The Application of Polymers as Water and Soil Conservation Agents in Farming Areas Mulching

Odidi, D. O., Uwague, E. E., Anokwuru, S.N., Omozusi, E.J., Oghomieje, L.A., and Ibikunle, O.O.

Rubber Research Institute of Nigeria, Benin City, Edo State, Nigeria.
Corresponding author's email: uncledee4life2017@gmail.com

Received 13 October 2025, Accepted 10 December 2025, Published 20 December 2025

Direct Research Journal of Agriculture and Food Science

Direct RESEARCH JOURNALS

Vol. 13(3), Pp. 296-304, December 2025

https://journals.directresearchpublisher.org/index.php/drjafs; https://www.ajol.info/index.php/drjafs

Research Article
ISSN: 2354-4147

ABSTRACT

The act of mulching is almost as old as man himself. Man has been practicing mulching for quite a very long time now. Mulch is used to conserve and preserve moisture and reduce the growth of weeds. Many materials can be used as mulch. These can be broadly divided into organic and inorganic, synthetic (man-made / artificial) and natural. Such mulch materials include, grass, stones, glass, weeds, plastics etc. polyethylene (PE) is one of the most effective, due to its excellent strength, low cost and its ability to act as a boundary between sunlight and water. Biodegradability issues however, constitute serious challenges in the use of petroleum – based materials. Hence, biodegradable polymers are being developed from fossil fuels. This paper will focus on the uses, challenges and prospects of mulch materials derived from polymers.

Keywords: *Mulching, polymers, preserve, biodegradability, synthetic*

Citation: Odidi D.O., Uwague, E. E., Anokwuru S.N., Omozusi E.J., Oghomieje, L.A., & Ibikunle,O.O., (2025). The Application of Polymers as Water and Soil Conservation Agents in Farming Areas Mulching. *Direct Research Journal of Agriculture and Food Science*. Vol. 13(3), Pp. 296-304. https://doi.org/10.26765/DRJAFS179936

INTRODUCTION

With the increasing demand for good quality food and raw materials and a higher quantity of agricultural production to feed the ever increasing populace and the demands of industries, and the great challenges of adverse weather occasioned by the climate change problems, Nigeria must evolve better and more efficient ways of water production, conservation and management for the much needed boost in agrarian output to be a reality. Agricultural sustainability is essential to enhance food, raw materials and water security. We will look at various ways of conserving and managing water in the soil for sustainable agro based bumper harvests. We will consider the use of polymer hydrogels and mulch films for moisture preservation and prevention of weed growth. (Mansoor et al., 2022 and Prakash et al. 2021). Water is the most consumed substance on the Earth. Scarcity of water is becoming a real problem and in many countries there is an urgent issue of water shortage and prolonged drought, due to lack of rain or scanty rainfall, and abnormally high temperatures, most worst in the third world countries. (Allen et al 2018). Climate changes are not evenly distributed, it depends on regional climate differences, resources availability, adaptive capabilities and much more, greenhouse effect, result in much harm on those countries which did very little in producing the accumulation of such hazardous gases and chemicals (Lelieveld et al 2012). Most countries in Africa, especially the horn of Africa, i.e. Sudan, Ethiopia, Eritrea, Niger, Mali, Burkina Faso are already suffering from the effects of prolonged drought, with human and animal casualties. High temperatures and drought are on the increase these days. Northern Nigeria is already suffering from little amounts of rainfall, high temperatures, drought, dust storms, erosion and rapid desert encroachment. In India, Nepal and other Asia countries, there reports of decreasing rainfalls and decreasing groundwater reserves and more droughts (Devineni et al 2013). For the past 20 years in Africa, succeeding years have recorded higher temperatures and have therefore being hotter than the previous years. Predictions are that by 2080, African will witness average temperature increase of 4.5℃ with very adverse effects on precipitation patterns (Rosenstock et al 2018). For China, temperatures are likely to increase by about 1.5℃ by the year 2100 with very infrequent precipitations, alternating with flash floods and droughts, not ruling out heatwaves. (Piao et al 2010). Exhaustion of water and scarcity poses a challenge to development, more so, as the agricultural sector is the largest consumer of water and would suffer the most from water scarcity. (Roy et al 2019). The Millennial Development Goals (MDGs), Sustainable Development Goals (SDGs), Climate – Smart Agriculture (CSA) and other United Nations development goals and agenda would not see fruition, if concerted efforts are not put in place and carried out. These goals are the skeletal structure on which sustainable water supply and management can be anchored on. (Rosenstock et al 2018, ECOSOC, 2019). Soil moisture and soil nutrients contents has a direct effect on soil fertility, and hence crop yield. Lack of water or infrequent amount of water can course heavy crop failures and food shortages and mass poverty for farmers and far nations too. In dry (arid) or semi – dry areas, paddy rice, wheat and most cereals must be irrigated. (Devineri et al 2013).

