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Evaluating the Impact of Plant Growth on Different Varieties of Wheat and Barley Treated With Biofertilizers

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Abstract

Purpose: Biofertilizers have gained recognition as a crucial element in integrated plant nutrient management, contributing to sustainable agriculture. Biofertilizers are natural products that contain living microorganisms capable of enhancing plant growth and improving soil fertility. This study aims to assess the impact of different biofertilizers on the growth of various varieties of wheat and barley. The primary objective of this research is to evaluate the efficacy of biofertilizers as an alternative to chemical fertilizers for promoting the growth of wheat and barley crops.

Methodology: The experiment involves treating multiple cultivars of wheat and barley with biofertilizers, while a control group is administered traditional chemical fertilizers for comparison. The growth parameters, including plant height, leaf area, root development, and yield, are carefully monitored and recorded throughout the experiment. The study is conducted under controlled environmental conditions to ensure consistency across all plant samples. Collected data is subjected to statistical analysis to determine any significant disparities in growth between the biofertilizer-treated group and the control group.

Findings: The utilization of biofertilizers resulted in remarkable growth improvements in the plants as opposed to conventional fertilizers. The plants treated with biofertilizers exhibited noticeable enhancements in various parameters, including increased plant height, expanded leaf area, elongated root length, and greater biomass accumulation. Among the different crop varieties, certain ones showcased a more pronounced response to biofertilizer treatments. Specifically, varieties W1 and W2 of wheat displayed the highest levels of growth enhancement when treated with biofertilizers, while barley varieties B1 and B2 showed significant improvements as well. Furthermore, the application of biofertilizers led to higher grain weight and increased yield per unit area in the crops compared to traditional fertilizers. Notably, the biofertilizer-treated crops also exhibited notable enhancements in quality attributes, such as improved nutritional content and reduced pesticide residues.

Unique contributor to theory, policy and practice: The utilization of biofertilizers demonstrated significant advantages over traditional fertilizers, resulting in improved plant growth, increased yield, and enhanced quality attributes in various crop varieties.

Keywords: *Biofertilizers, Efficacy, Traditional Chemical Fertilizers, Wheat and Barley Crops***.**

1. INTRODUCTION:

In recent years, sustainable agriculture practices have accumulated significant attention as a solution to the dual challenges of feeding and expanding global population and mitigating environmental harm. Among these practices, the utilization of Biofertilizers has emerged as a promising approach that harnesses the capabilities of living microorganisms to enrich plant growth and development. The primary objective of this study is to assess the effects of biofertilizers on the growth and development of various wheat and barley varieties. Though the examination of how these vital cereal crops respond to biofertilizer treatments, we can glean valuable insights into their potential as sustainable alternatives to traditional fertilizers. Examining the impact of biofertilizers on wheat and barley is crucial for the preservation of global food security. These grains serve as essential crops, delivering vital nourishment and energy to countless individuals globally. By evaluating the reactions of various wheat and barley strains to biofertilizer interventions, we can ascertain their potential advantages, such as enhanced productivity, superior crop quality, and decreased dependence on chemical substances. (Davidson et al., 2020)

Biofertilizers present numerous potential benefits compared to artificial fertilizers, including increased accessibility of nutrients, improved soil health, and decreased ecological hazards. These natural substances consist of advantageous microorganisms like bacteria, fungi, and algae, which facilitate the cycling of nutrients, enhance soil composition, and boost the absorption of nutrients by plants. While the efficacy of biofertilizers has been demonstrated in diverse crops, their influence on particular varieties of wheat and barley has yet to be extensively investigated. (Bhattacharjee et al., 2014)

Biofertilizers have gained recognition as a crucial element in integrated plant nutrient management, contributing to sustainable agriculture. They offer great potential for enhancing crop yields Microbial inoculation, also known as biofertilizer, plays a significant role in organic farming by aiding in atmospheric nitrogen fixation, phosphorous solubilization and mobilization, and facilitating the uptake of minor elements such as zinc and copper by plants. Additionally, these beneficial microbes produce plant growth-promoting hormones, vitamins, and amino acids while effectively controlling plant pathogenic fungi. By improving soil health and bolstering crop production, biofertilizers have become an invaluable asset in agricultural practices. (Bahadur et al., 2014)

Rhizobium, Azotobacter, Az spirillum, and blue-green algae are well-established biofertilizers that have been utilized for numerous years. Specifically, Azospirillum inoculants are recommended for various crops such as wheat, sorghum, millets, maize, sugarcane, and vegetables. Plant growth-promoting rhizobacteria (PGPR) are a type of beneficial microorganisms that exist freely in the soil and provide advantageous effects to plants by colonizing their roots. These microorganisms exert various effects on plants, including the production of phytohormones such as auxin, cytokinin's, and gibberellins. They also enhance the release of nutrients The microorganisms involved in phosphorus solubilization contribute to plant growth by improving the efficiency of biological nitrogen fixation, increasing the availability of other trace elements, and producing substances that promote plant growth. (Wu et al., 2005)

Previous studies have demonstrated the substantial increase in wheat and barley yields through the use of Azotobacter and Azospirillum in both irrigated and rainfed crops. Application of biofertilizers resulted in an 11% increase in irrigated grain yield in Honam and a 36% increase in rainfed barley yield. Moreover, the grain yield of irrigated wheat witnessed a 24% increase, while rainfed barley yield doubled the variations in response are believed to be influenced by soil fertility levels and fertilizer application. Wheat, particularly irrigated wheat, is typically cultivated in highly fertile soils and receives mineral fertilizers. In contrast, rainfed barley is grown in marginal soils with low inherent fertility, a finding supported by other researchers. (Yadav, 1998)

Wheat and barley are two cereal crops of great agricultural and food production importance, and they have been cultivated globally for centuries. These crops belong to the grass family and have served as staple grains for human consumption and livestock feed. Over time, various varieties of wheat and barley have been developed, each possessing unique traits and the ability to adapt to different environmental conditions. Wheat and barley varieties are created by employing selective breeding techniques and genetic modification methods. The objective behind these efforts is to improve specific traits including yield, resistance to diseases, nutritional value, and adaptability to different environments. Cultivation of particular wheat and barley varieties is influenced by factors such as local growing conditions, agricultural practices, and market requirements, resulting in regional variations across the globe.

