BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF CROP SCIENCE

AN INVESTIGATION ON THE PROSPECTS OF HYDROGELS IN MAIZE PRODUCTION UNDER WATER DEFICIT CONDITIONS: A CASE OF RUSHINGA DISTRICT

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A dissertation submitted in Partial Fulfillment of the requirements for B.Sc. Honors Degree in Crop Science

RESEACH PROJECT SUBMISSION APPROVAL FORM

This research project is the outcome of my original research work, and I'm submitting it to fulfill The requirements of the Bachelor of Agricultural Science Honors Degree in Crop Science. As far as I'm aware, the results presented in this project have not been submitted to any other institutions before, nor are they being currently submitted elsewhere.

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As the supervisor of the aforementioned student's research project, I can attest that the project is ready for submission.

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DECLARATION

I Leeroy Chamukwira do hereby declare that this dissertation was the result of my own original efforts and investigation and such work has not been presented elsewhere for any degree or any university program. All other supplementary sources of information have been acknowledged by means of references.

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CERTIFICATION OF THE DISSERTATION

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The undersigned certify that they have read and recommend to the Bindura University to accept a dissertation entitled: **AN INVESTIGATION ON THE PROSPECTS OF HYDROGELS IN MAIZE PRODUCTION UNDER WATER DEFICIT CONDITIONS .A CASE OF RUSHINGA DISTRICT**

Submitted by

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In partial fulfillment of the requirements for the Bachelor of Science Honors Degree in Agriculture.

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ABSTRACT

Hydrogels are polymeric materials with the ability to absorb and retain large amounts of water, making them a promising soil amendment for improving water availability and crop productivity. In this study, we investigated the effects of incorporating hydrogel into the soil on the growth and yield parameters of maize (Zea mays L.) under water deficit conditions. A field experiment was conducted over two treatments (Treatment A and Treatment B) in which maize was grown with and without the application of hydrogel at same concentrations. Plant height, leaf length, and grain yield were measured at various growth stages. The results showed that the addition of hydrogel significantly improved all the growth and yield parameters of maize compared to the control treatment. Maize plants grown with hydrogel exhibited greater plant heights, with up to a 15% increase compared to the control. Leaf length was also enhanced, with the hydrogel treatment resulting in leaves that were 10-20% longer than the leaves of the control plants. Most importantly, grain yield was increased by 18-22% in the hydrogel-amended plots relative to the untreated plots. These findings suggest that the use of hydrogel as a soil amendment has the potential to enhance maize productivity by improving water availability and nutrient retention in the root zone. Further research is needed to optimize the application rate and method of hydrogel incorporation to maximize the benefits for maize and other cereal crops. Overall, this study provides evidence that hydrogel technology can be a valuable tool for improving the sustainability and resilience of maize production systems in draught conditions.

DEDICATION

To my parents with love, Mr and Mrs Chamukwia l love you yesterday and forever.

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Contents

CHAPTER ONE: INTRODUCTION

1:1BACKGROUND OF STUDY

As climate change continues globally, its negative impacts have reduced water availability which is one of the principal ecological constraints that hinder agriculture's sustainability and Africa is not an exception (FAO 2022). Agriculture in Zimbabwe contributes to 19% of the country's GDP. Approximately 80% of Zimbabweans depend on this agriculture which is mostly rain fed for their livelihoods (Madzwamuse, 2010). Once, Zimbabwe was a food exporting nation with the country recording surpluses in food production almost every year. In recent years, the nation's crop production largely declined and one of the main contributing factors of this has been attributed to erratic and sub-normal rainfall amounts. Over the past decade, the amount of rainfall the country receives has deviated from the multi-decadal mean on a regular basis (UNEP, 2010). On the later part of the 20th century, runoff in the country decreased by 20 to 30% (MMET, 1998).Hydrogels are one way to enhance available water and water use efficiency (WUE) (El-Asmaret al., 2017, Liaoet al., 2016, Yu et al., 2011). Once hydrogels are in contact with water, they turn into a gel and can absorb water 400 to 1600 times their original weight (Ahmed, 2015, Sureshet al., 2018). The amount depends on the molecular weight, formation and structure of the hydrogel (Riad et al., 2018). Farmers have been used hydrogels as water-holding agents to boost the available soil water content essential for plant growth and crop yield (Abrishamet al., 2018, Guoet al., 2020, Liaoet al., 2016, Yu et al., 2012, Yu et al., 2012). The hydrogel used in agriculture is mainly polyacrylamides with acrylic acid as basic units (Bai et al., 2010). Recently, hydrogels have included cellulose (Mi et al., 2018), protein (Kong et al., 2019), and starch (Mahmoodi-Babolan et al., 2019) in their structures. In addition to the benefit of increasing available water, hydrogels can improve soil physical, chemical, and biological properties especially in arid and semi-arid areas where rainfall is scant and, irregular long dry spells and evaporation are high .Many studies have shown the effect of hydrogels on increasing WUE. They increase yield, plants survival under drought stress and long dry spells and reduce irrigation frequency by increasing the amount of water available for plants .The differences in the effect of hydrogels on soils and plants reported in the literature can be attributed to different experimental conditions, such as soil texture, crop used, hydrogel properties and origin and irrigation water quality (El-Asmaret al., 2017, Miet al., 2017, Yu et al., 2012, Yu et al., 2012).

However, much emphasis is now given to natural polysaccharide polymers over synthetic polymers because of controlled release systems, safety to the environment, cost-effectiveness, easy accessibility, and biodegradability (E. Ferrari, A. Paz, and A. C. Silva, “Deficit hydric no metabolism da soja em semeaduras antecipadas no mato grosso,” *Nativa*, vol. 3, no. 1, pp. 67–77, 2015). Super absorbent hydrogels with fascinating structures and properties can be prepared from the polysaccharide with abundant hydroxyl groups. Polymer hydrogels that originated from cellulose have high absorbency, high strength, good salt resistance, nontoxicity, excellent biodegradability, and biocompatibility as compared with the synthetic polymer hydrogels. Hydrogel forms an amorphous gelatinous mass on hydration when applied in soil, and it is capable of cyclic adsorption and desorption of water for a longer period. Hence, it is considered an effective tool in conserving adequate amounts of water quickly in soil and providing water and dissolved nutrients slowly to the plants over an extended period when the surrounding soil near the crop root zone starts drying up. The specific objective of this review work was to find out the efficacy of hydrogel on soil water retention and release characteristics for alleviating drought stress and simultaneously improving maize production under moisture stress conditions.