In as much as rainfall is not certain, rivers too cannot be relied upon due to variations in climate conditions. From the foregoing, it is pertinent to look at alternative sources in order to have better and higher crop yields. Water consumption by plants depends on irrigation system, agro meteorological parameters such as evapotranspiration, and soil properties. (Jacoby et al 2017). To reduce waste erosion and leaching, irrigation has to be properly planned and efficient with the maintenance of a profitable balance between the availability of water to plants in the soil and the actual or real volume needed for plant optimum growth. (Agaba et al 2011). Scientifically, efficient and fool proof long term water management has been developed in addition to computer aided modeling and genetic algorithm optimization. (Ines et al 2006). The challenges of much water waste and high cost in irrigation has necessitated the search for alternative means of maintaining soil moisture, fertility and productivity. One of such route is the use of soil conditioners. There was a noticeable reduction in soil leaching, erosion, better water retention and holding capacity in soils, reduction in infiltration rates, stoppage of fertilizers / materials and pesticide runoffs and reduction of evaporation of water in irrigated fields (Prakash et al 2021). Soil conditions are being planned for zones of water scarcity and lack of precipitation (Narjary et al 2012). Local farming communities began to use organic manure such as poultry dropping, fishery waste water, animal droppings, straw mulch, weeds, agro-processing wastes, and effluents, bitumen (treated and untreated), compost, farmyard manure, petroleum emulsions as soil conditions. Others used polyacrylamide (PAAm), a hydrophilic, (water loving) polymer. (Tayel & El – Hodx 1981, De Boodt 1975). Studies were done in the 1970 using a gelating material called verdyol for soil conditioning. Tayel & El – Hady (1981), proposed a supergel – hydrophilic polymer which forms gel immediately on contact with water, for soil conditioning in poor or sandy soils, which are also usually heavily leached and porous. These studies showed that a hydrophilic polymers could be used for soil remediation and conditioning because of the swelling properties or hydrophilic nature. Later the materials were developed into hydrogels. (Bruck 1973, Krzzanski & Dubrovskii 1992). We can define hydrogels as three – dimensional (3 – D) polymeric networks that can retain a large volume of water within their structures and swell without dissolving in water (Guilherme et al., 2015). Alterations and modifications during formulation. Compounding synthesis. Preparation and production of hydrogels can make them useful and even excellent for soil remediation, conditioning and upgrading. Demitri et al showed that soils remediated or treated with hydrogels showed a very marked improvement in water retention (Demitri 2013). Hydrogels act as water reservoir for plants, release micro and macro nutrients gradually to improve the soil (Jamnongkan and Kaewpirom 2010). The breakdown products help to fertilize the soil by releasing nutrients, hence enhancing symbiotic organism growth and development (Abel El – Rehin, 2006). We are going to look into the merits of these hydrogels in this paper. The other method for soil water conservation we are considering is the application mulch, this technique has been applied from time immemorial in farming systems. We can simply define mulching as the application of mulch materials simply and directly on the surface or top of the soil for diverse reasons, such as reduction of evaporation, production of plant seedlings aid young shoots through reduced evaporation, insulation, control of weeds and prevention of soil erosion (Chalker – Scott 2007). Mulches protect delicate crop species from harsh abiotic and biotic stresses and conditions, they occur as a consequence of adverse weather and climatic conditions, insects, pests and weeds. Mulches enhance crop yields (Khan et al 2020). Over the years, different materials have been used for mulching. Technological improvements also change the use of mulch from stone to films, then plastics, like the olefins, were introduced in the 50s to 60s and these, polyethylene, polypropylene and polystyrene became the vague. Due to the non-biodegradable nature of the hydrocarbons, their use

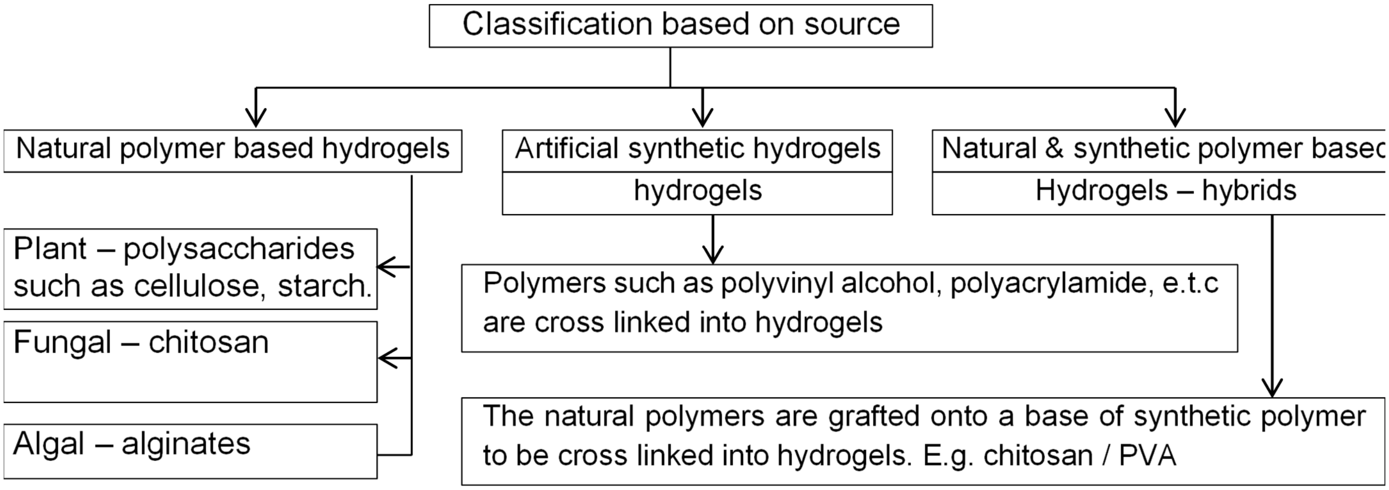

Figure 1: Source-based classification of hydrogels (Ghobashy 2020).