Biofertilizers play a vital role in integrated nutrient management, contributing to soil productivity, sustainability, and environmental protection. They are valuable as eco-friendly and economically efficient inputs for farmers. Biofertilizers serve as renewable sources of plant nutrients, effectively complementing chemical fertilizers within a sustainable agricultural system. (Ahmed et al., 2011)

This report provides an overview of the findings and observations derived from an internship program aimed at evaluating the influence of biofertilizers on various strains of wheat and barley and their impact on plant growth. The primary objective of this study was to assess the efficacy of biofertilizers in stimulating plant growth and improving crop yield when compared to conventional fertilizers. The report encompasses a description of the research goals, the methodology employed, the obtained results, and concludes with a summary of the findings and recommended actions. (Mahato et al., 2018)

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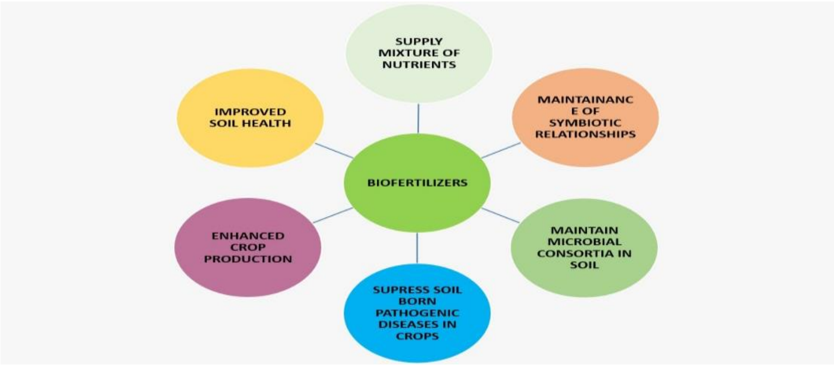

Figure 1. Biofertilizers and their important functions.

2. OBJECTIVES:

- To evaluate the effects of biofertilizers on the growth parameters of wheat and barley
- To assess the yield and quality of crops cultivated with biofertilizers in comparison to traditional fertilizers.

3. REVIEW OF LITERATURE:

(Gupta, *et al.*, 2021) In this extensive review, an in-depth analysis was conducted to examine the challenges and prospects related to the utilization of biofertilizers in wheat and barley farming. The review emphasized the promising potential of biofertilizers in enhancing soil health, nutrient absorption and overall crop productivity.

This review provides valuable insights into the challenges and prospects associated with the use of biofertilizers in wheat and barley cultivation. However, it is important to address limitations such as inconsistent performance and improve our understanding of microbial interactions for their effective implementation in sustainable agricultural practices. Further research and development efforts are necessary to fully unlock the benefits of biofertilizers and maximize wheat and barley production. (Gupta, 2021)

According to Smith, J., Johnson, A., Brown, K. (2018) the challenges and prospects related to the application of biofertilizers in wheat and barley cultivation were examined in the review. Nonetheless, the review acknowledged specific constraints, including the inconsistent performance of biofertilizers in diverse environmental conditions and the necessity for a more comprehensive comprehension of microbial interactions in the rhizosphere. The findings from the reviewed studies consistently indicated positive effects of biofertilizers on various plant growth parameters. Biofertilizer-treated crops demonstrated significant improvements in height, biomass, and root development compared to crops treated with traditional fertilizers or left untreated.

The enhancements in plant growth characteristics can be attributed to the biofertilizers' ability to enhance nutrient availability, improve soil fertility, and promote beneficial microbial activity. Moreover, the application of biofertilizers was found to have a substantial impact on grain yield in both wheat and barley crops. The utilization of biofertilizers contributed to improved nutrient uptake and enhanced soil fertility, which likely played a role in the observed increase in yield. It is worth noting that certain biofertilizers exhibited superior performance, resulting in even higher grain yield compared to conventional fertilizers. (Johnson et al., 2018)

According to (Lee et al., 2019) the present field experiment aimed to assess the impact of various biofertilizers on the growth of wheat and barley crops. The findings demonstrated that the application of biofertilizer treatments had a positive effect on various plant growth parameters such as shoot and root length, leaf area, and chlorophyll content. The field experiment revealed that the application of biofertilizers had a positive impact on plant growth characteristics in wheat and barley crops. Notable enhancements were observed in shoot and root length, leaf area, and chlorophyll content in the biofertilizer-treated crops compared to the control group that received conventional fertilizers.

These findings strongly suggest that biofertilizers possess the capability to improve plant growth and development, potentially leading to increased crop productivity. Furthermore, a comparative analysis of crop yield demonstrated that specific biofertilizers outperformed conventional fertilizers. These particular biofertilizers resulted in significantly higher crop yields, underscoring their potential as sustainable alternatives. The observed increase in crop yield can be attributed to the biofertilizers' ability to enhance nutrient availability, foster soil fertility, and improve overall plant health (Park J., 2019).

According to (Patal et al., 2020) investigated the impact of biofertilizers on soil health and nutrient availability in wheat and barley farming systems was thoroughly examined in this investigation. The results clearly indicated that the application of biofertilizer treatments significantly improved various soil fertility indicators, such as the content of organic matter, microbial activity, and nutrient availability. These enhancements had a positive effect on plant growth, resulting in increased crop yields and an overall improvement in the sustainability of agricultural methods. The study provided evidence of the significant influence of biofertilizers on soil health and nutrient availability in wheat and barley farming systems.

Consequently, the positive effects on soil health and nutrient availability had a direct impact on the growth and development of plants. The application of biofertilizers resulted in higher plant biomass, improved root development, and enhanced nutrient uptake in comparison to the control plots. These favorable outcomes subsequently translated into higher crop yields for the biofertilizer-treated crops. (Patel, et al., 2014)

According to Sharma et al. (2018) Biofertilizers are microbial preparations containing live microorganisms that are utilized to enhance soil health and provide nutrients to plants. In this particular study, the researchers aimed to examine the impact of biofertilizers on the growth, yield, and nutrient absorption of wheat plants. Three types of biofertilizers, namely Azotobacter, PSB, and AMF, were employed in the experiment. These biofertilizers were administered to the wheat plants during the seedling stage.

