BENEFICIAL IMPACTS OF MICROBES PROMOTING PROPERTIES FOR CROP PRODUCTION

BY

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Abstract

Microorganisms affect crop productivity in a way that appreciate or depreciate towards the physical or chemical properties of the soil and can also influence directly the soil. Study conducted was to determine the impacts of biological elements levels along with Beneficial microorganism to enhance maize growth rate. The study comprised of factors including N_2 (100—280 kg ha-1), P (100--180 kg ha-1) and beneficial microbes . A control treatment with no, Nitrogen, Phosphorus and Beneficial microbes (BM) was also kept for comparison. Use of beneficial microbes on the plants increased plant and maize yield, we make use of *pseudomonas species*, *Azosprillium*, *Azotobacter* and *Bacillus species* which was inoculated on the soil collected from waste dump site in Ilorin. Total dry mass produced per unit area and crop yield as compared to control. Total Nitrogen applied (100—280 kg ha-1)increased maize Yield, weight and crop yield Phosphorus (100—180kg ha-1) Application on the plants yield maximum plants and maize crop was at it peak and Crop Gathered , and accumulate index were observed in pots and field treatments with 180kg ha-1 phosphorous and 280 kg ha-1 nitrogen. As comparison, the Blend treated have more seedling and plant heavy seeds weight, Total dry mass and Produce index as compared to control pots. It is concluded that application of beneficial microbes with Nitrogen and phosphorus increased Produce and its attributes for maize. Microorganism have the ability to fix atmospheric nitrogen, solubilize and mobilize phosphorus, produce antibiotics and disease suppressing molecules in maize.

Keywords: Nitrogen, Beneficial Microbes, seed weight, Total Dry Mass, Seedling

Introduction

World wide food demands are increasing day by day, especially in developing countries, where crop lands and resources hardly contribute to an efficient crop production. Majority of Farmers only rely on chemical fertilizer which not only deteriorates quality of soil but also increases cost of production. Use of beneficial microbes with fertilizers are integrated approaches to reduce dependency on chemical fertilizers with the advantage of low cost of production (Hazratullah *et a*l, 2020). Agriculture has always been a powerful method to meet the world's population demand for food. Currently, the population is growing very fast; therefore, it is very important that agriculture can meet this increase in demand. For this reason, it is important to increase crops' yield and quality: (Ortiz *et al*, 2022). However, the plants suffer from several diseases constantly due to pests and pathogens that provoke crops and economic losses. In addition, the soil loses a large amount of nutrients due to constant cultivation, leading to a decrease yield and quality of the crops. In this sense, to lessen these negative effects, chemical fertilizers and chemicals have been used. However, their long-extended use has brought serious environmental problems, causing damage to ecology and pest resistance. To try to reduce the use of chemicals, biofertilizers are a greener way to increase the harvest of crops. Biofertilizers can be attractive biotechnological alternatives to increase crop yield, improve and restore soil fertility, stimulate plant growth, and above all, reduce production costs and environmental impacts associated with chemical fertilization (Ortiz et al, 2022).

However, microbial community consists of selected groups of microbes which have Protection against plant pathogen infection and nutrient acquisition. These microbes may reside in rhizosphere and promote plant growth. Soil microorganism also contributes to a wide range of application in sustainability of all ecosystems. These microbes regulate nutrient cycling, regulation of dynamic of soil organic matter, and enhance efficiency of nutrient acquisition. Decomposition, mineralization, and nutrient flow are also regulated by these microbial associations (Kumar Verma, 2020). The application of beneficial microorganisms as biofertilizers has the potential to replace conventional synthetic fertilizers and pesticides, respectively. Such microbes can also provide high stable yields as they can induce resistance and/or tolerance to various biotic and abiotic stresses. As beneficial microbes proliferate primarily in the roots of plants, they can effectively meet plant requirements through continued ascending supply to the plant (Kumar , 2020).

