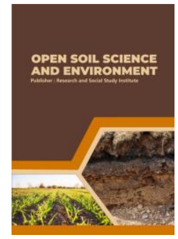
Open Soil Science and Environment 01 (01): 29-34 2023

Contents lists available at openscie.com

Open Soil Science and Environment

Journal homepage: https://soilenvironment.com



Effect of Polyacrylamide on Soil Water Content as A Soil Conditioner

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ARTICLE INFO

Article History:
Received 10 August 2022
Revised 18 August 2022
Accepted 24 August 2022
Published 5 September 2022

Keywords:
Polyacrylmide
Soil conditioner
Soil water content

ABSTRACT

Soil conditioners that can be used is polyacrylamide (PAM). In general, PAM is applied to flocculate solids in liquids such as for water treatment, papermaking processes. The use of soil conditioners, especially with PAM, can absorb water up to several times its dry weight. In addition, PAM also has important environmental benefits, soil conservation and irrigation efficiency for agriculture making its use economically feasible. The use of PAM as a soil conditioner has the potential not only to increase crop production but also to minimize percolation and evaporation losses of irrigation water. However, soil conservation activities using PAM to absorb water in increasing the efficiency of water use for plants have not been sufficiently utilized. Therefore, this research was conducted to find out how much benefit the effect of polyacrylamide has on increasing the soil's water holding capacity using laboratory experiments. polyacrylamide as a soil conditioner can increase soil water content. The highest soil water content was found in the P6 treatment (10% Polyacrylamide). The higher the dose of polyacrylamide, the soil water content will be high. The use of polyacrylamide has the potential to reduce the frequency of irrigation.

1. Introduction

The city of Bogor is one of the capital's buffer zones because of its proximity to Jakarta. One of the impacts is the occurrence of significant land conversion from agricultural cultivation land to residential or tourist area land. Changes in land use result in reduced water catchment areas and reduced soil ability to hold rainwater. According to Widianto (2004) states that land use change causes changes in surface soil properties in the form of a decrease in the amount of organic matter and the amount of pore space in the soil. As a result of the decrease in the amount of pore space in the soil, the soil's ability to hold water decreases, resulting in increased surface runoff, increased pressure on the rainwater drainage system, flooding, and poor water quality in the area. The low ability of the soil to hold water will reduce the growth of plant roots and can even cause death in plants before the plants wither permanently so that it can reduce plant productivity.

The ability of the soil to hold water for plants needs to be improved considering the importance of efficient use of water for plants. Soil productivity for crops is largely affected by the low water holding capacity of the soil and excessive deep percolation. Thus, soil management should aim to increase the capacity of the soil to hold water and reduce losses due to evaporation of irrigation water. One of the efforts that can be made to increase the ability of the soil to retain water is by using soil conservation technology using a soil conditioner. In general, soil conditioners have ingredients that can increase soil aggregates and increase the soil's ability to hold organic matter by increasing the cation exchange capacity of the soil (Dariah et al, 2015).

One of the soil conditioners that can be used is polyacrylamide (PAM). In general, PAM is applied to flocculate solids in liquids such as for water treatment, papermaking and screen printing processes. The use of soil conditioners, especially with PAM, can absorb water up to several times its dry weight. In addition, PAM also has important environmental benefits, soil conservation and irrigation efficiency for agriculture making its use economically feasible. The use of PAM as a soil conditioner has the potential not only to increase crop production but also to minimize percolation and evaporation losses of irrigation water. However, soil conservation activities using PAM to absorb water in increasing the efficiency of water use for plants have not been sufficiently utilized. Therefore, this research was conducted to find out how much benefit the effect of polyacrylamide has on increasing the soil's water holding capacity using laboratory experiments.

2. Methods

The experimental soil was taken from the field location (6040'12.8"S 106049'54.3"E) which is located in Rancamaya Village, South Bogor District, Bogor City. Soil was obtained from a depth of 20 cm from the surface, with a rainfall of 201.7 mm/day. Then the soil was sieved using a sieve with a diameter of 2 mm. The soil fraction less than 2 mm was used for further study. The sifted soil is dried in the sun until the soil is dry and not moist.

The initial treatment of the soil in the experiment was that the soil fraction less than 2 mm was mixed with polyacrylamide at a level of 0 gr (P1), 0.5 gr (P2), 1 gr (P3), 1.5 gr (P4), 2 gr (P5), and 2.5 gr (P6). Meanwhile, the weight of the soil for each treatment was 100 gr (P1), 99.5 gr (P2), 99 gr (P3), 98.5 gr (P4), 98 gr (P5), and 97.5 gr (P6). Each glass is filled with soil that has been mixed with polyacrylamide to achieve a specific gravity of 100 gr. Each treatment was repeated 3 times. Research using plastic cups. Each glass is stored randomly each day to ensure an even distribution of light and air throughout each glass. The soil sample used was given 60 ml of water on the first day and then allowed to stand for 24 hours (assuming the soil has been filled with water to reach field capacity). On the last day, the soil was dried in the oven for 24 hours at a temperature of 105 C. Where the dry weight will be used as a calculation of the % water contained in the soil (soil water content).