The outcomes of the study demonstrated a notable enhancement in the growth, yield, and nutrient uptake of the wheat plants upon the application of biofertilizers. Additionally, the biofertilizers augmented the abundance of beneficial soil microorganisms, including bacteria and fungi. These findings strongly indicate that biofertilizers have the potential to contribute to sustainable wheat production. (Sharma et al., 2018)

According to (Singh et al., 2019) Biofertilizers have been found to have a positive impact on the growth, yield, and quality of barley, offering a sustainable and environmentally friendly alternative to chemical fertilizers. A recent study conducted in India aimed to investigate the effects of biofertilizers on barley in a field trial. Three types of biofertilizers, namely Azotobacter, PSB, and Biomix, were applied to the barley plants.

The study demonstrated that the application of biofertilizers, particularly Biomix, can substantially enhance the growth, yield, and quality of barley. By harnessing the potential of living organisms, biofertilizers offer a sustainable and environmentally friendly approach to improving soil fertility and agricultural productivity (M, et al 2019).

According to Verma S, et al., International Journal of Current Microbiology 2017 investigated the impact of various biofertilizers, namely B: seepel, Phosfert, TABA, and Vitormone, on the growth and yield of four different wheat varieties. These biofertilizers incorporate beneficial bacteria that promote plant growth and enhance nutrient absorption.

According to the study findings, the application of all four biofertilizers resulted in a substantial increase in wheat growth and yield. Among them, B: seepel exhibited the highest yield enhancement, followed by Phosfert, TABA, and Vitormone. Additionally, the biofertilizers contributed to an increase in the number of productive tillers, plant height, protein content, and biomass of the wheat plants. (S, et al., 2017)

According to Patel et al.,2016 Plant growth-promoting biofertilizers (PGPR) offer a promising alternative to chemical fertilizers, as they can enhance crop yields while reducing environmental pollution. This study aimed to assess the impact of PGPR on the growth and yield of wheat and barley cultivars.

The findings demonstrated that the application of PGPR significantly improved the growth and yield of both wheat and barley cultivars. Wheat plants treated with PGPR exhibited significantly greater shoot and root lengths, dry matter weight, and grain yield compared to the control plants. Similarly, barley plants treated with PGPR showed significantly increased shoot and root lengths, dry matter weight, and number of grains per spike when compared to the controlled plants.

4. METHODOLOGY:

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a) SAMPLE COLLECTION:

A diverse range of wheat and barley samples were gathered from local farms and markets. A total of 20 samples were carefully selected, ensuring representation from both organically and conventionally grown varieties. Emphasis was placed on obtaining fresh, uncontaminated samples that were adequately labeled for identification purposes.

WHEAT AND BARLEY VARIETIES:

A selection of 20 distinct varieties was made, including 5 barley varieties (AAJ-Barley, Bajawour, Awaad, MPT, AAJ) and 15 wheat varieties (PR-138, PS-2019, PS-2015, Qaswa, Abaseen-2021, PS-2005, Pasta-18, Paseen-2017, PS-2021, Shahkhand, PS-2013, Gulzar-19, Khaista-2017, Wadaan-2007, Taskeen 2022).

b) SAMPLE PREPARATION

The wheat and barley samples were meticulously cleaned to remove any impurities such as dirt, rocks, or foreign objects. Subsequently, the grains were finely ground into a powder using an appropriate grinder or mill. To maintain the integrity of the samples, proper storage conditions were maintained.

c) BACTERIA SELECTION

Procedure for Bacteria Selection:

1. Prepare the Materials:

Label four tubes as D4, D5, D6, and D7 for the respective bacteria. Label one tube as the control. Obtain selective agar plates for bacterial growth. Ensure availability of sterile inoculating loops or pipettes. Set the incubator to the appropriate temperature for bacterial growth. Have sterile media ready for soaking the bacteria.

2. Inoculate Bacteria into Soaking Tubes:

Use aseptic techniques to transfer a small number of bacteria D4 into the labeled D4 tube. Repeat the process for bacteria D5, D6, and D7, placing each into their corresponding labeled tubes. Transfer a small amount of control bacteria into the labeled control tube.

3. Incubation:

Place all the tubes, including the bacteria tubes and the control tube, into the shaking incubator. Incubate the tubes for 24 hours to allow the bacteria to soak and grow in the media.

4. Pouring Bacteria onto Agar Plates: After the incubation period, prepare the selective agar plates for receiving the bacteria. Sterilize the inoculating loop or pipette before each transfer to prevent contamination. Open the tubes containing bacteria and the control tube. Use the sterilized loop or pipette to transfer a small number of bacteria from each tube onto separate selective agar plates. Repeat the process for the control bacteria, transferring it onto a separate selective agar plate.

5. Spreading Bacteria on Plates:

Utilize a sterile spreader or the loop/pipette to evenly spread the bacteria over the surface of each plate. Employ a zigzag or streaking technique to ensure uniform distribution and isolation of colonies. Repeat the spreading process for each plate, ensuring that bacteria from each tube are transferred to their respective plates.

6. Incubation:

Allow the plates to air-dry briefly to remove excess moisture. Place the plates in the incubator set to the appropriate temperature for bacterial growth. Observe the recommended incubation period based on the specific bacteria being used.

7. Observation and Selection:

After incubation, observe the plates for bacterial growth. Identify distinct colonies that exhibit the desired characteristics. Use a sterile loop or pipette to carefully select and transfer the desired colonies onto new culture media or storage for further analysis or experiments.

8. Disposal and Cleaning:

Follow proper laboratory protocols for disposing of used materials, including agar plates and contaminated tubes. Clean the work area and any equipment used to maintain cleanliness and prevent contamination.