became a source of concern (Steinmetz et al 2016). In 2021, the food and agricultural organization (FAO), an arm of the United Nations Organization (UNO) recommended the use of bio-based polymers for mulching practices (Moshood et al 2022). Due to emission of gases from the burning of fossil fuel and the accumulation of same, leading to global warming and its attendant climate and adverse effects on rainfall patterns worldwide, leading to massive crop losses from droughts. There is an urgent necessity to develop efficient and sustainable water resources management, also available statistics indicate that the availability of arable land for cultivation is reducing very fast, due to increase in constructions, (houses, roads, factories, e.t.c). also, irrigation and soil erosion reduces available water resources worldwide, especially in developing countries, there is also the grave issue of climate change and pollution while, arable land is shrinking worldwide, the Earth's population is increasing, that implies more mouths to feed too (Campi et al 2021). The millennial development goals of UNO aims at eliminating hunger by 2030, and the consequent Sustainable Development Goals (SDGs), includes access to quality food by all, increasing agricultural yields, and adopting sustainable agro-forestry and agro-allied productivity system that is suitable, sustainable, manageable and efficient, with the chief aim of increasing harvests worldwide. This can only be achieved by adopting farming methods that are environmentally friendly, ecologically viable and functional and practicable (Bizikova et al 2020). Worldwide, the mulch market is about USD3.5 billion as at 2020 and is expected to rise to USD5.1 by the year 2027 (Li et al 2023). Due to environmental challenges pose by the use of non-degradable polymers, bio-degradable polymers have a far better and greater potential to replace hydrocarbons from fossil fuels. We will look at the issues surrounding mulching in farming, advantages, mulch materials and options for sustainable agro-practices.

MATERIALS & METHODS

Classification of Hydrogels

Several methods have used to categorize hydrogels such categorizations are usually based on the following criteria, source, synthesis method, crosslinking modes and pore or particle size (Ahmed 2015) (Figure 1).

Classification base on source

Cellulose hydrogels can be manufactured from cellulose ethers and are not toxic, hazardous and are bio-degradable (Ghobashy 2020). Carboxyl methyl cellulose (CMC) and hydroxyl ethyl Cellulose (HXC) are also good. (Montessano et al 2015). Novel hybrid hydrogels based on starch, chitin, tulip extracts have shown good swelling and bio-degradability (Kollar et al 2016). Hydrogels are formed from the crosslinking of polymers that occur naturally or are synthetically made. Such polymers include polyacrylamide, (PAA), polyvinyl alcohol (PVA) and polyethylene oxide, (PEO), these are however, very toxic the environs (Zhang et al 2019). Natural hydrogels have low swelling power, but bio-gradable (Ahnadi 2015). The best approach seems to be a combination of natural and synthetic polymers (Prakash et al 2021).

Classification based on method of synthesis or preparation

Solution, graft, radiation-induced radical, bulk and inverse suspension polymerization are unduly used in the manufacture of polymeric hydrogels. Attempts to combine chitosan-based hydrogel unit PAA and PVA. Also is with solution polymerization, by the process of homo-polymerization and copolymerization was done with tutipalin, A (gotten from tulip extraction). Using bulk

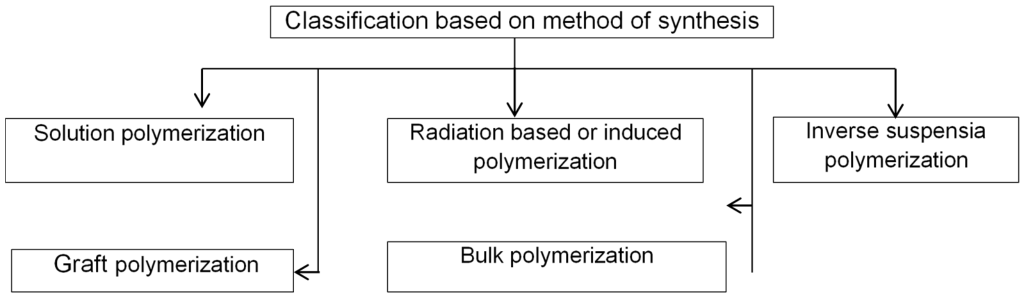

Figure 2: Classification based on methods of synthesis / preparation (Ahmed, 2015, Kanzonskii & Dubrovskii).

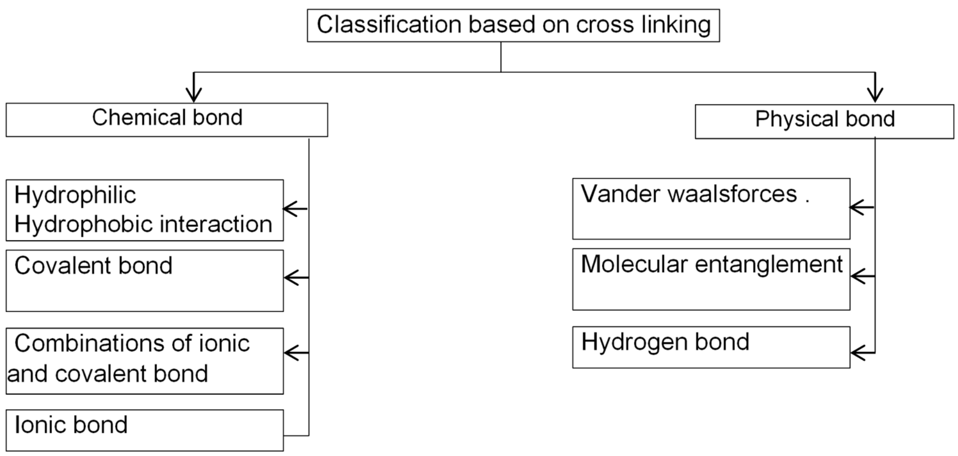

Figure 3: Classification according to crosslinking types (Ahmadi et al 2015)

polymerization processes, a large single matrix was produced, which can be derived in the desired shape and size. Irradiating monomer units in a chamber with high energy radiation such as gamma rays, X-rays, amongst others result in crosslinking. The method of preparation and the amount or number or density of the crosslinking agents' initiators and other reactors usually determine the characteristics and properties of the hydrogel, especially parameters like its swelling degree, resistance temperature and response to pH (Kollar et al 2016, Ahmed 2015, Guilherme et al 2015). (Figure 2).

