez and Gomez-Brandon, (2012), vermicompost has consistently demonstrated beneficial effects on plant growth that are independent of nutrient availability and conversions. Theunissen *et al.* (2010) claim that the nutrients N, P, K, Ca, Mg, S, Fe, Mn, Zn, and Cu found in vermicompost are beneficial to plant nutrition, photosynthesis, the chlorophyll content of leaves, and the nutritional value of different plant parts (roots, shoots, etc. and fruits). The application of organic manure increased levels of the important nutrients Nitrogen (N), Phosphorous (P), Potassium (K), and Carbon (C), according to a research by Dalal *et al.,* (2014). They came to the conclusion that employing natural fertilizers increases the soil's total microbial count, an indication of healthy soil. The study also showed that chemical fertilizers performed less well than organic fertilizers. It is suggested that using organic fertilizers will promote healthy plant growth. As a result, the application of organic fertilizer showed how vegetable production has the potential to improve soil quality, environmental sustainability, attain food security,

and encourage sustainable agriculture.

B. Inorganic fertilizer: These are generated purposefully or are derived from inanimate sources.

Results of using inorganic fertilizer

Inorganic fertilizers are increasingly overtaking organic fertilizers in the fight to increase agricultural output because of the many advantages they provide. The following is a review of some of the main advantages, one of which is that since mineral fertilizers have a relatively high concentration of minerals and because those nutrients release quickly, direct breakdown is not necessary.

Application of inorganic fertilizers

The bulk of the fertilizers that are used on farms have some kind of synthetic foundation. Even though the manufacture of natural fertilizers requires a lot of manual effort and time, many farmers are nevertheless open to the concept of employing those (Gonzales *et al.,* 2015). This is due to the fact that natural fertilizers tend to be prohibitively expensive and have a very limited supply.

The production of vegetables often makes use of a variety of cultural management strategies, one of the most common of which is the use of fertilizers, as well as the application of inorganic or organic sources of fertilizer. According to Masarirambi *et al.,* (2010), the application of chemical fertilizers has been and continues to be an essential component to the growth of crops in both industrial and agricultural farming. This is done so that plants may swiftly eat, absorb, and make use of the nutrients without wasting any of their energy. However, it is considered that these fertilizers have a significant adverse effect on the environment, including toxicity to humans, animals, and food.

Synthetic or Chemical fertilizers: They are essential for increasing the fertility of the soil and fostering the growth of crops. There is a wide variety of synthetic fertilizer available on the market today, including nitrogenous, phosphate, and potassium chemical fertilizer. In addition to causing an increase in crop production, the use of fertilizer also has an effect on the soil's physicochemical and biological properties.

A. Nitrogenous fertilizer: Synthetic ammonia, ammonium nitrate, nitric acid, and urea are produced together with nitrogenous fertilizers.

B. Phosphoric fertilizer: A kind of phosphate rock that is high in tricalcium and serves both as a source of the salt $(PO_4)_3$ and as a fertilizer.

C. Potassic fertilizer: A potassium source in sufficient amounts

3. Biofertilizers: These combinations, which include either active or inert cells of effective bacteria that fix phosphate and nitrogen, are a crucial component of organic farming since they contain both types of bacteria. Biofertilizers may operate independently or in conjunction with the roots of plants to fix atmospheric nitrogen, which results in a significant improvement in the fertility of the soil. If it is absent, the soil will release chemicals that stimulate plant growth, and the phosphates that were before insoluble in the soil will become soluble. A number of authors have looked at the function that biofertilizers play in the production of sustainable crops as well as the significance of their findings.

Characteristics of some biofertilizers

1. Nitrogen fixers Rhizobium: Being a member of the Rhizobiaceae family, having a symbiotic connection by nature, and having the ability to fix 50 to 100 kg of nitrogen per hectare only through collaboration with legumes. It benefits both oil-seed legumes like soybeans and groundnuts, which are used to make oil, as well as fodder legumes like berseem and lucerne, which are used to feed animals. The use of different types of pulses, including chickpeas, red gram, peas, lentils, and black gram, is allowed.