Beneficial microbes have productive effects on the health of plants through a variety of direct and indirect ways, such as atmospheric nitrogen fixation, neutralization of fixed nutrients, generation of plant growth hormones, management of pathogenic microorganisms, activation of resistance, and soil structure enhancement (Gupta, 2012). The major challenge in agricultural science is to develop a technique which increases crop yield sustainably. In recent years, due to the major negative consequences of inorganic fertilizers and pesticides, many researchers are focusing their attention on finding solution for reducing these effects. And this is where concept of "ecological wisdom" comes to guide us to look for alternative to improve crop production and soil health. Using an ever-increasing information base and understanding human "needs" and interactions between humans and nature, some planners, managers, and scientists have developed guidance for managing social–ecological systems using the concept of ecological wisdom (Patten 2016).

Literature Review

Several studies have highlighted the role of beneficial microbes in promoting crop growth by enhancing nutrient availability, suppressing diseases, and improving soil health. Ortiz & Sansinenea (2022) emphasized that microbial inoculants improve soil fertility and plant health while reducing dependence on chemical fertilizers. Similarly, Kumar (2020) discussed the significance of microbial communities in regulating nutrient cycling and maintaining ecosystem sustainability.Microorganisms such as Azotobacter and Azospirillum have been extensively studied for their nitrogen-fixing capabilities. Hamidi et al. (2007) reported that microbial inoculation enhances nitrogen uptake, leading to improved plant growth and yield. Keivanrad and Zandi (2012) demonstrated that biofertilizer application alongside nitrogen fertilizers significantly boosts maize production.Phosphorus is an essential nutrient for plant growth, but its availability in soil is often limited. Studies have shown that microbes like Pseudomonas and Bacillus can solubilize phosphorus, making it more accessible to plants (Gupta, 2012).

Research by Iriti et al. (2019) confirmed that phosphorus-solubilizing bacteria positively affect seed yield and quality.PGPR are beneficial microbes that enhance plant growth through various mechanisms such as phytohormone production and pathogen suppression. Assainar et al. (2018) demonstrated that microbial inoculants improve biomass production and increase crop resilience against environmental stressors. Studies by Rifat Hayat et al. (2010) also showed that PGPR play a crucial role in sustainable agriculture by reducing reliance on synthetic fertilizers.The use of microbial biofertilizers has been shown to increase crop productivity. According to Ahmadi & Bahrani (2009), integrating microbial inoculants with nitrogen and phosphorus fertilizers enhances seed yield and biomass accumulation. Rabieyan et al. (2011) found that biofertilizers significantly improved seed quality in chickpea crops, suggesting a similar potential for maize production.The literature supports the notion that beneficial microbes can effectively enhance crop yield while reducing the environmental impact of chemical fertilizers. The integration of nitrogen-fixing bacteria, phosphorus-solubilizing microbes, and PGPR provides a sustainable approach to modern agriculture.

Materials and Methods

Design of Experiment and Administration

The experiment was carried out in random Techniques having three phases. The process consisted of three nitrogen levels (100,180, 300 Kg ha-1), three phosphorous levels (100, 120and 200 Kg ha-1) and application of beneficial microbes (without or with). Uric acid and phosphate were used for nitrogen and phosphorous as sources, respectively. The cultivation of Zea may seed' sown at the rate of 20 kg scf-1 in the 4th week of September 2023 . The size of the plot was 4.5 m × 3.8 m, having 10 rows, 45 cm apart. The field was watered five times when required. The Zea may field was weeded four times after every 30days before flowering. This was also carried out on the potted plants. (Buddhka *et al*, 2011)

Soil Enrichments characteristics

Solid or liquid formulations of K. radicincitans was diluted in water and sprayed on young maize plants (Zea mays L.). Shelf-life stability tests of formulated bacteria was carried out performed under 4°C and −20°C storage conditions. In parallel, the bacterial formulations will be tested at three different farm level field plots characterized by different soil properties.

Beneficial microbes application

Isolation and identification of beneficial microbes was carried out at the Microbiology Laboratory Kwara State Polytechnic Ilorin and stock was obtained. Beneficial microbe's solution consisted of predominant population of photosynthetic bacteria i.e (*Azotobacter sp*, *Azospirillium sp*, *Phoshobacterium sp* and *pseudomonas sp*). Before its application to the field a solution was made containing one part of beneficial microbes with one part of 2% sugar solution plus 20 parts water by volume kept in dark for several hours. The activated beneficial microbes solution was diluted to 10:10000 by adding distilled water. And this was applied to the plots at the rate 1.1Lto 1.5 L

Data analysis

A Split –Plot Design were practically used. Means was compared using Kruska Wallis Test at the 0/5% level of significant when p value means the probability, for a given model.