Classification based on crosslinking type

The process of cross-linking enables polymers to form three dimensional matrices and structures, which display elastic properties and facilitate swelling as well as providing stability to the structure of the matrix. Chemical crosslinking is permanent and confers strength and durability to the hydrogels – very much desired property for use where high temperatures, varying pH, pressure e.t.c are encountered (Figure 3). Physical crosslinks are normally reversible due to its ready response to disorientation and destabilization because of external surroundings and environmental stimuli. Response to external stimuli is a big plus for hydrogels because the hydrogel can be used as a smart material in many applications, viz moisture and pH sensors. Swelling degree has a direct bearing on crosslinking density. The swelling degree has an inversely proportional relationship to the crosslink density (Guilherma et al 2015, Shinet et al 2010, Trellis et al 2011, and Prakash et al 2021).

Classification based on pore sizes

Classification based on pure sizes for farming operations, swelling ratio is however, of far greater significant than swelling rate in addition to slow release kinetics and biodegradability, a glossary matrix with absorption of a few hours can still efficiently in soil for agricultural use (Figure 4) (Parthasarathi et al 2018).

Stimuli Responsive Hydrogels (SRH)

These class of smart polymers are super absorbent materials that properties in response to particular changes

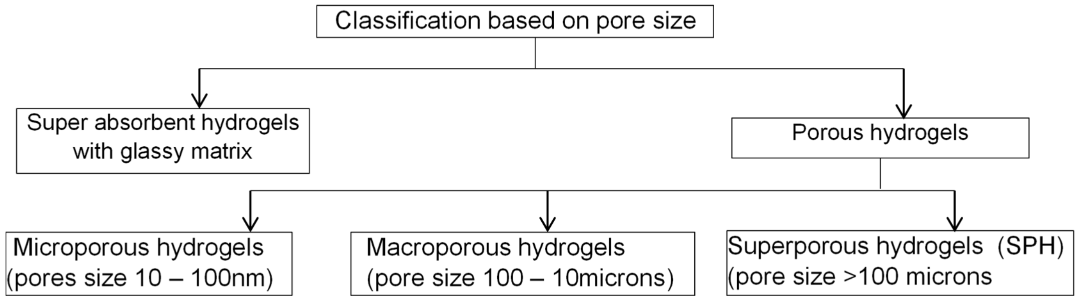

Figure 4: Classification based on pure sizes (Chen et al 1991)

in environmental parameters. Such parameters include temperature, over burden pressure, pH, ionic concentration, osmotic pressure and electromagnetic fields (Rehman et al 2011, Ahmed 2015). A good photonic crystal hydrogel is one which undergo a change of colour in response to change in pH. An interpenetrating photo polymerized hydrogel showed a colour change within 10 – 20 seconds for pH ranging from 3 to 6 (Slin et al 2010). The absorption of water by hydrophilic polymers in the hydrogel matrix could be used in monitoring the water content of the surroundings. Agarose based hydrogel films mixed with dapoxyl sulphonic acid (fluorophori) changed over a range of 30 to 40nm wavelengths for a 0% to 100% change in air humidity and gaseous medium with a 15 – minutes response time (Trellis et al 2011). Trellis et al (2011) pointed out that the ……. of surroundings or environmentally sensitive fluorphore in place of polymer chains linkers for detection of changes in the environment, helps the proper incorporation of this characteristics in a number of hydrogels for their utilization as smart materials. This, has opened an avenue for the exploitation of smart polymer hydrogels in farming application like moisture – based release systems, time – based fertilizer release systems and enzyme – based pesticide / fungicides / bacterioxide / herbicide systems.

Characteristics of Hydrogels

Listed below are some properties of polymer hydrogels employed in farming;
(a) A good swelling degree with excellent accretion
(b) The structure must be able to withstand from the soil and surroundings.
(c) The polymer must be capable of slow release of water to fertilizers.
(d) The hydrogel should enrich the activities of microbes in the soil.
(e) Hydrogels must be biodegradable (Ahmed 2015, Neethan et al 2018).

Parameters useful for polymer hydrogel efficiency

(a) Amount of fertilizer releasable. (Jamnongkan & Kaewpiren, 2010).
(b) Amount of fertilizer released in water. (Jamnongkan & Kaewpiren, 2010).
(c) Water absorbency, this is also called swelling times or swelling degree (%). (Jamnongkan & Kaewpiren, 2010 and Latif et al 2016).
(d) Water retention soil. (Jamnongkan & Kaewpiren, 2010).
(e) Water holding capacity of soil (WHC). Usually calculated in percentage (Rychter et al 2019).
(f) Slow release properties lack of controlled release of chemicals usually results in eutrophication. The use of coated fertilizers and cross – linked chemically based polysaccharide based hydrogels helps in reducing or stopping chemicals loss. (Canitherme et al 2015).
(g) Swelling properties of polymer hydrogels – swelling refers to the property of a material to retain water, as a result of its cross-linking and hydrophobicity. (Ahmed, et al 2015). Super absorbent polymer (SAPs) and super porous hydrogels (SPHs) are relatively newer classes of polymers (Chen et al 1999).
(h) Water retention properties of polymer hydrogels. An ideal hydrogel for farming purpose should be averse to degradation and hold water under loading conditions and for extended period of time. This is necessary to supply water to plant root heirs. SAPs are used because of their very high water retention under pressure. (Omnidien et al 2005).