2. **Azospirillum:** a member of the Spirilaceae family that exhibits associative and heterotrophic traits and may also be found in nature. In addition to having the ability to fix nitrogen at a rate of 20 to 40 kg per year, they also create chemicals that control the progression of development. In spite of this, this genus is home to a number of additional species, including *A. amazonense, A. halopraeferens,* and *A. brasilense. The A.lipoferum* and the *A.brasilense* strains have been chosen for the most part to emphasize the advantages of vaccination as well as their widespread dissemination.

3. Azotobacter: belongs to the family Azotobacteraceae, is heterotrophic, aerobic, and lives in a free-living habitat. They can be found in neutral or alkaline soils, although the species *A. chroococcum* is the one that is most frequently found in agricultural soils. Other species that have been formally described include *A. macrocytogenes, A. insignis, A. vinelandii,* and *A. beijerinckii*. Low levels of Azotobacter are frequently found in rhizobacteria of agricultural plants and soils that have been sun-

Table 1. Different fertilizers used and effects observed on plants.

Sr. No.	Crop/Vegetable/ Fruit/ Flower	Botanical Name	Type of fertilizer	Effect observed	Authors
1	Watermelon	*Citrullus lanatus*	Organic manure + Biofertilizer	Length of main vine, no. of fruits per vine more in combined form	Sonkamble *et al.,* 2022
2	Cucumber	*Cucumis sativus*	Poultry manure (Organic fertilizer)	Produced the highest number of fruit than the inorganic fertilizer	Fadare *et al*., 2022
3	Okra	*Abelmoschus esculentus*	NPK fertilizer + Poultry manure	Highest yield obtained than the sole application of org & inorganic fertilizer	Reddy *et al*., 2022
4	Aloe	*Aloe barbadensis miller*	Organic manure + Biofertilizer	Maximum number of leaves, maximum gel yield in combined form	Cheena *et al*., 2022
5	Summer squash	*Cucurbita pepo*	Organic manure + chemical fertilizer	Maximum fruit yield per plant than the sole application of other fertilizer	Kaur and Rattan, 2021
6	Banana	*Musa sp.*	Organic manure + inorganic fertilizer	Maximum plant height, highest survival percentage	Tomar *et al*. 2021
7	Spinach .	*Spinacia oleracea* L.	Level of nitrogen and Phosphorus	Length of leaves, fresh weight ofyield/ha than other level	Patel *et al*., 2021
8	Brinjal	*Solanum melongena* L.	Organic + inorganic + Biofertilizer	Maximum number of fruit and higheryield than alone use of fertilizer	Sachan *et al*., 2021
9	Cauliflower	*Brassica oleracea var. botrytis*	Vermicompost (Organic fertilizer)	Provides best result in terms of yield and high vitamin C content	Belbase and Bc, 2020
10	Maize	*Zea mays* L.	Biofertilizer + organic fertilizer	Having higher starch content than the chemical fertilizer.	Gao *et al*., 2020
11	Zinnia	*Zinnia elegans*	Combination of NPK and biofertilizer	Maximum plant height, maximum seed yield per plant than control.	Slathia *et al.,* 2019
12	Amaranthus	*Amaranthus cruentus* L.	Poultry manure (Organic fertilizer)	Better growth, yield than other organic and inorganic fertilizer	Ogedengbe *et al.,* 2019
13	Carrot	*Daucus carota* L.	Inorganic fertilizer	Highest yield for root tuber girth and length than organic fertilizer	Olorunmaiye *et al*., 2019
14	Radish	*Raphanus sativus*	Vermicompost (Organic fertilizer)	Maximum weight of tuber, maximum plant height than other.	Kumar and Gupta, 2018
15	Strawberry	*Fragaria × ananassa*	Biofertilizer + 5% mineral fertilizer	Maximum number of fruits/ plant, fruit weight than other	Khalil and Agah, 2015
16	Rice	*Oryza sativa*	Organic fertilizer + Inorganic fertilizer	Higher grain yield in combination than the alone use of fertilizer	Sharadha and Sujathamma *et al.,* 2018

