Effects of poly vinyl alcohol/starch as Soil Conditioners on the physical properties of loamy sand and loam soils following different wetting and drying cycles

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Abstract

This study assesses in loamy sand and loam soils, treated with levels of poly vinyl alcohol/starch 0 , 0.15 , 0,25, 0.35 % on samples, 24 pots wetting and drying (1-4) cycles. After different cycles have been used, the results pointed out a significant increasing in soils moisture. The amount of available water increased 20–25.6%and 21.1–34.6% by weight treated soils in loamy sand and loam respectively, while soil moisture was increased relative 6.3–11.1% to the control treatments after cycles . Soil available water increased slightly while wetting and drying cycles. The application polymer increased the moisture retention at field capacity and wilting point linearly in loamy sand and loamy soils value of (R^2 = 0.949*) and (R^2 = 0.907*),(R^2 = 0.059) and (R^2 = 0. 787*) respectively. Seed germination of Sun flower(Helianthus annuus L.) was not affected In loamy soil, seed germination was higher than In loamy sand soil , and seedling increased with increase in level of polymer compared with control. The amendment with starch decreased the rate of soil moisture losses that caused a delay in wetting in both soils . The amendment was effective in improving soil moisture availability and thus increased seed germination.

Keywords: This study, polyvinyl alcohol , wetting sandy, Loamy sand soils.

Introduction

There are areas in Iraq corresponding to desertification definitions. Soil sealing is the result of construction activities Thus, desertification research is an important challenge for Iraq geography . Zubair soils ,no vegetation, climate sub humid, and other aspects of land in order to identify and make a comparison of promising kinds of land use in terms applicable to the objectives of the evaluation, (FAO, 1978-81).The productivity of coarse textured soils is mostly limited by their low water holding capacity(WHC) and excessive deep percolation losses, drought water in arid and semiarid regions is an important limiting factor for agriculture, Jhurry , 1995, The need to improving soil physical properties in view of increasing water holding capacity,(Al-Omran et al.,1987).There for use polymer of inefficient , widely adopted in agriculture, Some researchers have expressed that these materials significantly reduce water loss, Stefansson, 1973 . Polymeric were known since 1950s. The polyvinyl acetate dispersion slowly degrades over 12 to 18 months. The rate of degradation will be accelerated in moist soil conditions and those with a high organic content .The primary degradation product of the polymer is classified as "inherently biodegradable" according to the modified Zahn Wellens Test (OECD 302B).The proprietary additives in the commercially available product have been classified as "readily biodegradable," in accordance with stringent closed bottle test (OECD301D) and screening test for evaluation of ultimate biodegradability; BOD28/COD>60%. Polyvinyl acetate dispersion builds up a three-dimensional network in the topsoil - comparable to a "liquid crust" , Weerawarna ,(2009). It does not affect soil's permeability to rain, but retains moisture longer in the soil. On turf grass consisting of polyvinyl acetate treated plots showed a 10 % higher water content in the soil (Stahl JD, et, al,. 2000) . polymer increased the water use efficiency of soybeans by about 12 and 19 times, respectively. Sivapalan, (2001). Amendments can reduce soil penetration resistance (Busscher et al., 2009).Increase (WHC) and soil aggregation, protection soil organic matter (Goebel et al., 2005) . One of the best options to be blended with starch Polyvinyl alcohol, Zou , et. al,. (2008). Much interest lies in blending starch with PVOH, Zou and Xin ,2008 , because(starch + PVOH) blends have demonstrated excellent compatibility, Yun et al., 2008 . Amendments are usually applied in environments with alternating dry and wet conditions. Polymers are their sustainability, recently there has been a demand for biopolymers that are derived from feedstock such as starch or cellulose starch is the most attractive candidate because of its low cost, and safety polymer, Guohua, et., al. (2006).