1:2Problem Statement

Droughts have significantly affected the nation, leading to decreased life expectancy and increased emigration. Notably, during the 1991/1992 drought, maize production plummeted by nearly 75%, leaving a vast number of people in urgent need of food aid.(GMB 1992). In that year, the Grain Marketing Board's intake of domestic maize was around 13,000 tons, merely enough for two days of national consumption. Additionally, over a million cattle succumbed to starvation. Subsequent droughts in 1993, 1994, 2002, 2004, and 2012 seasons further impacted livelihoods (FAO 2010). The 2012 drought resulted in a 45% deficit in maize, the nation's staple food, causing about 1.4 million Zimbabweans to face famine. These recurrent droughts since 2002 have led to stagnation in rural livelihoods, which are largely agriculture-based. Despite efforts to alleviate rural poverty through strategies like conservation farming and food handouts, these measures have not offered a lasting solution due to their temporary nature. This project is trying to find solution in increasing yield and moisture availability during dry conditions such as draught. It is also specializing in trying to find the negative and positive effects of hydrogel so as to give various farmer of its advantage and disadvantage when applied to maize3 production

1:3Aim

To investigate if the use of Hydrogel in maize production in Rushinga district which is in Zimbabwe natural region 3

1:3:1Objectives

- To determine if the use of hydrogel can reduce water deficit in maize
- To determine the effects of hydrogel on maize yield
- To determine the effects of hydrogel on crop growth

1:3:2Research Questions

- What is hydrogel absorbent polymer
- How does it reduce water deficit conditions on maize plants
- How can this problem of drought be solved in trying to enhance high yields

1:4Hypothesis

H 0: The use of hydrogel does not increase maize production under water deficit conditions

H 1: The use of hydrogel increase maize production under water deficit conditions

H 2: The use of hydrogel can solve the problem of draught and enhances yield

H 3: Hydrogel increases crop growth

1:5Justification

The justification for investigating the use of hydrogels in maize production to mitigate water deficit conditions is multifaceted. Firstly, with the global increase in water scarcity due to various factors such as climate change, overuse of resources, and environmental degradation, traditional farming methods are becoming unsustainable in many regions. Hydrogels, by virtue of their high water absorption and retention capabilities, offer a promising alternative to enhance soil moisture and reduce the need for frequent irrigation, thus conserving water. Additionally, in drought-prone areas where water scarcity significantly impacts agricultural productivity and food security, hydrogels can provide a viable solution to maintain crop yields and support rural livelihoods. The application of hydrogels in agriculture could lead to more resilient farming practices that are less dependent on variable rainfall patterns and more adaptable to changing climatic conditions. This research not only has the potential to improve food security but also contributes to the sustainable management of water resources in agricultural practices.

1:6 Limitations

One of the primary limitations is the initial cost and the economic feasibility of hydrogel application on a large scale, which might be a significant factor for small-scale farmers. Additionally, the effectiveness of hydrogels can vary depending on the specific type used, as well as the soil characteristics and climate conditions, making it crucial to select the right hydrogel formulation for specific environments. Another limitation is the potential environmental impact, including concerns about the biodegradability of synthetic hydrogels and their long-term effects on soil health and microorganism populations. Understanding these limitations not only highlights the challenges in the application of hydrogels but also underscores the need for continued research and innovation in sustainable agriculture practices.

1:7Delimitations

The research was carried out at Chikodza farm in Bungwe village under Rushinga district in Mashonaland Central It falls under agro ecological zone IV. Rushinga district receives low rainfall per year (4 5 0 -6 5 0 mm). It is also subject to periodic seasonal droughts. The temperature ranges from 24 to30degrees in summer and they may fall to below 20 degrees in winter. The type of soil is sandy loam which has moderate nutrients and easy penetration of water and moderate aeration for the growth

CHAPTER2: LITERATURE REVIEW

2.1 ORIGIN AND DISTRIBUTION OF MAIZE

The origin and distribution of maize (Zea mays), also known as corn, is a story that spans thousands of years and showcases the incredible journey of domestication and globalization. Maize is believed to have originated over 9,000 years ago in the region that is now Mexico, from a wild grass called teosinte (Wikipedia). This transformation through selective breeding by the indigenous peoples of Mesoamerica is one of the most significant achievements in agricultural history, leading to a plant that bears little resemblance to its ancestor, with much larger and more productive ears. From its humble beginnings in Mexico, maize spread throughout the Americas before European explorers and colonizers introduced it to the rest of the world following their arrival in the 15th and 16th centuries (Enderson, E., & Cutler, H. C. 1942 Races of Zea mays). Its adaptability to different climates and soils allowed it to thrive across continents, becoming a staple food in many countries and contributing to the dietary needs of billions of people. Today, maize is grown on every continent except Antarctica, with the United States, China, Brazil, Argentina, and India being among the largest producers(S.R. Eckhoff, ... S.C. Yang, in Encyclopedia of Food Sciences and Nutrition (Second Edition), 2003).

2.1.2 Historical Perspective of Hydrogel Use in Agriculture

The concept of hydrogels in agriculture can be traced back to the mid-20th century when scientists began exploring water-absorbing polymers for soil conditioning. Early studies focused on the physical and chemical properties of hydrogels, including their water absorption capacity, biodegradability, and interaction with soil particles. Over the years, advancements in polymer chemistry have led to the development of various types of hydrogels, including synthetic and natural polymers, each with unique properties tailored for specific agricultural applications. Hydrogels function through their ability to absorb and retain water, thereby reducing water loss from the soil through evaporation and percolation. They release the absorbed water slowly, making it available to plant roots over an extended period. This mechanism is particularly beneficial in regions with limited water availability, as it ensures a more consistent water supply to crops. Additionally, hydrogels can improve soil structure, enhance nutrient retention, and reduce soil erosion, contributing to overall soil health.