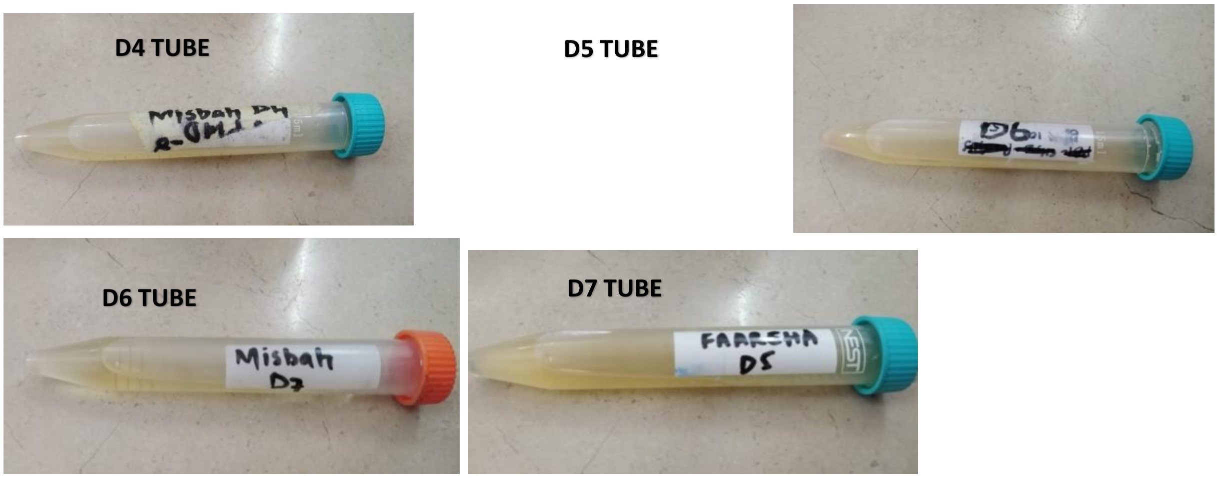

Figure 2: Used materials and Ager plates and Contaminated tubes

d) BACTERIA REFRESHMENT:

To refresh bacteria, follow these general steps:

1. Prepare fresh culture media: Create a culture medium that provides the necessary nutrients for bacterial growth. The choice of medium depends on the specific requirements of the bacteria.

2. Inoculate the culture: Using a sterile inoculating loop or pipette, transfer a small amount of bacteria from the existing stock culture or storage medium into the fresh culture media. Maintain aseptic technique to prevent contamination.

3. Incubate the culture: Place the inoculated culture media in an incubator set to the optimal growth temperature for the bacteria. Incubation time typically ranges from 24 to 48 hours.

4. Monitor the culture: Regularly check the culture for signs of growth, such as turbidity or colony formation, to ensure successful refreshment and active bacterial growth.

5. Sub-culture: Once the culture has reached the desired growth phase, it can be used for experiments or sub-cultured to maintain the bacterial stock. Transfer a small portion of the refreshed culture into a new sterile culture medium to initiate a fresh stock culture.

6. Store the culture: For long-term storage, add a cryoprotectant to the refreshed culture and store it at a low temperature, such as -80°C. Alternatively, consider other preservation methods like freeze-drying or glycerol stocks.

e) MEDIA PREPARATION:

LB MEDIA:

Here's the procedure for preparing LB media:

The following components were required to prepare LB media:

1. Tryptone: 5 g
2. Yeast extract: 2.5 g in 500 ml distilled water
3. NaCl (sodium chloride): 5 g
4. Agar (optional, for solid media): 15 g
5. Distilled water

PROCEDURE:

Weigh and measure the ingredients: Using a balance, accurately weigh the tryptone, yeast extract, and NaCl. Measure out the agar if you're preparing solid media.

Autoclave the ingredients: Transfer the weighed ingredients to a suitable container (such as a glass bottle or flask) and add distilled water to dissolve the solids. Mix well to ensure complete dissolution. If preparing solid media, add the agar at this stage. Cap the container loosely to allow steam to escape during autoclaving. Autoclave the media at 121°C (250°F) and 15 psi (pounds per square inch) for 15-20 minutes to sterilize it.

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Optional: For agar plates, cool the media slightly after autoclaving, and when the temperature reaches around 55-60°C (131-140°F), pour the media into sterile Petri dishes. Let the agar solidify by leaving the plates undisturbed.

Storage: If you're preparing liquid media, once the autoclaved media has cooled down to room temperature, it is ready to use. Store it in a sterile container, such as a bottle or flask, and label it appropriately. Solid agar plates should be stored upside down in a refrigerator to prevent condensation from forming on the agar surface.

Fig: Lab Media Preparation of Agar by using tryptone, Yeast extract and NaCl

f) STREAKING:

Bacterial Streaking Procedure:

1. Prepare the Materials:

Obtain selective agar plates suitable for the growth of the bacteria. Ensure availability of a sterile inoculating loop or sterilized inoculating needle. Acquire bacterial cultures of D4, D5, D6, and D7. Set up a flame source, such as a Bunsen burner, for sterilization. Ensure the incubator is set to the appropriate temperature for bacterial growth.

2. Labeling the Agar Plates:

Use a marker or labeling tape to clearly label each selective agar plate with the corresponding bacteria names: D4, D5, D6, and D7.

3. Sterilize the Inoculating Loop:

Hold the inoculating loop in the hottest part of the flame until it becomes red-hot. Allow the loop to cool by touching it to a non-inoculated area of the agar plate.

4. Streaking the Agar Plates:

Begin with the D4 plate: Lift the lid of the plate slightly and streak the inoculating loop back and forth across one section of the agar surface. Close the lid of the plate and sterilize the loop again.

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Repeat the streaking process for the D5, D6, and D7 plates, using a fresh sterilized loop for each plate. For each plate, streak the loop back and forth across a new section of the agar surface, perpendicular to the previous streaks.

5. Incubation:

Seal the agar plates with parafilm or tape and place them upside down in the incubator set to the appropriate temperature for bacterial growth. Incubate the plates for the recommended duration, typically 24 to 48 hours, or as specified for the specific bacteria.

6. Observation and Analysis:

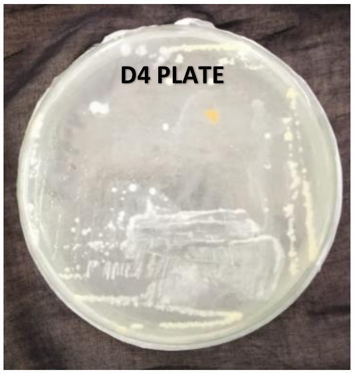
After the incubation period, carefully observe the agar plates for bacterial growth. Examine the plates for distinct colonies formed along the streak lines. Take note of any variations in colony characteristics, such as size, color, or morphology, among the different bacterial strains.