Materials and Methods

Two soils with different textures were evaluated, samples were collected from 0 –15cm depth on Zubair region from Basrah soil in south of Iraq ,of two calcareous soils, loamy sand and loam, (Typic Torripsamments) , Buringh (1960) classification .The soil was air-dried and passed through a 2-mm sieve, determined particle size analysis according to (Day,1965) . Soil properties, Soil bulk density was determined by the core method, soil surfers " crust", pH, EC , organic matter and $CaCO_3$, determined using standard procedures .The researches have been conducted at the Polymer Research Station experiment . Using different levels of polyvinyl acetate PVA [-(C_2H_40)-]n) mixed with 60g straw of wheat /5kg soil. The required weights of polymer were hand-mixed with dried soil to give four concentrations on a dry-weight basis (0,0.15,0.25,0.30) g/g. The soil samples were added to plastic containers (14 cm wide and height 20 cm with 5 kg of treated soil). Triplicate pots of each soil mixture were saturated with tap water by placing in containers for 24 hrs . The pots were saturated again and the procedure was repeated for the 4th wetting-drying cycles. all the pots were wetted with same amounts of tap water (EC =1.51 $dS \cdot m^{-1}$) the average during experiment ,to bring the moisture content of the soils to field capacity ; thereafter, the pots were wetted once a week. Field capacity of the soil was determined using the small- core method of Cassel and Nielsen (1986). The moisture lost was calculated by weighting the control (untreated soil) and this amount of water was added to each pot. The pots were raised to drain out the excess water gravimetrically and water holding capacity WHC was determined at the beginning of each cycle. The pots were placed under laboratory conditions. The weights of the pots were recorded daily times until no detectable weight loss was observed .Linear regression program was used to describe the soil moisture. After the end of 4th wetting-drying cycles ten sunflower(Helianthus annuus L.) seeds were planted. Determined percentage of seed germination(15) days and seed growth (25-35) days .

The main purpose of this study was to evaluate for varying of soil-water defecated 4th wetting and drying cycles following, amendment with PAV according the soil texture .

Results and Dissection

Table 1 presents some physical and chemical properties of soil surface, Therefore; loamy sand soil , clay (1.4%), silt (10.5%), and sand (85.5%). loamy soil , clay (18.6%), silt (38.6%), and sand (44.8 %) , calcareous virgin soils, loamy sand and loam. This region faces water scarcity, inherently low fertility soils, organic matter in loamy sand and loam (1-2) gkg^{-1} and soil sealing "crust" was (0.5-0.4) cm respectively , soil crust and more recently. Degradation processes within semi-arid areas are defined as desertification processes to dune sand in these areas**,** Abdulla et., al.1999.

Figure 1. After wetted and dried cycles to loamy and loamy sand soils, water-holding capacity(WHC) were correlation is significant at the 0.01 level with time. increases the amount of available water 20– 25.6%and 21.1–34.6% by weight treated soils in loamy sand and loam respectively, while soil moisture was reduced relative 6.3–11.1% to the control treatments .The amount of content water increased significantly with poly vinyl alcohol/starch concentration and linearly in both soils loamy and loamy sand and poly vinyl alcohol/starch concentration levels of polymer 0 , 0.15 , 0,25, 0.35 % , respectively.

Figure 2. The addition of polyvinyl alcohol polymer increased the moisture retention at field capacity and wilting point linearly in loamy sand and loamy soils value of (R^2 = 0.949*) and (R^2 = 0.907*),(R^2 = 0.059) and (R^2 = 0. 787*) respectively. The amount of available water(AW) increased significantly and linearly in both soils with treated soils compared with the control untreated soils , However increase soil-water holding capacity , the effects on long-term water retention and soil properties amendment by polymer are not well understood , Busscher et al., 2009.