2.2 ECONOMIC IMPORTANCE OF MAIZE

According Smutka, L.; Steininger, M.; Miffek, O. World agricultural production and consumption. . (**2009)** the economic importance of maize cannot be overstated, as it plays a pivotal role in global agriculture, economies, and food security. Maize is not only a staple food for millions of people around the world but also a critical raw material in the production of a wide range of products, adding layers of complexity and value to global markets. Firstly, maize is a primary source of calories and nutrition for populations across Africa, Latin America, and parts of Asia, serving as a cornerstone for food security in these regions (FAO2019). Its versatility allows it to be used in various forms, such as fresh corn, cornmeal, and corn flour, making it a fundamental ingredient in numerous traditional and modern cuisines. Beyond direct human consumption, maize is a key feedstock for livestock, supporting the dairy, meat, and poultry industries. The efficiency of maize in converting sunlight into energy-rich biomass makes it an ideal feed grain, contributing significantly to the economic viability of livestock farming. Moreover, maize is instrumental in the industrial sector, providing raw materials for the production of biofuels, particularly ethanol, which has become a vital component of the energy sector in countries like the United States and Brazil. This biofuel production not only helps in diversifying energy sources but also in reducing greenhouse gas emissions, aligning with global sustainability goals. Additionally, a variety of products ranging from sweeteners, like high-fructose corn syrup, to biodegradable plastics and pharmaceuticals, are derived from maize, showcasing its economic versatility. The starch extracted from maize is used in a myriad of industrial applications, including paper production, textile manufacturing, and as an ingredient in adhesives and coatings, further emphasizing its economic significance (Pajic Z., Radosavljevic M., Filipovic M., Todorovic G., Srdic J., Pavlov M. Breeding of specialty maize for industrial purposes. *Genetika.* 2010). Overall, the economic importance of maize is multifaceted, touching on food security, agricultural sustainability, industrial innovation, and energy production. Its role in supporting livelihoods, enhancing trade, and contributing to national economies makes maize an invaluable crop on the global stage.

2.3MAIZE PRODUCTION IN ZIMBABWE

Maize production in Zimbabwe holds a pivotal position within the country's agricultural sector and its overall economy (unsaid strategic economic research and analysis – Zimbabwe (sera) program.2012). As the primary staple crop, maize is central to the food security and dietary needs of the Zimbabwean people. The country has experienced fluctuating levels of maize production due to a variety of factors, including climatic variability, economic conditions, and policy changes, particularly in land management and agricultural investment. Zimbabwe’s agricultural landscape is predominantly characterized by smallholder farmers, alongside some commercial farming operations (Bratton, M. 1987. Drought, food, and the social organization of small farmer’s in Zimbabwe. In Drought and hunger in Africa, ed. M. Glantz, 213-244.Cambridge, United Kingdom: Cambridge University Press) These smallholder farmers are crucial to maize production but often face challenges such as limited access to inputs like quality seeds, fertilizers, and modern farming technologies. Additionally, erratic weather patterns, including prolonged droughts and occasional floods attributed to climate change, have increasingly impacted maize yields. According to (FAO2020) government programs and partnerships with international organizations have been instrumental in providing the necessary support and resources to improve maize production. These efforts are designed to increase food self-sufficiency, reduce import dependency, and ultimately improve the livelihoods of the Zimbabwean population engaged in agriculture. Despite the obstacles, the potential for increasing maize production in Zimbabwe is significant, given the country's fertile lands and the resilience of its farming communities. With continued investment in agriculture, adoption of sustainable farming practices, and supportive policies, Zimbabwe strives to reclaim its status as a major agricultural producer in Africa, ensuring food security and economic stability for its people.

2.4 THE ROLE OF WATER IN MAIZE PRODUCTION

Water plays a pivotal role in maize production, serving as the lifeblood of this globally significant crop. As one of the most water-dependent plants, maize's growth, yield, and overall health are intrinsically linked to the availability and quality of water throughout its lifecycle (Chorus, P., & Bartels, D. (2021). Water relations in maize under drought. Frontiers in Plant Science, 12, 652987). Understanding the role of water in maize production is crucial for optimizing yields, ensuring sustainability, and addressing the challenges posed by water scarcity and climate change. In the initial stages of growth, water is essential for germinating maize seeds. Adequate moisture in the soil triggers the germination process, enabling the seed to sprout and begin its growth journey. Insufficient water during this critical phase can lead to poor germination rates, uneven crop stands, and ultimately, reduced yields. As maize plants develop, water continues to play a critical role in their physiological processes (Farooq, M., Wahid, A., Kobayashi, N., Fujita, D., & Basra, S. M. A. (2009). Plant drought stress: effects, mechanisms, and management.

Agronomy for Sustainable Development, 29(1), 185-212.). It is a key component of photosynthesis, the process by which plants convert light energy into chemical energy, using it to produce the sugars that fuel growth and development. Water also facilitates the transport of nutrients from the soil to the plant, moving through the roots and up into the leaves, stems, and ears. This nutrient-water synergy is vital for the formation of healthy, high-yielding maize plants (Passioura, J. B. (2006). Increasing crop productivity when water is scarce—from breeding to field management. Agricultural Water Management, 80(1-3), 176-196.). The reproductive stage of maize, including flowering and grain filling, is especially sensitive to water availability. Adequate water during these stages ensures the successful pollination of the maize flowers and the proper development of the kernels. Water stress during the grain-filling period can lead to incomplete kernel development, reduced grain weight, and lower overall yields.

However, the relationship between water and maize production is not solely about the quantity of water available. The efficiency of water use—how effectively the crop converts water into yield—is also critical. This is where practices such as irrigation management, soil moisture conservation, and the adoption of drought-resistant maize varieties come into play. These strategies aim to optimize water use, ensuring that maize crops receive the right amount of water at the right times, thereby enhancing water use efficiency and productivity.