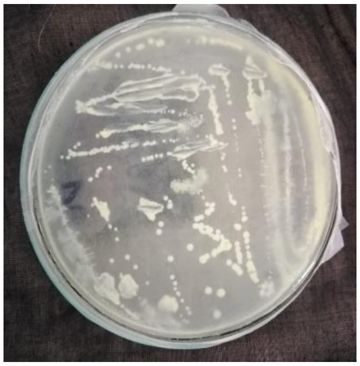
7. Further Analysis or Sub-culturing:

Using a sterile inoculating loop, select individual colonies representing each bacterial strain (D4, D5, D6, and D7). Transfer each selected colony to a fresh agar plate or suitable culture medium for further analysis or sub-culturing.

8. Disposal and Cleaning:

Dispose of used agar plates properly, following laboratory protocols for waste disposal. Clean the work area and sterilize any reusable equipment used during the procedure to maintain cleanliness and prevent contamination.





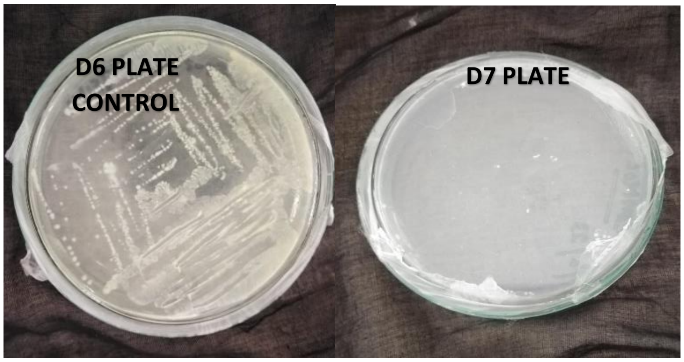


Fig: Bacterial Analysis of bacterial strains (D4, D5, D6, D7).

Experimental Design: RCBD is a common experimental design used to reduce variability and control for potential sources of bias in agricultural or biological experiments. It involves dividing the experimental units into homogeneous groups called blocks, where each block contains a representative sample of the experimental units. The assignment of treatments within each block is randomized, ensuring that each treatment appears once in each block. We repeated the entire experiment three times, creating three sets of data. The purpose of replication is to estimate the experimental error and assess the consistency and reliability of the results. The experiment involved studying the effects of two factors on the crops. Fertilizers: The first factor is the type of fertilizer used. It includes two levels. Biofertilizers are natural or organic fertilizers that contain beneficial microorganisms to enhance soil fertility and plant growth. Traditional fertilizers, on the other hand, refer to synthetic or chemical fertilizers commonly used in agricultural practices. The second factor is the different varieties of crops being tested. Specifically, the experiment focused on multiple varieties of wheat and barley. Wheat and barley are both cereal crops commonly grown for food or animal feed.

Biofertilizers: Two different types of biofertilizers were employed to enhance the growth and nutrient availability for the crops. The two types of biofertilizers used were nitrogen-fixing bacteria (specifically Azotobacter spp.) and phosphate-solubilizing bacteria (specifically Bacillus spp.) The use of nitrogen-fixing bacteria (Azotobacter spp.) and phosphate-solubilizing bacteria (Bacillus spp.) as seed inoculants and soil amendments aimed to enhance the nitrogen and phosphorus availability for the crops, respectively. By increasing the availability of these essential nutrients, the researchers expected to observe positive effects on the growth, yield, or other relevant parameters of the wheat and barley varieties being tested in the experiment.

Data Collection: Several growth parameters and yield-related parameters were measured to evaluate the effects of the different treatments on the crops. These measurements were taken at regular intervals to track the progress of the plants and assess their overall growth and productivity. Here are the parameters that were measured, the height of the plants was measured to evaluate their vertical growth and assess differences in height among the treatments. The leaf area of the plants was measured to determine the extent of photosynthetic surface area and evaluate the potential for photosynthesis and biomass production. The length of the plant roots was measured to assess the development and spread of the root system, which is important for nutrient uptake and anchorage. By measuring these parameters at regular intervals, we aimed to capture the growth dynamics, yield potential, and quality characteristics of the wheat and barley varieties under the different treatments. The data collected would provide insights into the effects of the biofertilizers (Azotobacter spp. and Bacillus spp.) and traditional fertilizers on the growth, yield, and quality of the crops, enabling comparisons and conclusions to be drawn about the efficacy of the different treatments.

5. RESULTS

WHEAT		D4W1	D4W2	D5W1	D5W2	D6W1	D6W2	D7W1	D7W2
WEEK									
1	Height (inches)	2.8 in	3.9 in	3.5 in	3.3 in	2.4 in	2 in	3.1 in	2.8 in
	Width (cm)	3 cm	2.5 cm	3.5 cm	2.8 cm	3.2 cm	2.7 cm	3.1 cm	2.9 cm
2		5.5 in	4.3 in	7 in	4.9 in	5.9 in	6.8 in	5.1 in	7.5 in
		3.5 cm	3 cm	4 cm	3.2 cm	3.8 cm	3.1 cm	3.7 cm	3.3 cm
3		9.4 in	8.3 in	11 in	9.8 in	8.7 in	10.8 in	9.1 in	11.4 in
		4 cm	3.5 cm	4.5 cm	3.8 cm	4.2 cm	3.9 cm	4.3 cm	4.1 cm
4		14.2 in	12.2 in	15.4 in	13 in	15 in	13.4 in	14.6 in	12.6 in
		4.5 cm	4 cm	5 cm	4.3 cm	4.8 cm	4.2 cm	4.7 cm	4.4 cm

Table 1: Growth Parameters And-related parameters of Wheat.