Figure 3. The application polymer increased the soil available water in both sandy loam and loamy soils compared with control, and linearly value of (R^2 = 0.836) and (R^2 = 0. 949*) respectively, thus reduces water losses. The addition of polymer increased the soil available water and field capacity increased slightly ,while wetting and drying cycles , the results shown in Figure 2. Stahl JD, et, al,. 2000

Table 1. The main physical and chemical properties of the experimental field soil samples.
*LS = Loamy sand , ** L = Loam

Na^+	Mg^{+2}	Ca^{+2}	$CaCO_3$ gkg^{-1}	O.M gkg^{-1}	EC dSm^{-1}	Bulk density ρb $\mu g\ m^{-3}$	Particle size gkg^{-1}			Texture
meq l^{-1}							clay	silt	sand	
11.8	16.2	12.8	218.9	1.00	4.0	1.53	14	105	855	LS*
19.6	17.0	8.41	198.2	2.00	4.7	1. 34	186	386	448	L**

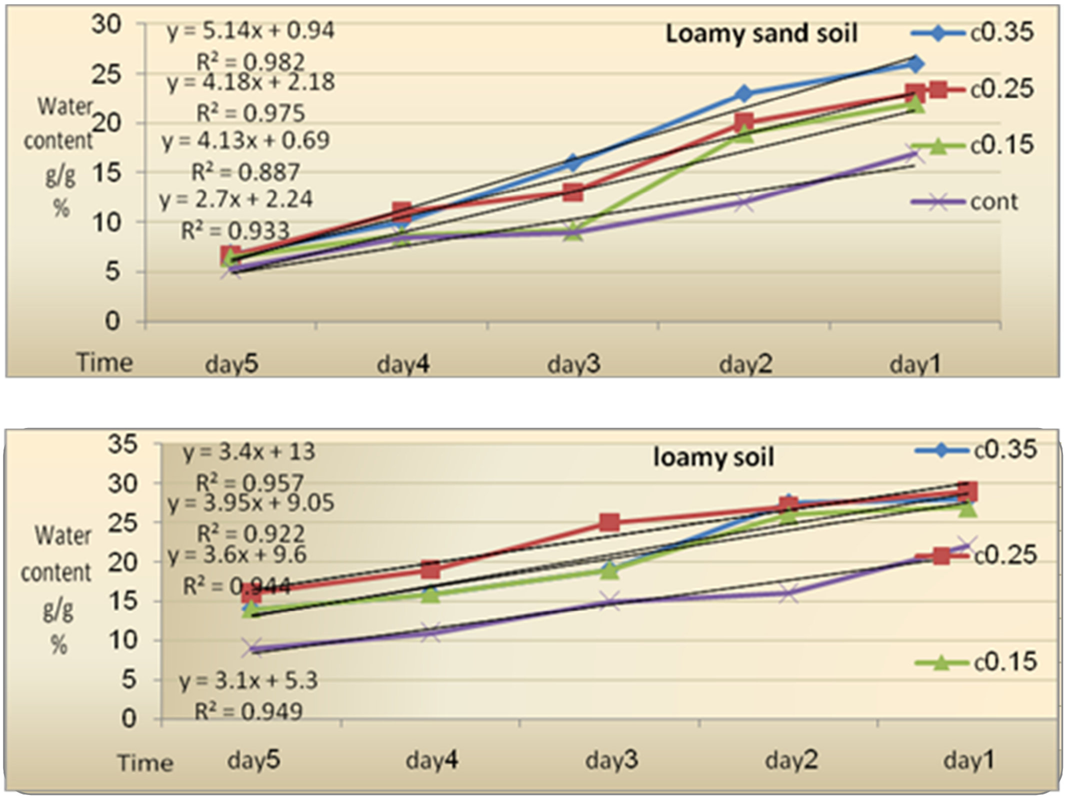


Figure 1. Effects of polymer concentration on soil water content at (WHC) after wetting and drying cycle.