2.5 THE ROLE OF HYDROGEL IN REDUCING WATER DEFICIT CONDITIONS

The core of hydrogel's benefits is its remarkable ability to retain water. In maize production, where water availability can often be a limiting factor, hydrogel acts as a reservoir, absorbing excess moisture when it's abundant and releasing it during dry periods, Yazdani et al. (2007). This ensures that maize plants have access to water at critical growth stages, significantly enhancing their drought tolerance and reducing the dependency on regular irrigation. This not only conserves valuable water resources but also mitigates the risks associated with unpredictable weather patterns, making maize cultivation more sustainable and resilient Furthermore, hydrogels can be engineered to encapsulate nutrients and release them in a controlled manner directly to the root zone of the maize plants (Alkhashaet , 2018, Chirinoet 2011.). This slow-release mechanism ensures that nutrients are available when the plants need them the most, enhancing nutrient use efficiency and reducing the need for frequent fertilizer applications. This targeted approach to nutrient delivery minimizes nutrient runoff and leaching, thereby reducing environmental pollution and promoting healthier crop growth. Another crucial aspect of hydrogel's role in maize production is its contribution to improving soil structure. By maintaining moisture levels within the soil, hydrogels help to prevent soil compaction and erosion, fostering better root development and facilitating the proliferation of beneficial soil microorganisms. Healthy soil is the foundation of successful agriculture, and by enhancing soil properties, hydrogels play an integral part in ensuring the long-term sustainability of maize farming practices.

2.6 Effect of hydrogel on soil physical and hydraulic properties

Given the crucial role of soil's physical and hydraulic properties in the availability of water, air, and nutrients for plants, it is important to note the fundamental. of soil different soil properties .(Akhteret al., 2004, El-Asmaret al., 2017, Guoet al., 2020, Mohawesh and Durner, 2019). Hydrogels, often referred to as "super absorbent polymers," have a fascinating impact on soil's

relative to their own mass, which significantly influences soil moisture content and its ability to retain water. This can lead to improved soil structure, enhanced plant growth, and increased resistance to drought conditions (H. Dorraji, A. Golchin, and S. Ahmadi, published in Soil and Tillage Research). Hydrogels can also reduce soil erosion and improve the soil's capacity to support agricultural productivity.

2.6.1 SOIL EVAPORATION

Hydrogels, known for their high water absorption and retention capacities, can alter the dynamics of water loss from the soil surface(El-Asmaret al., 2017, Miet al., 2017, Yu et al., 2012, Yu et al., 2012).. Studies have shown that incorporating hydrogel into the soil can reduce the rate of evaporation by holding more water within the soil matrix. For instance, research conducted in arid and semi-arid regions demonstrated that soils treated with hydrogel exhibited slower evaporation rates compared to untreated soils, leading to better water conservation and availability for plants (Journal of the Saudi Society of Agricultural Sciences December 2022). This is particularly useful in agriculture, where efficient water use is crucial for crop sustainability. Hydrogels also have the ability to absorb and retain large amounts of water, which can significantly influence the rate at which water evaporates from the soil. By adding hydrogel to soil, you can potentially reduce water loss through evaporation, thereby improving water availability for plants, especially in arid and semi-arid regions. Understanding this interaction can lead to more efficient water management practices in maize production

2.6.2 .Aggregate stability

"Wet sieving apparatus is used to measure soil stable aggregate" as described by Kemper and Roseau, (1986). ! Aggregate stability refers to the soil's ability to maintain its structure when exposed to external forces like water and wind. Hydrogels, with their water-retentive properties, can influence this stability by enhancing the cohesion between soil particles. Research indicates that incorporating hydrogel into the soil can significantly improve its aggregate stability, which helps in reducing soil erosion, improving water infiltration, and facilitating better root development. Enhanced aggregate stability also means improved soil aeration and nutrient retention, which are crucial for sustainable agriculture. (Journal of the Saudi Society of Agricultural Sciences December 2022)

2.6.3 Infiltrarion Rate

The infiltration rate is the speed at which water enters and moves through the soil. Hydrogels, known for their water-absorbing properties, can modify this rate by altering the soil's porosity and water-holding capacity. . Barrientos-Sanhueza . (2021) have shown that the addition of hydrogel to soil can improve its infiltration rate, allowing water to penetrate more efficiently and uniformly. This can be particularly beneficial for preventing water runoff and enhancing moisture availability for plant roots, leading to better crop growth and resilience. Another research by Alkhashaet , 2018, Chirinoet (2011.) have shown that hydrogels, with their high water retention capacity, can significantly influence this rate by modifying the soil's structure and porosity. This research has demonstrated that hydrogels can enhance the infiltration rate by allowing water to spread more evenly and efficiently through the soil profile. This improvement can help reduce surface runoff, enhance moisture availability, and promote deeper root growth, ultimately leading to more resilient and productive crops.t

2.7 Interaction with Fertilizers and Other Soil Amendments

The interaction between hydrogels and fertilizers is another critical area of research. Studies have shown that hydrogels can enhance the efficiency of fertilizers by reducing nutrient leaching and increasing nutrient availability to plants. For instance, Yazdani et al. (2007) reported that hydrogel application in combination with urea fertilizer resulted in higher nitrogen use efficiency and improved maize yield. These findings suggest that integrating hydrogels with conventional fertilization practices could optimize resource use and enhance crop productivity.

CHAPTER THREE: MATERIALS AND METHODS

3.1 LIST OF MATERIALS

Pegs x4

Garden liner x1

Rake x1

Hoe x1

Watering can x2

String x1

30cm ruler x1

Hands x2

Fertilizer 5kg

Mates x4

Scale x1

Maize Seed 4Kg

Hydrogel 2 Kg

3.2 SITE

The research was carried out at Chikodza farm in Bungwe village under Rushinga District, located in Zimbabwe, falls within the natural region known as Region IV. This region is characterized by semi-arid conditions, receiving moderate rainfall, often ranging between 450-650 mm annually. The area is primarily suitable for semi-extensive farming, which includes activities like livestock rearing and drought-resistant crop farming, due to the relatively low and erratic rainfall. The climate and geographical features of Region IV make it an intriguing area for studying agricultural practices and adaptation strategies in semi-arid environments.