Table 1. *Continued ...*

Sr. No.	Crop/Vegetable/ Fruit/ Flower	Botanical Name	Type of fertilizer	Effect observed	Authors
17	Pea	*Pisum sativum*	Used tea waste (Organic fertilizer)	Higher number of grains per pod and pod size than other organic fertilizer	Wazir *et al*., 2018
18	Pototo	*Solanum tuberosum* L.	Egg shell powder (Organic fertilizer)	Produced large sized tuber per plant than other organic fertilizer	Wazir *et al.,* 2018
19	Marigold	*Tagetes*	Inorganic fertilizer (NPK)	Provide maximum flower yield than organic manure	Dikr and Belete, 2017
20	Lettuce	*Lactuca sativa* L.	Organic fertilizer	Highest growth and yield as compared to chemical fertilizer	Hossain and Ryu, 2017
21	Cucumber	*Cucumis sativus*	Organic fertilizer + inorganic fertilizer	Maximum plant height, number of leaves and maximum length of fruit	Singh *et al*., 2017
22	Dahlia	*Dahlia variabilis* L.	Organic manure + biofertilizer	Maximum number of flowers, floweryield per hactare	Pandey *et al.,* 2017
23	Cabbage	*Brassica oleracea* L. *var. capitata*	Vermicompost (Organic fertilizer)	Higher yield and growth of cabbage than inorganic fertilizer	Nurhidayati *et al.,* 2016
24	Sweet pepper	*Capsicum annum* L.	Vermicompost (Organic fertilizer)	Produced heavier fruits than organic and chemical fertilizer	Adhikari *et al*., 2016
25	Tomato	*Solanum lycopersicum*	Vermicompost (Organic fertilizer)	Maximum number of fruits and plant than inorganic fertilizer	Kashem *et al*., 2015

cultivated. There is proof that rhizospheres are present in a number of agricultural plants, including wheat, maize, sugarcane, bajra, vegetables, and plantation crops.

4**. Blue green algae (Cyanobacteria) and Azo*lla*:** *Anabaena azollae* (BGA) may create symbiotic relationships with fungi, liverworts, ferns, and flowering plants that are able to fix nitrogen. However, the most prevalent symbiotic interaction has been discovered as occurring between the Azolla, which is a free-floating aquatic fern, and BGA. Similar to how rice is grown, azolla may be incorporated into the soil to create an organic fertilizer that can be used in agriculture. *A. pinnata*, the species most widely distributed in India, possesses the capacity for large vegetative reproduction on a scale suitable for commercial use.

5. Phosphate absorbers (Mycorrhiza): The host benefits from receiving the essential nutrients, such as phosphorus, calcium, copper, and zinc that would otherwise be inaccessible to it, with the help of the fine absorbing hyphae of the fungus. The fungal partner benefits by meeting its carbon requirements from the plant nutrients of the host. This is an illustration of a symbiotic interaction between a particular collection of microorganisms at the root system and the host plant. With the exception of plants from the families Chenopdiaceae, Amaranthaceae, Caryophyllaceae, Polygonaceae, Brassicaceae, Commelinaceae, Juncaceae, and Cyperaceae, these fungi are connected to the bulk of agricultural crops. These funguses don't have an impact on those plants. In India, the amount of fertilizer that was produced hit a record high of more than 46 million tons during the fiscal year of 2020. Fertilizers are necessary for crop development, yield, quality metrics, and even the health of the soil, but only when they are administered in line with the required dosage or when they are used sparingly. According to figures that were compiled from the 1950s through the 2000s by Yousaf *et al.* (2017), the use of fertilizer increased agricultural production by at least fifty percent. Yousuf *et al.* (2017) found that increasing the amount of NPK fertilizers used

resulted in a rise of 19-41% in rice productivity and a rise of 61-76% in soyabean yield. Different fertilizers which are studied and effects due to them on plants are mentioned in Table 1.

CONCLUSION

As a consequence of the fertilizer's ability to replenish the soil's natural nutrients, it is now widely acknowledged as an essential component of modern agricultural practice. But before anything else, a comprehensive soil study needs to be done. After that, you should fertilize the ground. Following an analysis of the soil's physical characteristics as well as its chemical composition, the best kind of fertilizers should be chosen. Processing using the most effective approach that is currently available. A failure to do so will result in a loss of both time and money; therefore it is essential that you keep this in mind. It is essential that fertilization be performed on schedule and at the appropriate intervals. For example, a whole year's worth of heavy rain, fertilization, and water from the fertilizer will seep into the soil in the surrounding area. This will ultimately lead to the depletion of soil fertilizer and the contamination of the ecosystem in the surrounding area.

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