The impact of polymer hydrogels on the soil

These polymers increase the ability of the soil to absorb and retain water in dry areas and drought prone places and helps plants by making more water available to roots. Better water retention will reduce the need for frequent irrigation. Terminologies and properties relating to soil water interaction are: Soil Water Capacity (SWC), Available Water Capacity (AWC), and Readily Available Water Capacity (RAWC), according to 15 2720 (1983). The quantity of these characteristics can be calculated and to the guidelines given above and many other standards (Narjay et al 2012). Polymer hydrogels give the soil texture and the porosity necessary for optimum air and water flow in the body of the soil and knows when to release stored water when the soil is dried up. This hydrogen activities

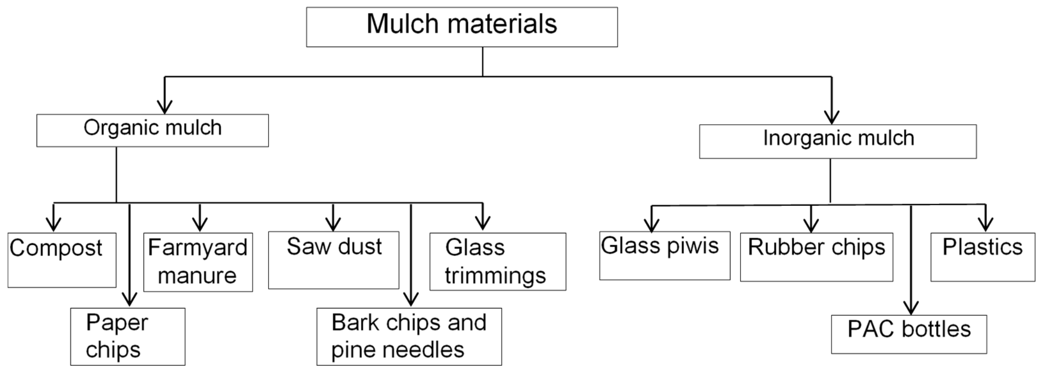

Figure 5: Classification of mulch materials.

assists in realizing the maximum growth potential for plants. Hydrogel particles or chesters, either soil porosity enables better aeration and oxygenation of the soil and plants (Guilherme et al 2015, Ghobashy 2010, Chen et al 2004 and Narjay et al 2012).

The impact of polymer hydrogel on soil microbial and fungal growth rates

The active role of soil microorganism is the fertility of thesoil is very essential in the soil matrix and useful for nutrient availability and uptake by plant roots. Soil micro – and macro – organisms such as fungi, bacteria, earthworms, millipede amongst others, but unicellular and multicellular are the means of achieving this complex nutrients breakdown and also the release to plants. The root system has a complex interaction with its environment with the likes of rhizobium fauna, azotobacter, nitrosamines, fungi bacterial e.t.c. a healthy population of nitrogen and other nutrient fixing bacteria is tantamount to increasing and optimizing overall yields of plants. This ecosystem is vital for a sustainable environment for plant cultivation and growth, as it ensures a better natural equilibrium between nutrients transfer, uptake and survival of the species and ever better hybrids production. There is thus, a complex interaction and relationship between microbes with polymer hydrogels taking part in complex reactions and exchange of enzymes. Soil microorganisms are brought in contact with nutrient release and degradation products of hydrogels. Since symbiosis is essential for plant growth, hydrogels applied for agricultural productivity should pose no toxicity to these symbiotic micro – organisms and hydrogels should be tested for such negative effects. (Prakash et al 2021, Jacoby et al 2017)

The impacts of polymer hydrogels on crop plants growth.

Many scientists has investigated the effects of the use of polymer hydrogels on the rate of plant growth, quality, quantity (or yields or harvest). In all, hydrogels have been found to be beneficial and greatly increased and improved yields. The following are some of the usefulness of hydrogels, better water use efficiency, dry biomass weight, better witting point, higher germinal rate index and quicker, better root length/ surface area, better shoot length, chlorophyll content improved, better plant height, Turgor potential, yield weight increases, and better lay content. (Ghobashy 2020, Prakash et al 2021, Mazen et al 2015, Demitri et al 2013, Chen et al 2004).

The great merit of model films to farming

To avert global hunger, we must meet the ever increasing global demand for not only food, but good quality food, hence effort must be geared towards increased food production and higher agricultural yields. Mulching is based on the principle protected cultivation and it involves the application of a protective ground cover, made of different materials that may be organic or synthetic, to improve the growth and yield of food or arable or stample crops. Mulches reduce: moisture loss, weeds, excessive temperature, pressure, adverse climate, erosion / run-offs. Leaching and increase percolation aeration water retention and better soil texture and soil fertility in all. (Mansor et al 2022, Mautra et al 2020).

Mulch types in use today

Mulches can be divided into organic and inorganic materials. Organic ones are derived from nature and can be biodegradable. Inorganic mulches are usually artificial that is man-made or synthetics and are difficult to decay by soil micro-organism (Figure 5).

Organically Sourced mulches

These are materials from animal droppings, human droppings, compost, farm yard manure (FYM), straw, husks, caw dust, grass, paper shreds, chips, available and biodegradable, hence environmentally friendly and green chemistry toast and sustainable. Thy great increase crop yields and harvests (Mansoar et al 2022 and Pinamonti 1998).