3.3 LAND PREPARATION

In November 2022, the land was cleared using a pick and hoe to loosen the soil. A rake was then employed to level the soil and break up clumps for a finer texture. Straight ridges were created with the help of a garden line and a club hammer. Compound D fertilizer was applied as a base layer and was broadcast by hand. Maize seeds were sown manually using the spot placement method, with two seeds placed at each planting station at a depth of 5 cm. The plants were thinned three weeks after they emerged. According to Abujamin, A.. S. Abujamin, and U. Kurnia, 1984 Land preparation is vital for ensuring optimal conditions for planting and crop growth. It involves clearing the land, loosening the soil, and creating a fine, leveled surface which helps in better seedbed formation. This process improves soil aeration, enhances water infiltration, and facilitates the even distribution of nutrients. Proper land preparation also helps in controlling weeds and pests, making it easier for plants to establish strong roots and grow more healthily

3.3 EXPERIMENTATION

The study utilized two treatments: Treatment A, which involved applying hydrogel to maize seed production, and Treatment B, which did not include the hydrogel application. Each treatment was replicated three times, and a completely randomized block design was employed to implement the treatments.

3.4 EXPERIMENTAL DESIGN

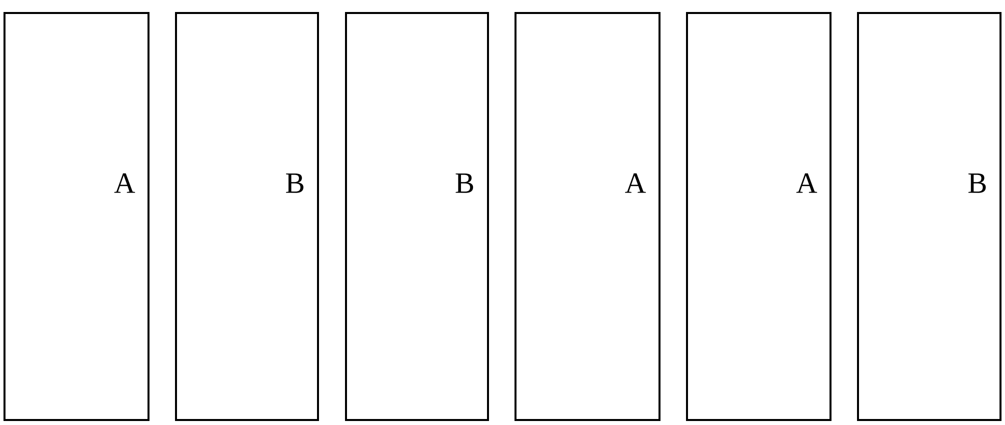

Fig 3.1: Plan layout for experimental study in the field.

3.5 DATA COLLECTION

3.5.1 TO MEASURE AND COMPARE THE GROWTH RATE (HEIGHT OF PLANTS)

Five plants were randomly selected from each plot. Height was used a parameter to measure the growth rate. The height of the plant was measured using a string and a 30cm rule at two weeks intervals, starting at pegging state 50% germination. The height was measured and recorded till the growth had ceased. A graph will be plotted using average heights to illustrate the growth. Appendix A shows the data collection form used in the studies

3.5.2 MEASURE LEAF LENGTH

Fully developed leaves from the 6 different maize plant, one from each plot, for accurate measurement were chosen and laid on a smooth, flat surface, this was firstly done 3 weeks after germination and the last measurement was done at 15 weeks after germination. There were later positioned the zero mark of the ruler at the base of the leaf, where it attaches to the stalk. The l extended the ruler along the length of the leaf and noted the measurement at the tip. If the leaf is longer than 30 cm, l would mark where the 30 cm ends and continue measuring from that point, adding the measurements together.

3.5.3 YIELDS AT HARVEST

Harvesting was done on the 28 th of April 2024 at 70 % moisture content , maize cobs were dried two weeks after Harvesting. Shelling was done, winnowing and a weigh balance was used to measure the Kernels. The yields were converted to ton/ha and average weight was used to draw bar graph to summarize the results. The data obtained was recorded on a data collection form Appendix

3.6 DATA ANALYSIS

The growth rate of maize crop was gauged using height as a parameter and analyzed through growth curves. Leaf length and yield averages were examined with a one-tailed test at a 5% significance level. It was assumed that the samples for both treatments followed a normal distribution.

Chapter4:Results

4.1 The Effects of Hydrogel on maize plant height in cm

Treatment	**Hieght3WAP**	**Hieght6WAP**	**Hieght9WAP**	**Hieght12WAP**	**Hieght15WAP**
A	**24.654**	**161.59**	**182.92**	**211.73**	**211.73**
B	**24.179**	**155.34**	**174.42**	**179.48**	**179.48**
LSD	**0.2558**	**0.932**	**6.251**	**3.701**	**3.701**
CV%	**0.4**	**0.2**	**1.3**	**0.7**	**0.7**
Pvalue	**0.010**	**0.001**	**0.22**	**0.001**	**0.001**

There was a significant different on maize plant height3WAP on treatment A and treatment B after measuring (P<0.05).There was no SD (significant different) between the field mean of maize after measuring plant height (P>0.05)

There was a significant different on maize plant height6WAP on treatment A and treatment B after measuring (P<0.05).There was a SD (significant different) between the field mean of maize after measuring plant height (P>0.05)

There was a significant different on maize plant height9WAP on treatment A and treatment B after measuring (P<0.05).There was a SD (significant different) between the field mean of maize after measuring plant height (P>0.05)

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There was a significant different on maize plant height15WAP on treatment A and treatment B after measuring (P<0.05).There was a SD (significant different) between the field mean of maize after measuring plant height (P>0.05)

4.2 The Effects of Hydrogel on maize plant leaf length in cm

Treatment	Leaf3WAP	Leaf6WAP	Leaf9WAP	Leaf12WAP	Leaf15WAP
A	7.308	27.538	41.50	58.30	58.30
B	6.758	25.734	37.13	49.97	49.97
LSD	0.5115	0.785	2.549	3.788	3.788
CV%	2.6%	2.2	2.4	2.5	2.5
Pvalue	0.42	0.037	0.012	0.006	0.006

There was a significant different on maize plant leaf 3WAP on treatment A and treatment B after measuring (P<0.05). Since the absolute difference between the means (0.55) is greater than the LSD (0.5115), we can conclude that the difference between the two treatment means is statistically significant at the 5% level.