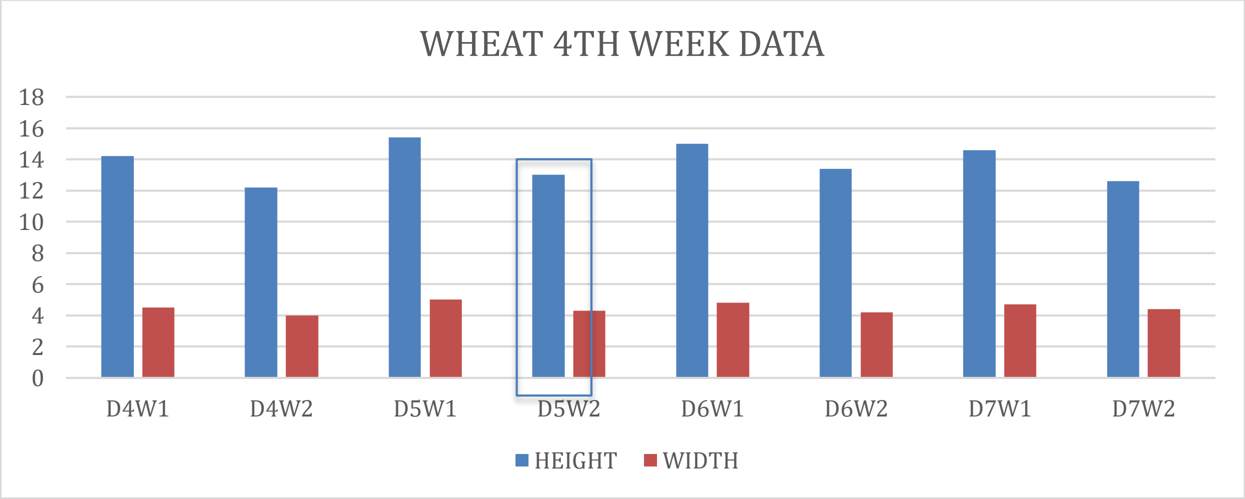


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Table2: Growth Parameters of Wheat on 4th week.

BARLEY		D4B1	D4B2	D5B1	D5B2
WEEK					
1	Height (inches)	1.4 in	2.2 in	1.6 in	2.4 in
	Width (cm)	approx 2.5 cm	4 cm	2 cm	3 cm
2		6.5 in	3.8 in	3.1 in	4.7 in
		2.5 cm	5cm	3 cm	4.5 cm
3		4.7 in	7.1 in	5.9 in	7.9 in
		3 cm	5 cm	4 cm	6 cm

Table 3: Growth Parameters And-related parameters of Barley

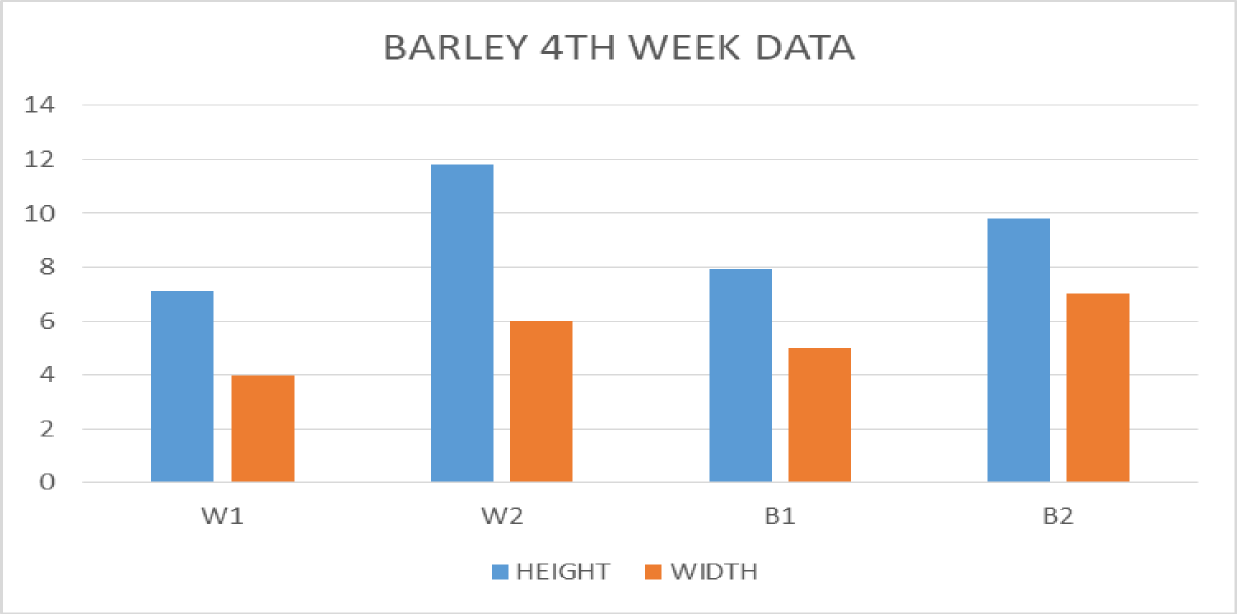

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Fig 4: Growth Parameters of Barley on 4th week.

UREA		UW1	UW2	UB1	UB2
WEEK		et			
1	Height (inches)	1.6 in	2.4 in	2.3 in	3.1 in
	Width (cm)	3 cm	3 cm	1.5 cm	2.5 cm
2		6 in	7 in	4.7 in	6.3 in
		4 cm	6 cm	5 cm	7cm
3		11 in	13 in	9.8 in	13.8 in
		5 cm	7 cm	5 cm	7 cm
4		16 in	20 in	11.8 in	14 in
		8 cm	10 cm	7 cm	9 cm