Man – made / Artificial / Synthetic Mulch

Materials such as glass, rubber sheets and plastic sheets and a host of other inorganic materials are usually used for mulching. Such materials, control temperatures, great minimize weed growth and enhance yields by about 15 – 40%. Plastic PE films are resistant to weathering. The PE films have low cost, low frequency of replacement, versatility and strength, hence very effective in the field. (Benoit & Demars 2018).

Recent Trends in Mulch Usage

The emphasis is now on the production of mulching materials that are ecosystem friendly (biodegradable) and sustainable. Such a material should be bio-based and easily degradable, while, having good tensile strength, and elongation. A good mulch material such be easy to install, good physical and mechanical properties, low cost, easily broken down by microbes into carbon dioxide, water, methane, inorganic and biomass compounds within one year or 12 months, and apart from being readily available and cheap, must never be toxic. (Xu et al 2016).

Some Biodegradable Polymers for Mulch Films

Biodegradation is the breaking down of macromolecules by the action of soil microorganism. Such a process is a two – step process: firstly, high molecular weight fragmentation occurs, as the long polymer chains are breakdown into smaller units such as oligomers, with polar chain ends or monomers with specific properties in the second stage, the oligomers and monomers formed in the first step are mineralized by microorganisms to produce carbon dioxide, methane, water and biomass. (Mansoor et al 2022).

Some Fossil Materials Based Biodegradable Polymers Employed in Mulching

These include synthetic materials such as poly urethanes ie poly butylene adipate terephthalate (PBAT), poly E-caprolactone or PCL and poly butylene succinate (PBS) (Mansoor et al 2022).

Bio-based Polymers Employed in Farming Mulch Preparation

Bio-based polymers

These are materials formed by nature. This formation was due to the actions of living organisms. Example of naturally formed materials are lipids, proteins and carbohydrates. Lipids include esters, acid polyesters or free acids, are usually hydrocarbons. Lipids also include fats, oils, fatty acids and waxes (Mansoor 2022). Lipids do not have affinity for water, hence not suitable for mulch. Proteins can be used for mulch. Proteins can be used for mulch and polysaccharides (starches). Examples include chitin, alginate, starch and cellulose. Such carbohydrate polymers can be classified into monosaccharaides, disaccharides and polysaccharides or primary, secondary and tertiary carbohydrates respectively.

Poly Lactic Acid (PLA)

PLA is produced by lactic acid forming microorganisms. It is made by using renewable resources as the substrate for the microorganisms such as corn, sugar beet, starch and other products. The monomers are produced by bacteria and the polymer is made through a synthetic process involving ring opening polymerization and poly condensation. Apart from its poor mechanical properties, it is a good mulch.

Polyhydroxyl Akanoates (PHA)

PHA are a class of aliphatic polyesters that are produced by a lot of bacterial as discrete noodles. The polyesters are synthesized intracellularly and used for storage of carbon in many prokaryotes. Poor mechanical properties. Blending improves their use as mulch.

Chitin

This polymer is found in natural cell walls of fungi and yeast and in the external skeleton of arthropods (insects). Chitosan readily dissolves in dilute acids and remains insoluble in water. It can be moulded to form films for mulch and it is the second most abundant biological polysaccharide found in nature. Chitin and chitosan are expensive, hence not popular mulching material.

The Alginates

The aliginates are an aliphatic, water soluble polymers found in cell walls of brown algae. It is chemically made up of B – of mannuronic acid (monomer M), and α – l – guluronic acid (monomer G). It can form 3 – D mesh networks in the presence of cations (Al^{3+}, Na^{+}, NH_3^{+}, Ha), where the cation acts as a cross-linker that joins the alginate chains from the residues. This property is greatly employed in the production of gels or films from alginates.

Starch

Starch is the main storage polysaccharide found in plants and is made of the chains of amylose and amylopectin. Starch is usually gotten from maize (corn), wheat, cassava, rice, sorghum, potato, yam, cocoyam, plantain e.t.c. starch is a very abundant and cheap polymer that can replace plastics. However, it has low mechanical properties, hence its limited use as mulch.

Cellulose

Cellulose is the main structural component of plant cells and is the most abundant polysaccharide in nature. It is a linear homopolymer made up of D-glucose units joined together through B – I, 4 glycoside bonds. Though, cellulose is found in plants, it can be produced by a lot of microorganisms including common soil – borne bacteria. The naturally occurring cellulose is found in two crystalline or allomorphic forms, 1α and $1\ \beta$, depending the network of hydrogen bonds formed between the hydroxyl groups of cellulose chains.

Commercial Biodegradable Mulches Available

These include moter – Bi, Biomax TPS, Biopar, Bionelle, Biosafe, Ingeo and Weed Guard Plus, the result gotten from field trials indicate that such mulch films are as effective as PE mulch in controlling need and moisture and enhancing crop plants growth. The major challenge is biodegradable materials are not much to replace non – biodegradable and also issues of high cost. If the economic feasibility and profitability of biodegradable mulches implies that, governments need to provide subsidies to enhance their increased use through extensive marketing. (Mansoor et al 2022).

Prospects of biodegradable mulch

Inspite of much research in the development and production of biodegradable mulch, large scale commercial exploitation and profitability is still not happening. To make profit and attract the needed funds, biodegradable mulch need to be cost effective, accessible to farmers, reduce their cost and promote them, to be able to replace the non – biodegradable plastic mulches. At present, degradable mulches are costly, difficult to manage and require the use of specialized equipment for application. Government need to give subsidies, and adopt policies that enhance the use of decomposable mulches. Among all the polymer considered, cellulose offers the greatest potential for further research and the only drawback is it cost of production. New processing technologies such as 3 – D printing and electrospining can bring down the cost of production.