There was a significant different on maize plant leaf 6WAP on treatment A and treatment B after measuring (P<0.05). Since the absolute difference between the means (1.304) is greater than the LSD (0.785), we can conclude that the difference between the two treatment means is statistically significant at the 5% level.

There was a significant different on maize plant leaf 9 WAP on treatment A and treatment B after measuring (P<0.05). Since the absolute difference between the means (4.37) is greater than the LSD (2.549), we can conclude that the difference between the two treatment means is statistically significant at the 5% level.

There was a significant different on maize plant leaf12WAP on treatment A and treatment B after measuring (P<0.05). Since the absolute difference between the means (8.33) is greater than the LSD (3.788), we can conclude that the difference between the two treatment means is statistically significant at the 5% level.

There was a significant different on maize plant leaf15WAP on treatment A and treatment B after measuring (P<0.05). Since the absolute difference between the means (8.33) is greater than the LSD (3.788), we can conclude that the difference between the two treatment means is statistically significant at the 5% level

4.2 The Effects of Hydrogel on maize yield measured in t/ha

Treatment	**Yield in t/ha**
A	**0.00250**
B	**0.00157**
LSD	**0.000686**
CV%	**10.3**
P value	**0.03**

There was a significant different on maize between treatment A and B after harvesting (P<0.05). The observed difference of 0.00093 t/ha is greater than the LSD value of 0.000686 t/ha. This indicates that the difference in mean yields between the two treatments is statistically significant.

CHAPTER5: DISCUSSION OFRESULTS

5:1Plant height results

The significantly higher plant heights observed in Treatment A (hydrogel) compared to Treatment B (control) at 3 WAP and 6 WAP suggest that the hydrogel had a positive effect on the early growth of the maize plants. The hydrogel likely improved soil moisture retention and nutrient availability, leading to enhanced nutrient uptake and better early growth of the plants. At 9 WAP, the difference in plant height between the two treatments was not statistically significant. This indicates that the initial growth advantage provided by the hydrogel may have diminished over time, and the plants in both treatments were able to achieve similar heights by the mid-growth stage. It is possible that as the plants grew larger, the relative impact of the hydrogel became less pronounced, or that the plants in the control treatment were able to compensate for the initial growth difference. The significant differences in plant height between the two treatments at 12 WAP and 15 WAP suggest that the hydrogel's positive effect on growth was re-established during the later growth stages. The sustained higher plant height in Treatment A compared to Treatment B at these later stages indicates that the hydrogel continued to provide benefits to the plants, potentially through improved moisture and nutrient availability. The low coefficient of variation (CV %) values throughout the experiment, ranging from 0.2% to 1.3%, indicate excellent experimental precision and consistency in the data collection. This high level of precision allows for reliable detection of statistically significant differences between the treatment means. The results suggest that the use of hydrogel can be an effective strategy to enhance maize growth, particularly in the early and late growth stages. The improved plant height observed with the hydrogel treatment may have implications for other growth and yield parameters, such as biomass production, cob development, and ultimately, grain yield.

5:2Leaf length results

At 3 WAP, the difference in leaf length between the hydrogel treatment (Treatment A) and the control (Treatment B) was not statistically significant. However, by 6 WAP, the hydrogel treatment had a significantly higher mean leaf length compared to the control, indicating that the hydrogel began to have a positive effect on leaf growth during this early growth stage. The improved leaf length in the hydrogel treatment at 6 WAP suggests that the hydrogel was able to enhance nutrient and water availability, leading to better leaf development. At 9 WAP, the hydrogel treatment continued to show a statistically significant increase in mean leaf length compared to the control. The continued positive effect of the hydrogel on leaf growth during the mid-growth stage indicates that the benefits provided by the hydrogel were sustained over time.

Larger leaf areas can contribute to increased photosynthetic capacity and overall plant productivity. The hydrogel treatment maintained a statistically significant advantage in mean leaf length compared to the control at both 12 WAP and 15 WAP.

The consistent and significant differences in leaf length during the late growth stage suggest that the hydrogel continued to provide benefits to the maize plants, potentially by improving soil moisture retention and nutrient availability. Larger leaves at the later growth stages can enhance light interception and promote further vegetative growth and development The low coefficient of variation (CV%) values, ranging from 2.2% to 2.6%, indicate excellent experimental precision and consistency in the data collection. The high level of precision allows for reliable detection of statistically significant differences between the treatment means. The improved leaf growth observed in the hydrogel treatment may have positive implications for other plant growth parameters, such as stem diameter, biomass accumulation, and ultimately, grain yield. Larger leaves can increase the plant's photosynthetic capacity, leading to enhanced carbon assimilation and nutrient transport to other plant parts. The sustained leaf growth advantage provided by the hydrogel throughout the growing season suggests that it could be a valuable tool for improving maize productivity.

5:3 Yield Results

The observed difference in mean yields between Treatment A (0.00250 t/ha) and Treatment B (0.00157 t/ha) is 0.00093 t/ha. This difference is statistically significant, as it is greater than the LSD value of 0.000686 t/ha. The p-value of 0.03 confirms the statistical significance at the 95% confidence level. While the absolute yield difference of 0.00093 t/ha may seem small, it could have important practical implications. In commercial maize production, even small increases in yield per hectare can translate to substantial gains in total productivity and profitability for farmers.