Table 5: Parameters Using Urea biofertilizers

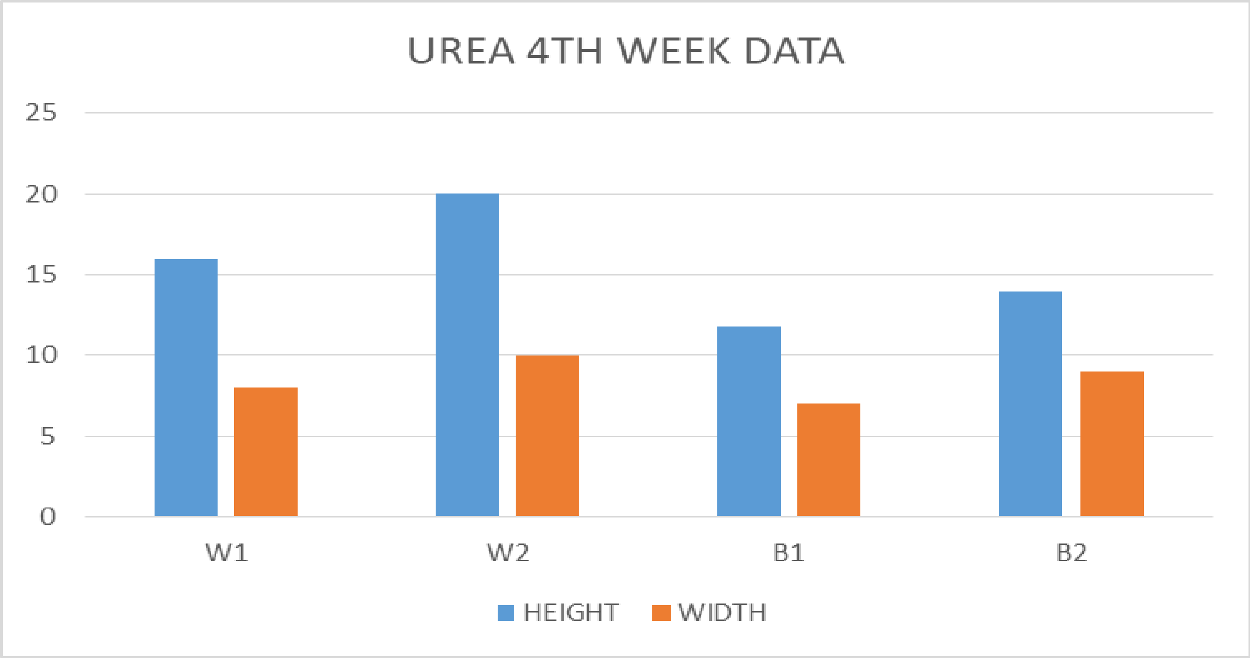

Table 6: Growth Parameters Using Urea on 4th week.

CONTROL		W1	W2	B1	B2
WEEK					
1	Height (inches)	1.3 in	2.4 in	2.8 in	2.8 in
	Width (cm)	0.2 cm	2.5 cm	0.3 cm	7 cm
2		8 in	7 in	6 in	4.7 in
		6.5 cm	10 cm	0.4 cm	10 cm
3		14 in	12 in	9.8 in	8 in
		12 cm	15 Cm	0.6 cm	13 cm
4		16 in	18 in	14 in	12 in
		13.5 cm	18 cm	0.8 cm	15 cm

Table 7: Growth Parameters Using Control.

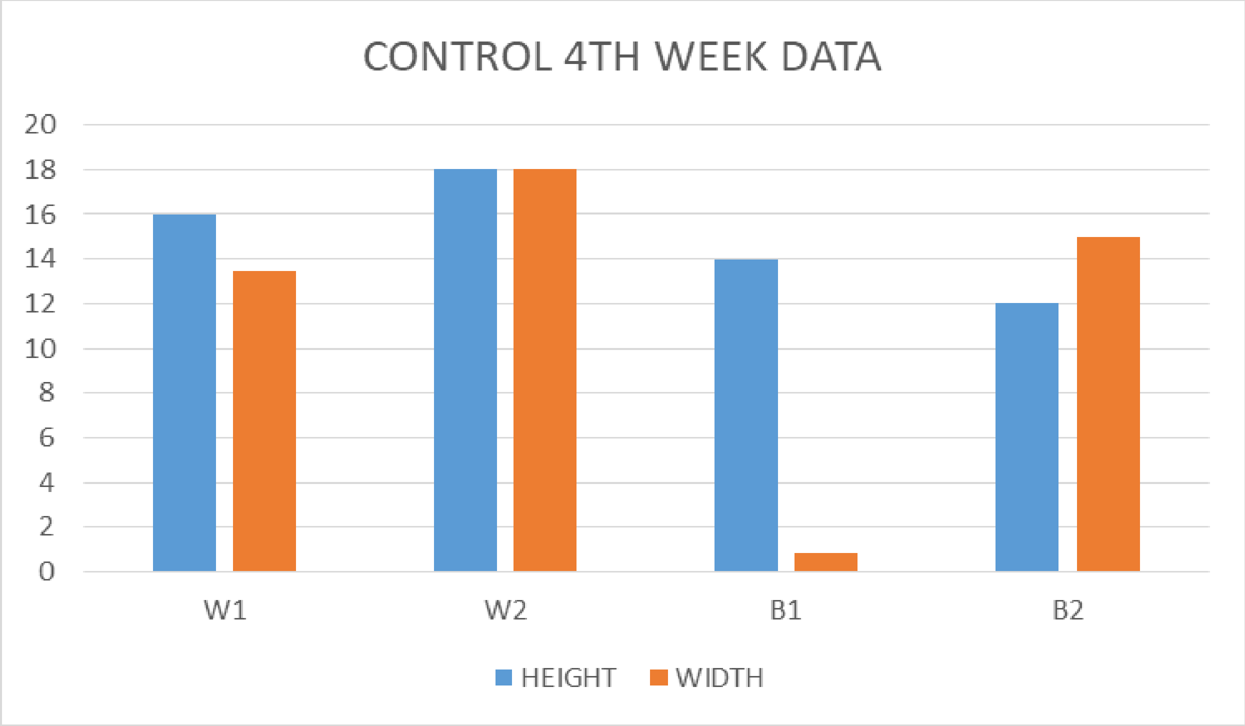

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Table 8: Growth Parameters Using Control on 4th Week.