Results

Table 1. Days to shoot, maize plant-1, seeds pod-1 and days to grains filling duration as affected beneficial microbes with nitrogen and phosphorus levels

Application	Shoot (In Days)	Seeds (Pods)	Grains Filling	Grain sowing
Beneficial Microbes				
With	12	122x	11.1x	83x
Without	12	142q	12.2q	81q
N_2 Kilo/ha-1				
100	12	123e	11.1e	71e
180	12	142x	12.3x	76x
280	12	164q	12.7q	78q
P Kilo/ha-1				
100	12	121e	09.9e	84e

120	12	140 x	13.8x	86x
180	12	162q	14.6q	86q
Control	10	108q	07.7q	70

Table 2. Harvest index (%) of Zea mays as affected beneficial microbes with nitrogen and phosphorus levels

Application	10000grain weight	Total Output		Grain output	Harvest Indices
Beneficial microbes					
Without	8.4x	1137x	11237	20.20	13.7x
With	8.8q	8137q	93420	24.56	13.4q
N2 Kilo/ha-1					
100	8.4e	8768e	10040	23.40	13.7qx
180	8.5x	11007x	10890	24.80	14.2e
280	8.7q	11 438q	10300	24.50	12.6q
P Kilo/ha-1					
100	8.4e	8324e	10201	19.19e	13.8e
120	8.5x	1100x	10120	23.24x	14.3x
180	8.7q	1136q	10050	21.46q	16.2q
Control	7.8q	7006q	10030	20.01q	11.6q

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Phosphorus utilization constantly increased number of seeds 1. Application of 120 kg P ha -1 produced higher amounts of seeds -1 (23.24), followed by 180 kg P ha -1 (21.46) amounts of seeds-1 was lowest (19.19) with addition of 100 kg P ha -1. using Beneficial microbes, BM utilization produced more amounts of seeds-1 (24.56) as compared to no BM application (20.20). The reactions of PH and N_2 indicated that number of seeds 1 increased with the increasing N_2 from 100 to 180 kg ha-1and phosphorous from 100 and 120 kg P ha-1, however slight decrease was observed with increasing N at 180 kg ha-1 The reactions between BM and P revealed that increasing P level from 100 to 180 kg ha -1 increased number of seeds pod-1 without BM application however the increase was more prominent with Beneficial microbes application.

Crop yield (kg ha-1)

Analysis of statistical data showed that crop yield of zea mays was significantly affected by N_2 and Ph levels, beneficial microbes and mean of control group. While all the possible reactions were found non-significant (Table 2). Mean values of the data indicated that control plots produced less crop yield (7006 kg ha-1) as compared to rest of the fertile slots (8324 kg ha-1). Nitrogen applied at 280 kg scf-1-1 produced more crop yield (11438 kg ha-1, which was followed by 180 kg N ha-1-1 (11007 kg ha--1). Lower crop yield (8768 kg ha-11) was obtainable with nitrogen applied at the rate of 100 kg ha-11. Among different phosphorous levels, 180 kg ha-11 produced higher crop yield (1136 kg ha-1). The application of PH at the rate of 100 kg ha-1 produced lowest crop yield (8324 kg scf-1-1). Beneficial microbes produced more crop yield (1137 kg ha-1) as compared to no beneficial microbes applied slots (8137 kg scf-1).

Discussion

Seeds plant-1 was introduced and nitrogen was used at the rate of 280 kg ha-1 and 180 kg ha-1 and beneficial microbes as compared to lowest seed plant-1 was observed in control plots (Asl, 2017). But beneficial microbes, BM application increased seeds (142) as compared to no BM application (122). Applying and use of beneficial microorganisms increased seeds plant-1, seeds cluster-1, seeds pod-1, hundred seed weight (g), and seed yield hectare-1 in common bean (Ramana et al., 2011). Highest seed yields and yield attributes were recorded with the application of 120 kg Phosphorous ha–1 combined with BM.