Given the relatively low base yields in the study (around 0.2 t/ha), a 0.00093 t/ha increase represents a 37% relative improvement in yield. This suggests the use of hydrogel could be a valuable tool for improving maize productivity, particularly in water-limited or drought-prone environment

CHAPTER 6

6.0 CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

According to the study plants grown with hydrogel (Treatment A) consistently showed higher plant heights, faster growth rates, and higher yields compared to the plants grown without hydrogel (Treatment B) A data clearly demonstrates the beneficial impact of using hydrogel as a soil amendment for maize crop growth and productivity. The results of this study suggest that the use of hydrogel could be a valuable technique for improving crop yields, especially in regions with draught challenging environmental conditions. In conclusion, the data clearly indicates that the use of hydrogel as a soil amendment can significantly enhance maize crop growth and productivity compared to not using hydrogel. These findings have important implications for improving agricultural practices and potentially increasing crop yields in a sustainable manner.

6.2 RECOMMENDATION

The substantial improvements in plant growth and yield observed with the use of hydrogel suggest that it should be strongly considered for implementation in agricultural production. Therefore l recommend growers and farmers to evaluate the potential benefits of incorporating hydrogel into their soil management practices, particularly in areas with limited water availability or during periods of drought. While the use of hydrogel has demonstrated positive effects on plant growth and yield, it is important to also consider the environmental implications and long-term sustainability of this approach. To facilitate the widespread adoption of hydrogel technology, it would be beneficial to, provide educational resources and training programs for farmers and growers on the proper use and benefits of hydrogel and collaborate with agricultural extension services to disseminate information and support the implementation of hydrogel-based practices. Also there is need to explore government incentives or subsidies that could encourage the use of hydrogel, particularly in regions facing water scarcity or drought challenges.

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Appendices

Analysis of variance

Variate: Hieght3

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Plot stratum					
Treatment	1	0.081667	0.081667		
Plot.*Units* stratum					
Treatment	1	0.300833	0.300833	34.94	0.010
Residual	3	0.025833	0.008611		
Total	5	0.408333			

Information summary

Model term	e.f.	non-orthogonal terms
Plot stratum		
Treatment	0.111	
Plot.*Units* stratum		
Treatment	0.889	Plot

Tables of means

Variate: Hieght3

Grand mean 24.417

Treatment	1	2
	24.654	24.179

Standard errors of means

Table	Treatment
rep.	3
d.f.	3
e.s.e.	0.0568

Standard errors of differences of means

Table	Treatment
rep.	3
d.f.	3
s.e.d.	0.0804

Least significant differences of means (5% level)

Table	Treatment
rep.	3
d.f.	3
l.s.d.	0.2558

Stratum standard errors and coefficients of variation

Variate: Hieght3

Stratum	d.f.	s.e.	cv%
Plot	0	*	*
Plot.*Units*	3	0.0928	0.4

Analysis of variance

Variate: Hieght6

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Plot stratum					
Treatment	1	0.1667	0.1667		
Plot.*Units* stratum					
Treatment	1	52.0833	52.0833	455.10	<.001
Residual	3	0.3433	0.1144		
Total	5	52.5933			

Information summary

Model term	e.f.	non-orthogonal terms
Plot stratum		
Treatment	0.111	
Plot.*Units* stratum		
Treatment	0.889	Plot

Tables of means

Variate: Hieght6

Grand mean 158.47

Treatment	1	2
	161.59	155.34

Standard errors of means

Table	Treatment
rep.	3
d.f.	3
e.s.e.	0.207

Standard errors of differences of means

Table	Treatment
rep.	3
d.f.	3
s.e.d.	0.293

Least significant differences of means (5% level)

Table	Treatment
rep.	3
d.f.	3
l.s.d.	0.932

Stratum standard errors and coefficients of variation

Variate: Hieght6

Stratum	d.f.	s.e.	cv%
Plot	0	*	*
Plot.*Units*	3	0.338	0.2

Analysis of variance

Variate: Hieght9

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Plot stratum					
Treatment	1	2.667	2.667		
Plot.*Units* stratum					
Treatment	1	96.333	96.333	18.95	0.022
Residual	3	15.253	5.084		
Total	5	114.253			

Information summary

Model term	e.f.	non-orthogonal terms
Plot stratum		
Treatment	0.111	
Plot.*Units* stratum		
Treatment	0.889	Plot

Tables of means

Variate: Hieght9

Grand mean 178.67

Treatment	1	2
	182.92	174.42

Standard errors of means

Table	Treatment
rep.	3
d.f.	3
e.s.e.	1.381

Standard errors of differences of means

Table	Treatment
rep.	3
d.f.	3
s.e.d.	1.953

Least significant differences of means (5% level)

Table	Treatment
rep.	3
d.f.	3
l.s.d.	6.215

Stratum standard errors and coefficients of variation

Variate: Hieght9

Stratum	d.f.	s.e.	cv%
Plot	0	*	*
Plot.*Units*	3	2.255	1.3

Analysis of variance

Variate: Hieght12

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Plot stratum					
Treatment	1	24.000	24.000		
Plot.*Units* stratum					
Treatment	1	270.750	270.750	150.14	0.001
Residual	3	5.410	1.803		
Total	5	300.160			

Information summary

Model term	e.f.	non-orthogonal terms
Plot stratum		
Treatment	0.111	
Plot.*Units* stratum		
Treatment	0.889	Plot

Tables of means

Variate: Hieght12

Grand mean 204.60

Treatment	1	2
	211.73	197.48

Standard errors of means

Table	Treatment
rep.	3
d.f.	3
e.s.e.	0.822

Standard errors of differences of means

Table	Treatment
rep.	3
d.f.	3
s.e.d.	1.163

Least significant differences of means (5% level)

Table	Treatment
rep.	3

d.f. 3
l.s.d. 3.701

Stratum standard errors and coefficients of variation

Variate: Hieght12

Stratum	d.f.	s.e.	cv%
Plot	0	*	*
Plot.*Units*	3	1.343	0.7

Analysis of variance

Variate: Hieght15

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Plot stratum					
Treatment	1	24.000	24.000		
Plot.*Units* stratum					
Treatment	1	270.750	270.750	150.14	0.001
Residual	3	5.410	1.803		
Total	5	300.160			