Conclusion

The sustainable production of staple, arable and cash crops is very key to the enhancement of food, employment and water security. The use of hydrogels and mulch materials in farming has received a great deal of attention among all cadres of society globally. Polymer hydrogels and mulch have been envisaged as effective soil remediators, and conditioners in dry and semi-dry zones of the planet. Such polymers improve soil texture and structure, provide the needed porosity and soil aeration for optimum flow of air and water, and regulates soil salinity and the release of stored water in dried soils. The ideal properties of hydrogels and mulch have been done, also their syntheses, properties and challenges regarding issues of biodegradability and costs and other issues have been looked into. Polymer hydrogels and mulch are good soil conditioners, improve water use efficiency, plant health and yields and reduce the need for frequent irrigation. Polymer hydrogels and mulch are good for paddy crops and wheat which need much water. New polymers that respond to stimuli with moisture and time for efficient optimum utilization of chemicals such as; pesticides, insecticedes, bacterioxides, fertilizers, fungicides amongst others should be focused on. More so on their decomposition, water retention ability, irrigation efficiency, and their availability and affordability to most farmers residing in the third world nations. With mulch needed emphasis by all and sundry polymer hydrogels and mulch will become more popular among the global agricultural community for plant production, innovating environmentally friendly systems that will greatly enhance sustainable millennial development goals.

REFERENCES

Prakash, S; Vasudevan, S; Banerjee, A; Joe, A.C; Goetha, K.N; and Mani, S.K (2021). Sustainable Irrigation through the Application of Hydrogel: A Review. Alinteri J. of Agric. Sc, 36 (2): 38 – 52, doi 47059/ alinteri/ V3612/ AJAS21113

Bhattachorya, A; (2018). Changing Climate and Resources Use Efficiency in Plants. Academic Press.

Chen, J; Park, H & Park, K (1999). Synthesis of Superporus Hydrogels with Fast Swelling & Superabsorbent Properties: Journal of Biomed. Mat. Res: An Official Journal of the Soc. For Biomaterials. The Japanese Soc. for Biomats. and the Australian Soc. Biomats, 44(1), 53 – 62.

Chen, S; Zammorodi, M; Fritz, E; Wang, S & Hutterman, A (2004). Hydrogel Modified Uptake of Salt Ions and Calcium in Populus Euphratia under Saline Conditions' Tras 18(2) 175 – 183.

De Boodt, M; (1975). Use of Soil Conditioners around the World; Soil Conditioner 7, 1 – 12.

Demitri, C; Scalera, F; Madghiele, M; Sannino, A; Moffezzoli, A (2013). Potential of Cellulose – based, Superabsorbent Hydrogels as Water Reservoir in Agriculture. IJPS.

Ecosoc, U (2019). Special Edition: Progress Towards the Sustainable Development Goals Report of See-gen, Advanced Unedited Version, New York / US, United Nations.

Fumio, U; Hiroshi, Y; Kumiko, N; Sachihiko, N; Kenji, S; Yasunor, M (1990). Dwelling & Mechanical Properties of Polyvinyl Alcohol Hydrogels. Int. J. of Ph. IJOPH. 58(2), 135 – 142.

Ghobashy, M.M. (2020). The Application of Natural Polymer Based Hydrogels for Agriculture in Hydrogels Based on Natural Polymers; Elserier, pp 329 – 356.

Guilherme, M.R; Aouado, F.A; Fajardo, A.R; Martins, A.F; Paulino, A.T; Davi, M.F; Rubira, A.F; & Munic, E.C (2015). Superabsorbent Hydrogels Based on Polysaccharides for Application in Agriculture as Soil Conditioner and Nutrient Carrier: A Review; European Polymer J. 72, 365 – 385.

Ines, A.V; Honda, K; Gupta, A.D; Droogers, P & Clemente, R.S (2006). Combining Remote Sensing – Simulation Modeling and Generic Alorithm Optimization to Explore Water Management Options in Irrigated Agric. AWM 83 (3), 221 – 232.

Jamnongkan, J & Kaewpiran (2010). Potassium Release Kinetic and Water Retention of Controlled Release Fertilizers Based on Chitosan Hydrogels, JOPAE, 18(3), 413 – 421.

Katayamo, T; Nakauma, M; Todoriki, S; Philips, G.O & Tado, M (2006). Radiation – induced Polymerization of Gum Arabic (Acacia Senegal) in Aqueous Solution; Food Hydrocolloids. 20(7), 983 – 989.

Kaieanskii, K & Dubrovskii, S (1992). Chemistry and Physics of “Agricultural” Hydrogels in Polyelectrolyte, Hydrogels Chromatographic Materials; Spinger, pp 97 – 133.

Kollar, J; Mrilik, M; Marwcikovo, D; Krone Kova, Z; Liptaj, T; Lacik, L; & Mosnacek, J (2016). Tulips: A Renewable Source of Monomer for Superabsorbent Hydrogels; Macromol 49(11), 4047 – 4057.

Latif, I.A; Abdullah, H.M and Saleem, M.H (2016). Electrical and Swelling Study of Different Prepared Hydrogels. Am. J. Polym. Sci. 6(2), 50 - 57.

Montesano, F.F; Parente, A; Santamaria, P; Sannino, A & Serio, F (2015). Biodegradable Superabsorbent Hydrogel Increases Water Rentention Properties of Growing Media and Plant Growth; A & ASP, 4, 451 – 458.

Narjolly, B; Aggarwal, P; Singh, A; Chakraborty, D and Singh, R (2012). Water Available in Different Soils in Relations Hydrogel Application; Geoderma 187, 94 – 101.