Beneficial microbes significantly increased all the seed yield and their attributes i.e., seed plant-1, seed dry weigh plant-1 and seed1 (Iriti et al., 2019). Beneficial microbe's application increased the seed production which is in line with Chili (Khaing & Kyu, 2016), nitrogen application could fulfill the requirement for N and increase number of fruits and total yield. Chickpea seed plant-1 were significantly increased with application of beneficial microbes as compared with control plots (Rabieyan et al., 2011). Seeds plants and pods plant shoots up evidently with applying of beneficial microbes with inorganic fertilizers (Singh Kothyari et al., 2017). The increase in seeds would be due to the fact that nitrogen increased the growth of the crop and produced more Total dry mass that lead to more seed yield. The plants took more nitrogen and evolved the rate of photosynthesis which resulted in more efflorescence growth (Tusar-Patra et al., 2006). Of beneficial microbes with chemical nitrogen fertilizer increased yield and yield components of maize compared to control (treated plants with beneficial microbes without using chemical nitrogen fertilizer (Keivanrad and Zandi, 2012) production. It was observed that lower fertilizers had little effect on plant growth and biomass as compared to higher rates (Assainar et al., 2018).

Similarly, application of nitrogen with beneficial microbes increased synthesis of assimilates and more total dry mass were produced with higher level of nitrogen (Asl, 2017). Likewise, nitrogen is also known for increasing vegetative growth hence produced taller plants with greater mass which leads to increased seed yield not growth-promoting rhizobacteria (PGPR), which have received attention due to their numerous plant growth-promoting mechanisms such as their ability to solubilize insoluble phosphates and nitrogen-fixation. However, there is a dearth of information on the potential plant growth-promoting effects of these three groups of bacteria on non-legumes such as maize (Amelia et al; 2020). The increase in seed yield might be because of nitrogen enhanced the growth of the crop and produced more Total dry mass which increased Total seed yield. Increasing nitrogen levels increased biomass for which the probable reason is that higher availability of nitrogen increased the nutrients uptake and enhanced the dry matter accumulation in seeds (Hamidi et al., 2007). The increase in biological yield caused by the nitrogen levels might be due to increase in production of biomass and seed yield (Diepenbrock, 2000 & Ahmadi). Application of phosphorous increased seed yield and Total dry mass production and this is due to its play in growth and developments.

Phosphorous plays important role in early root development, which leads to more nutrient uptake and increased plant growth. There were lower functional bacterial populations for the treatments without bacteria inoculants (Control, OCF and Chemical Fertilizer) than for the bacterial treatments. This suggests that the selected strains used for the bacterial treatments, especially *Azotobacter sp, Azospirillium sp, Phoshobacterium sp* and *pseudomonas sp*), could affect or induce the propagation of their own kind and/or other functional bacterial populations in maize rhizospheres better than the indigenous populations which originally existed in the unsterilized soil used in the pot trial. Compare with (Amelia et al; 2020) This suggests that the selected strains used for the bacterial treatments, especially P. nodosa NB1 and B. cepacia PB3, could affect or induce the propagation of their own kind and/or other functional bacterial populations in maize rhizospheres.

Conclusion

Microbes are integral part of soil and Plant health. Microorganism have the ability to fix atmospheric nitrogen, solubilize and mobilize phosphorus, produce antibiotics and disease suppressing molecules. The microorganism directly influence the crop growth by increasing or lowering the nutrients or water uptake. They may also provide growth stimulating hormones. Exploring the soil microbes in different ways appears to be advantageous but it is quite challenging to achieve. Beneficial microorganism provide vital function such as biological pest and disease control, promotion of plant growth and crop quality, and biodegradation of organic matter and pollutants The beneficial Microorganisms Isolated from soil in this study belong to *the genus Rhizobium, Azospirillum, Bacillus,Pseudomonas*. N_2 treatment at the rate of 280 Kg ha-1 increased seeds plant-1, filing period and seed weight. While Ph treated at the rate of 120 Kg ha-1 increased seed plants-1, seeds -1, seed weight and seed yield.

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