Information summary

Model term	e.f.	non-orthogonal terms
Plot stratum		
Treatment	0.111	

Plot.*Units* stratum

Treatment	0.889	Plot

Tables of means

Variate: Hieght15

Grand mean 204.60

Treatment	1	2
	211.73	197.48

Standard errors of means

Table	Treatment
rep.	3
d.f.	3
e.s.e.	0.822

Standard errors of differences of means

Table	Treatment
rep.	3
d.f.	3
s.e.d.	1.163

Least significant differences of means (5% level)

Table	Treatment
rep.	3
d.f.	3
l.s.d.	3.701

Stratum standard errors and coefficients of variation

Variate: Hieght15

Stratum	d.f.	s.e.	cv%
Plot	0	*	*
Plot.*Units*	3	1.343	0.7

Analysis of variance

Variate: Leaf3

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Plot stratum					
Treatment	1	0.16667	0.16667		
Plot.*Units* stratum					
Treatment	1	0.40333	0.40333	11.71	0.042
Residual	3	0.10333	0.03444		
Total	5	0.67333			

Information summary

Model term e.f. non-orthogonal terms

Plot stratum

Treatment	0.111	

Plot.*Units* stratum

Treatment	0.889	Plot

Tables of means

Variate: Leaf3

Grand mean 7.033

Treatment	1	2
	7.308	6.758

Standard errors of means

Table	Treatment
rep.	3
d.f.	3
e.s.e.	0.1137

Standard errors of differences of means

Table	Treatment
rep.	3
d.f.	3
s.e.d.	0.1607

Least significant differences of means (5% level)

Table	Treatment
rep.	3
d.f.	3
l.s.d.	0.5115

Stratum standard errors and coefficients of variation

Variate: Leaf3

Stratum	d.f.	s.e.	cv%
Plot	0	*	*
Plot.*Units*	3	0.1856	2.6

Analysis of variance

Variate: Leaf9

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Plot stratum					
Treatment	1	1.0417	1.0417		
Plot.*Units* stratum					
Treatment	1	25.5208	25.5208	29.84	0.012
Residual	3	2.5658	0.8553		
Total	5	29.1283			

Information summary

Model term	e.f.	non-orthogonal terms
Plot stratum		
Treatment	0.111	
Plot.*Units* stratum		
Treatment	0.889	Plot

Tables of means

Variate: Leaf9

Grand mean 39.32

Treatment	1	2
	41.50	37.13

Standard errors of means

Table	Treatment
rep.	3
d.f.	3
e.s.e.	0.566

Standard errors of differences of means

Table	Treatment
rep.	3
d.f.	3
s.e.d.	0.801

Least significant differences of means (5% level)

Table	Treatment
rep.	3
d.f.	3
l.s.d.	2.549

Stratum standard errors and coefficients of variation

Variate: Leaf9

Stratum	d.f.	s.e.	cv%
Plot	0	*	*
Plot.*Units*	3	0.925	2.4

Analysis of variance

Variate: Leaf12

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Plot stratum					
Treatment	1	0.540	0.540		
Plot.*Units* stratum					
Treatment	1	92.407	92.407	48.93	0.006
Residual	3	5.666	1.889		
Total	5	98.613			

Information summary

Model term	e.f.	non-orthogonal terms
Plot stratum		
Treatment	0.111	
Plot.*Units* stratum		
Treatment	0.889	Plot

Tables of means

Variate: Leaf12

Grand mean 54.13

Treatment	1	2
	58.30	49.97

Standard errors of means

Table	Treatment
rep.	3
d.f.	3
e.s.e.	0.842

Standard errors of differences of means

Table	Treatment
rep.	3
d.f.	3

s.e.d. 1.190

Least significant differences of means (5% level)

Table	Treatment
rep.	3
d.f.	3
l.s.d.	3.788

Stratum standard errors and coefficients of variation

Variate: Leaf12

Stratum	d.f.	s.e.	cv%
Plot	0	*	*
Plot.*Units*	3	1.374	2.5

Analysis of variance

Variate: Leaf15

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Plot stratum					
Treatment	1	0.482	0.482		
Plot.*Units* stratum					
Treatment	1	105.021	105.021	27.92	0.013
Residual	3	11.286	3.762		

Total	5	116.788

Information summary

Model term	e.f.	non-orthogonal terms
Plot stratum		
Treatment	0.111	
Plot.*Units* stratum		
Treatment	0.889	Plot

Tables of means

Variate: Leaf15

Grand mean 59.32

Treatment	1	2
	63.75	54.88

Standard errors of means

Table	Treatment
rep.	3
d.f.	3
e.s.e.	1.188

Standard errors of differences of means

Table Treatment

rep.	3
d.f.	3
s.e.d.	1.680

Least significant differences of means (5% level)

Table	Treatment
rep.	3
d.f.	3
l.s.d.	5.346

Stratum standard errors and coefficients of variation

Variate: Leaf15

Stratum	d.f.	s.e.	cv%
Plot	0	*	*
Plot.*Units*	3	1.940	3.3

Analysis of variance

Variate: YIELD

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Plot stratum					
Treatment	1	6.667E-09	6.667E-09		
Plot.*Units* stratum					
Treatment	1	1.141E-06	1.141E-06	18.42	0.023

Residual	3	1.858E-07	6.194E-08

Total	5	1.333E-06

Information summary

Model term	e.f.	non-orthogonal terms
Plot stratum		
Treatment	0.111	
Plot.*Units* stratum		
Treatment	0.889	Plot

Tables of means

Variate: YIELD

Grand mean 0.00203

Treatment	1	2
	0.00250	0.00157

Standard errors of means

Table	Treatment
rep.	3
d.f.	3
e.s.e.	0.000152

Standard errors of differences of means

Table	Treatment
rep.	3
d.f.	3
s.e.d.	0.000216

Least significant differences of means (5% level)

Table	Treatment
rep.	3
d.f.	3
l.s.d.	0.000686

Stratum standard errors and coefficients of variation

Variate: YIELD

Stratum	d.f.	s.e.	cv%
Plot	0	*	*
Plot.*Units*	3	0.000249	12.2