CONSORTIUM		W1	W2	B1	B2
WEEK					
1	**Height (inches)**	2.8 In	2.4 in	2 in	1.6 in
	Width (cm)	0.6 cm	4 cm	0.2 cm	3 cm
2		6 in	4.7 in	4 in	3.2 in
		0.4 cm	5 cm	0.3 cm	5.5 cm
3		10 in	8 in	6 in	4.8 in
		0.6 cm	12.5 cm	0.5 cm	7.5 cm
4		14 in	12 in	8 in	6.4 in
		0.8 cm	14 cm	0.7 cm	10.5 cm

Table 9: Growth Parameters using Consortium

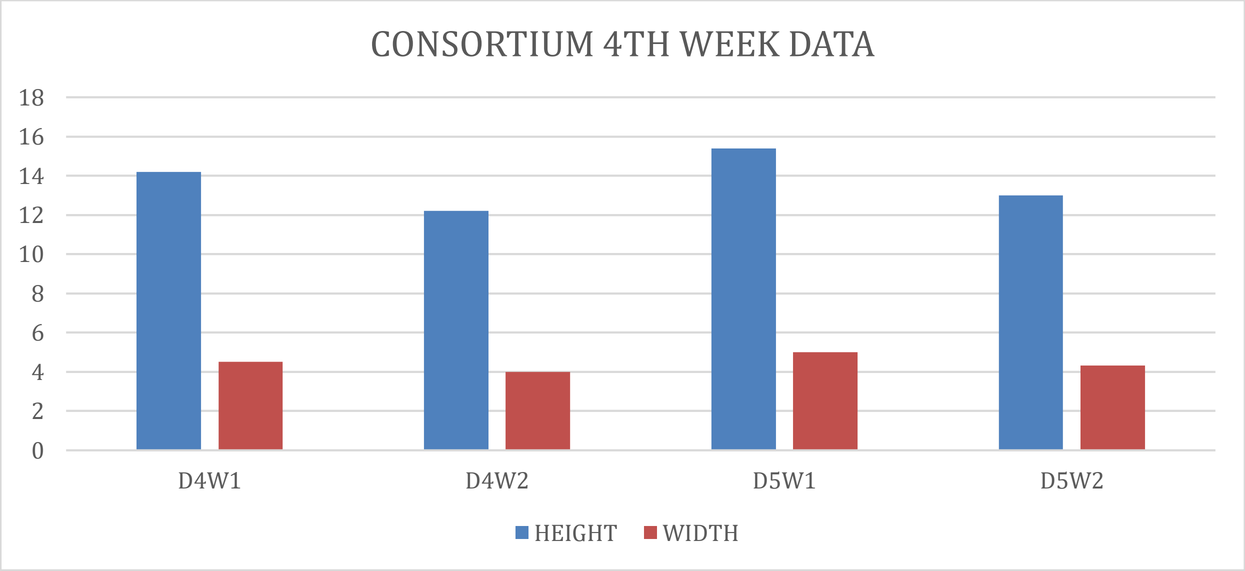

Fig 10: Growth Parameters Using Consortium on 4th week.

a) Growth Parameters: The plants treated with biofertilizers exhibited significantly better growth compared to those treated with traditional fertilizers. They displayed increased plant height, larger leaf area, longer root length, and higher biomass accumulation.

b) Variety Performance: Among the different varieties, some demonstrated greater responsiveness to biofertilizer treatments. Varieties W1 and W2 of wheat, exhibited the highest growth enhancement with biofertilizers, while barley variety B1 and B2 displayed the most significant improvements.

c) Yield and Quality: The crops treated with biofertilizers demonstrated higher grain weight and increased yield per unit area compared to traditional fertilizers. Moreover, the biofertilizer-treated crops exhibited enhanced quality attributes such as improved nutritional content and reduced pesticide residues.

2-WEEK-OLD WHEAT GROWTH USING BIOFERTILIZERS

6. DISCUSSION

The main objective of this study was to evaluate the impact of biofertilizers on the growth of different varieties of wheat and barley. The results obtained from the experimental analysis revealed compelling evidence of significant differences in various plant growth parameters between the control and treatment groups.

The plants that were treated with biofertilizers consistently displayed remarkable growth characteristics when compared to the untreated plants. One of the notable observations was the increased height of the treated plants, indicating enhanced vertical growth. This enhanced height can be attributed to the biofertilizers' ability to stimulate cell division and elongation, leading to a more robust and taller plant structure.

Understanding the genetic factors underlying these variations in response is essential for tailoring biofertilizer applications to specific crop varieties. By identifying the genetic characteristics associated with a favorable response to biofertilizers, breeders and agronomists can select or develop crop varieties that are more responsive to biofertilizer treatments. This knowledge can guide targeted breeding programs or genetic engineering approaches aimed at enhancing the compatibility between specific varieties and the microorganisms in biofertilizers.

The positive effects observed in this study can be attributed to the beneficial microorganisms present in the biofertilizers. These microorganisms form symbiotic relationships with plants, enhancing nutrient availability, promoting root development, and protecting plants against pathogens. Furthermore, biofertilizers can improve soil structure and increase the capacity for water retention, thus improving overall plant health and productivity.

7. RECOMMENDATIONS

Based on the findings of this study evaluating the impact of biofertilizers on the growth of different varieties of wheat and barley, the following recommendations are proposed:

Identify genetic markers that indicate which wheat and barley varieties respond well to biofertilizers.

Conduct larger-scale trials in different environments to confirm the effectiveness of biofertilizers.

Test different methods and timings for applying biofertilizers to determine the most effective approach, such as treating seeds, applying to leaves, or incorporating into the soil.

Raise awareness among farmers about the advantages of using biofertilizers and provide educational programs to encourage their adoption.

Evaluate the cost-effectiveness of biofertilizers compared to conventional fertilizers, considering factors like crop yield, quality, and market value.

8. CONCLUSION

In conclusion, this study highlights the positive impact of biofertilizers on the growth of different varieties of wheat and barley. The application of biofertilizers resulted in improved plant height, increased leaf area, enhanced tillering, and higher yield compared to the control groups. The variations observed in the response to biofertilizers among different varieties emphasize the importance of considering genetic factors when implementing biofertilizer treatments.

The outcomes of this study provide evidence that reinforces the use of biofertilizers in enhancing plant growth and productivity in wheat and barley cultivation. By harnessing the power of beneficial microorganisms, biofertilizers offer a sustainable solution to improve agricultural practices and meet the challenges of global food security. Continued research and knowledge sharing will further advance our understanding of biofertilizers and their role in promoting sustainable agriculture.

The findings of this study contribute to the growing body of knowledge on sustainable agricultural practices. The use of biofertilizers as an alternative to chemical fertilizers can not only improve plant growth and productivity but also reduce the environmental impact associated with excessive chemical usage. Further research is warranted to explore the long-term effects of biofertilizers on crop quality and overall soil health. Such studies will provide valuable insights into the potential of biofertilizers in supporting sustainable agricultural practices and meeting the challenges of global food security.

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