Soil water content:

$$KA = \frac{BA\text{-}BKT}{BKT} \; x \; 100\%$$

where KA is the soil moisture content (%), BA is the initial weight of the soil (g), and BKT is the dry weight of the soil after being oven-dried (g).

3. Results and discussion

Polyacrylamide (PAM) is a water soluble polymer produced by polymerization of acrylamide containing one or more copolymers which are widely used as flocculants in waste treatment. The polymer groups present in PAM form hydrogen bonds in aqueous solutions. PAM with high molecular weight is a solid flocculant suspended in water through neutralization and becomes a link between particles. So that PAM is generally used to increase sedimentation in waste treatment, oil recovery, paper making, mining, and other fields (Feng Yu, dkk. 2015).

Many studies have been carried out on the use of PAM in agriculture. In the 1980s researchers became aware of the effect of PAM on soil improvement and gradually the potential for applying PAM in soil management was recognized. PAM also functions to form aggregates or soil structures. PAM can be used in powder or liquid form to improve soil physical properties. Due to its water-soluble characteristics and high molecular weight, PAM can be used as a soil amendment to be managed in increasing infiltration, reducing runoff, preventing erosion, controlling non-point sources of pollutants, preventing nutrient loss, and protecting the soil and water environment. In addition, PAM is also widely used in agriculture because of its low cost and easy and fast application (Yonghun, 2016).

PAM has also been widely used because it is a suitable conditioner for water retention agents. The function of PAM in increasing the available soil pore volume can increase infiltration and reduce the amount of rainwater runoff which is the cause of erosion. The suspended sediment from the PAM-treated soil showed increased flocculation compared to the untreated soil. This increase in flocculation can help settle it so as to reduce the turbidity of rainwater runoff and improve water quality. PAM can be used as an additive in water treatment to remove suspended particles from runoff water. In addition, PAM can also be used to provide a suitable medium for vegetation growth for further stabilization (California Stormwater BMP Handbook, 2003).