Neethu, T; Dubey, P & Kaswala, A (2018). Prospects and Applications of Hydrogel Technology in Agriculture; Int. J. Curr. Microbiol. App Sc 7(5), 3155 – 3162.

Parthasarathe, T; Varitha, K; Mohandess, S & Vared, E (2018). Evaluation of Drip Irrigation System for Water Productivity and Yield of Rice. Agr. J. 110(6), 2378 – 2389.

Rosenstak, T.S; Nowak, A & Givetz, E (2018). The Climate – Smart Agric. Papers: Investigating the Business of a Productive, Resilient and Low Emission Future, Springer.

Ahmadi, F; Oviesi, Z; Samani, S.M; & Amoozpar, Z (2015). Chitosan Based Hydrogels, Characterization and Pharmaceutical Applications: A Review. Res. In Ph. Sc. 10 (1) 1.

Ahmed, E.M (2015). Hydrogel: Preparation, Characterization and Applications: A Review. J. of Adv. Res. 6(2), 105 – 121.

Rychter, P; Rogacz, D; Leucicko, K; Kollar, J; Kowale, M & Mosnacek, J (2019). Ecotoxicological Properties of Tulipauri α – Based Superabsorbents Versus Conversional Superabsorbents Hydrogels. Adv. In Polym Tech.

Trellis, I; Gopilshetty, V; Zhou, J; Pito, M; Motornor, M; Kate, E & Minko, S (2009). Stimuli – Responsive Hydrogel Membranes Coupled with Bicatalytic Process. ACS Applied Mats & Interfa. 1(3), 532 – 536.

Woodhouse, J & Johnson, M (1991). Effect of Superabsorbent Polymers on Survival & Growth of Crop Seedlings. Agric . Water Mgt 20 (1), 63 – 70.

Xi ao, X; Yu, L; Xie, F; Bao, X; Liu, H; Ji, Z & Chen, L (2917). One – Step Method to Prepare Starch – Based Superabsorbent Polymer for Slow Release of Fertilizer. Chem. Engr. J. 309, 607 – 616.

Zhang, Y; Liang, X; Liu, H & Yao, J (2014). An Eco-friendly Slow Release Urea Fertilizer Based on Waste Mull being Branches for Potential Agric. Appllications. ACS Sustainable Chem. & Engr. 2(7), 1871 – 1878.

Mansoor, Z; Tchuenbou – Magata, F; Kowalczuk, M; Adamus, G; Manning, G; Parati, M; Radecka, I; Khan, H; Polymer use as Mulch Films in Agriculture – A Review of History, Problems and Current Trends. Polymers 2022, 145062. https://doi.org/103390/polym 14235062.

Lightfoot, D.R .(1994). Morphology and Ecology of Lithic – Mulch Agriculture. Geogr. Rev. 1994, 84, 172 – 185.

Ray, M; Biswasi, S. Impact of Mulching on Crop Production: A Review. Trends Bio Sci 2016, 9, 757 – 767.

Steinmetz, Z; Kldlmann, C; Schaefer, M; Buchman, C; David, J; Troger, J; Mufioz, K; Fror, O; Schaumann, G.E. Plastic Mulching in Agriculture. Trending Short – Term Agronomic Benefits for Long – Term Soil Degradation? Sci. Total Environ (2016), 550, 690 – 705.

United Nation Organisation. 7th Sept. 2022.

Li, K; Jia, W; Xu, L; Zhang, M; Huang, Y. The Plastisphere of Biodegradable and Conventional Microplastics from Residues Exhibit Distinct Microbial Structure, Network and Function in Plastic – Mulching Farmland. J. Hazard Mat. 2023.

Wang, K; Sun, X; Long, B; Li, F; Yang, C; Chen, J; Ma, C; Xie, D; Wei, Y. Green Propduction of Biodegradable Mulch Films for Efective Weed Control. ACS Omega 2021 6, 32327 – 32333.

Xu, A; Buchanan, R. L; Micallef, S.A. Impact of Mulches and Growing Season on Indicator Bacteria Survival During Lettuce Cultivation. Int. J. Food Microbiol. 2016, 224, 28 – 39.

Pinamonti, F; Compost Mulch Effects on Soil Fertility, Nutritional Status and Performance of Grapevine. Nutr. Cycl. Agroecosyst. 1998. 51, 239 – 248.

Benoit, G; Dernars, S. Evaluation of Organic and Inorganic Compounds Extractable by Multiple Methods Commercially Available Crumbrubber Mulch. Water Air Soil Pollat. 2018, 229, 1 – 13.

Dong, H; Yang, G; Zhang, Y; Yang, Y; Wang, D; Zhou, C; Recycling, Disposal, or Biodegradable – Alternative of PE Plastic Films for Agric. Mulching? A Life Cycle Analysis of their Environmental Impacts. J. Clean. Prod. 2022, 380, 134950.

Yang, Y; Li, P; Jiao, J; Yang, Z; Lv, M; Li, Y; Zhou, C; Wang, C; He, Z; Liu, Y; et al. Renewable Sourced Biodegradable Mulches and their Environmental Imparts. Sci. Hurtic. 2020, 268, 109375.

Ahmad, S; Raza, M.A.S; Valipur, M; Saleem, M.F; Zaheer, M.S; Ahmad, S; Toleikiene, M; Haider, I; Aslan, M.U; Nazar, M.A. Potential Agricultural and Environmental Benefits of Mulches – A Rev. Bull Natl. Res. Cent. 2020, 44, 1 – 16.