Figure 1. Polyacrylamide

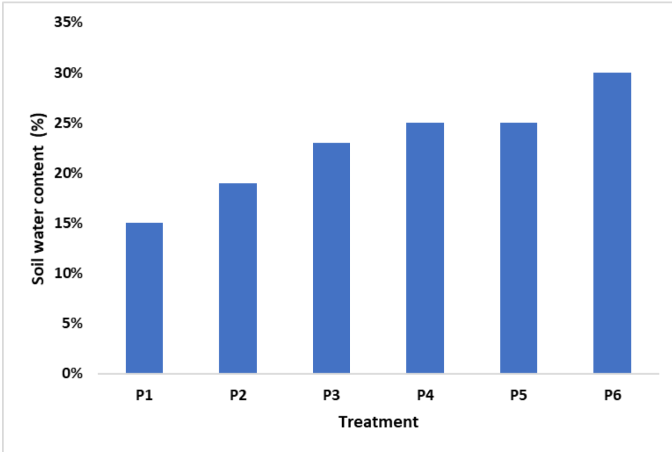

Figure 2. Soil water content on the 5th day of observation

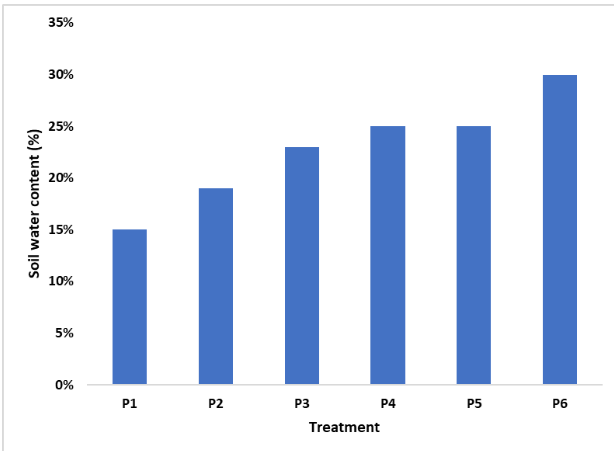

Figure 3. Soil water content on the 6th day of observation

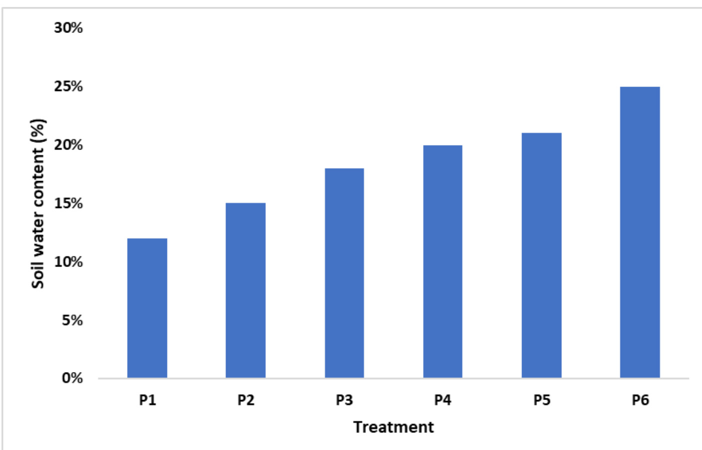

Figure 4. Soil water content on the 7th day of observation

Figure 1-3 shows, the highest water content was found in the 6th treatment because it was the soil containing the highest dose of polyacrylamide. This shows that the higher the dose of polyacrylamide contained in the soil, the higher the value of the soil water content. Soil water content is closely related to soil moisture where the higher the percentage value of water content, the more water available in the soil so that the soil moisture is higher. The higher the soil moisture value, the more water available so that plant growth can grow well. In the analysis of soil water content, the dose of polyacrylamide in the 6th treatment was the best dose because it was able to hold the highest water content in each observation.

Dry polyacrylamide granules form a gel after absorbing water and the gel functions as a layer to hold water in the soil macro pores. The results of the five experimental observations of the effect of polyacrylamide on the soil's water holding capacity show that polyacrylamide in the soil is able to reduce the amount of water lost due to evaporation. Likewise for the soil moisture value, the higher the dose of polyacrylamide contained in the soil, the soil moisture value also increases. This is in accordance with research conducted by Johnson and Veltkamp (1985) where the cross-links contained in polyacrylamide can act as a structural barrier and provide physical resistance for stored water to release it in evaporation.

To meet the water needs of plants, especially around the root area, the water content in the soil must be sufficient so that plants can grow optimally so that they can produce maximum production. Based on this, soil water content data is needed to determine the water capacity contained in the soil whether it meets the water needs of plants or not. Provision of irrigation water must be done if the water content in the soil is not sufficient for plant growth. With the conservation of agricultural soil using polyacrylamide, the water contained in the soil can be used efficiently by plants because it can reduce water loss caused by evaporation. So that the schedule for giving irrigation water can be reduced if the water contained in the soil is sufficiently available for plant growth.

The excess amount of water contained in the soil can be utilized by plants. Polyacrylamide promotes better plant growth while reducing losses due to deep percolation and evaporation. In addition, enough water stored in the soil for plant growth also indicates that it can reduce irrigation scheduling so that it can efficiently use irrigation water for plants. According to Baasiri (1986) in a greenhouse experiment, cucumbers grown in soil treated with polyacrylamide showed much higher yields while reducing the amount of irrigation required. In a field study conducted by Silberbush (1993) stated that corn and cabbage yields increased as the amount of polyacrylamide in the soil increased.

The results of this study indicate that polyacrylamide soil conditioner has the ability to increase groundwater while suppressing the loss of evaporation of water that has been absorbed by the soil. That way, the use of polyacrylamide for tillage can reduce the frequency and amount of irrigation so that water utilization by plants can be more efficient. In this laboratory-scale study, the use of polyacrylamide has been shown to hold water in the soil. The higher the dose of polyacrylamide contained in the soil, the higher the ability of the soil to hold water. This is because the polyacrylamide granules form a gel after absorbing water and the gel functions to hold water from the soil macro pores due to evaporation. In addition, polyacrylamide also functions to increase soil moisture. The higher the dose of polyacrylamide contained in the soil, the higher the percentage value of soil moisture. This is in accordance with the statement stated by the USDA (2008) where one of the factors that affect soil water holding capacity is soil moisture. The higher the capacity of the soil to hold water, the higher the soil moisture value so that it is good for plant growth. In this study, the dose of soil in the 6th treatment was the most effective dose because it could retain more groundwater than the polyacrylamide dose found in the other treatments.

4. Conclusions

The conclusion from this study is that polyacrylamide as a soil conditioner can increase soil water content. The highest soil water content was found in the P6 treatment (10% Polyacrylamide). The higher the dose of polyacrylamide, the soil water content will be high. The use of polyacrylamide has the potential to reduce the frequency of irrigation.

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