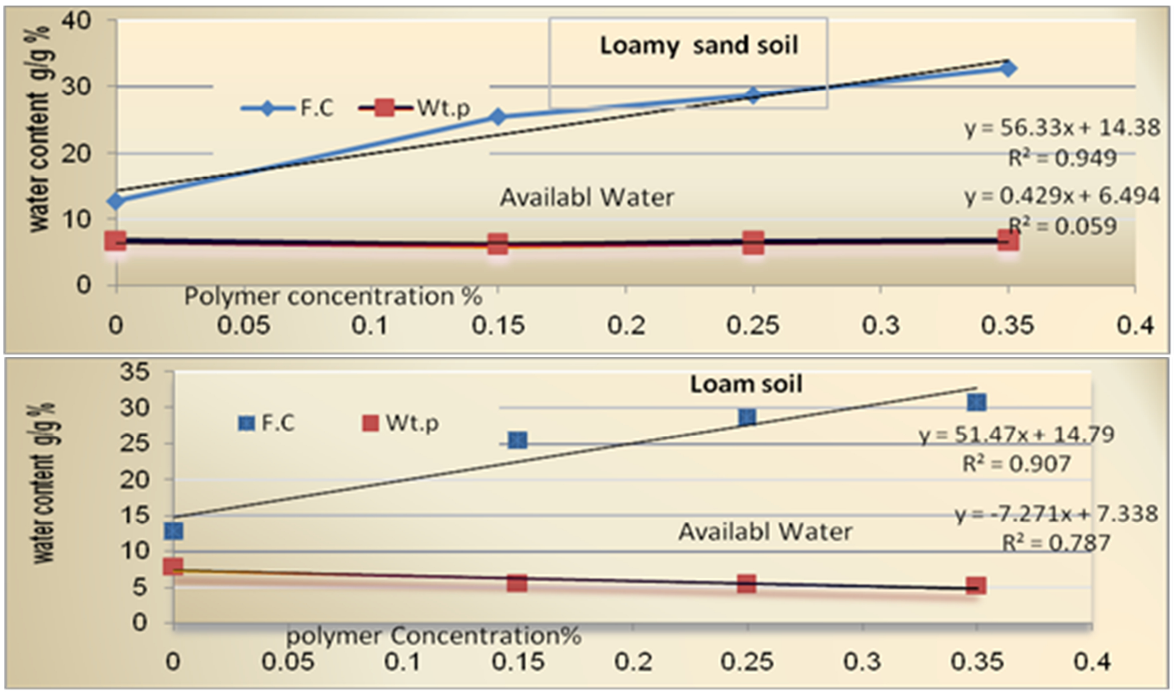


Figure 2. Effects of polymer concentration on water content at field capacity F.C and permanent wilting point wt .p.

Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.4, No.24, 2014

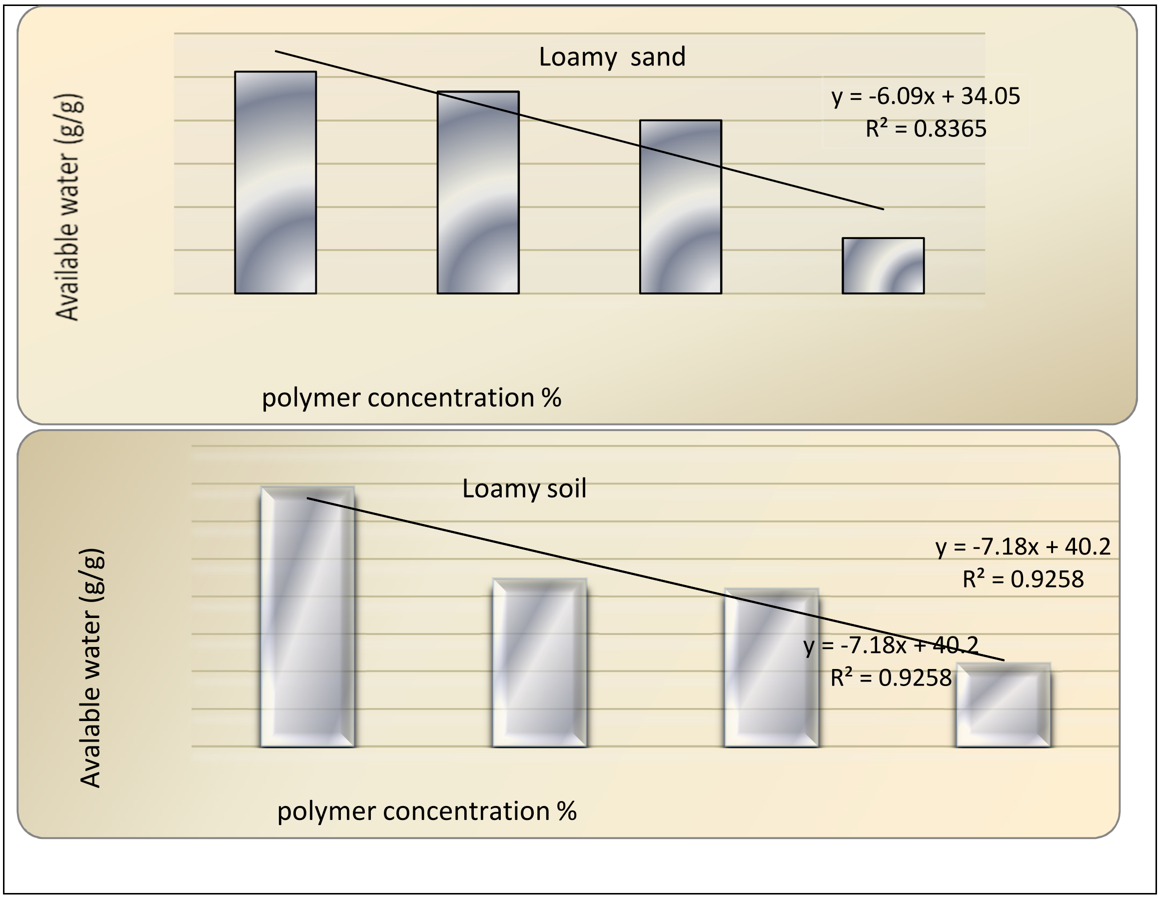
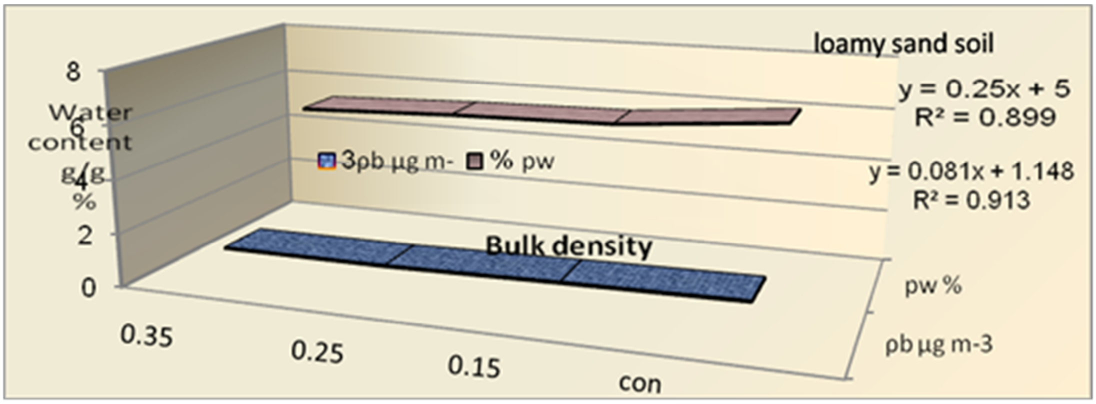


Figure 3. Effects of polymer concentration on Available water after wetting and drying cycle.

Figure 4.Show the effects of poly vinyl alcohol/starch concentration levels as soil amendment on bulk density both in loamy and loamy sand soils with treated soils compared with untreated soils , However would persist for at least varying of water defecated after four wetting and drying following cycles ,thus addition of polyvinyl alcohol after reduces bulk density and increased the moisture retention at available water linearly in loamy sand and loam soils value of (R^2= 0.899*) and (R^2 = 0. 913*),(R^2= 0.478) and (R^2 = 0.939*) respectively . Basing on these first results , Amendment poly vinyl alcohol/starch effected soil physical properties under following cycles dry and wet as condition compared with control treatments. Maintaining soil physical condition in an adequate state contributes toward soil and water conservation , (Singer et al., 1992) .



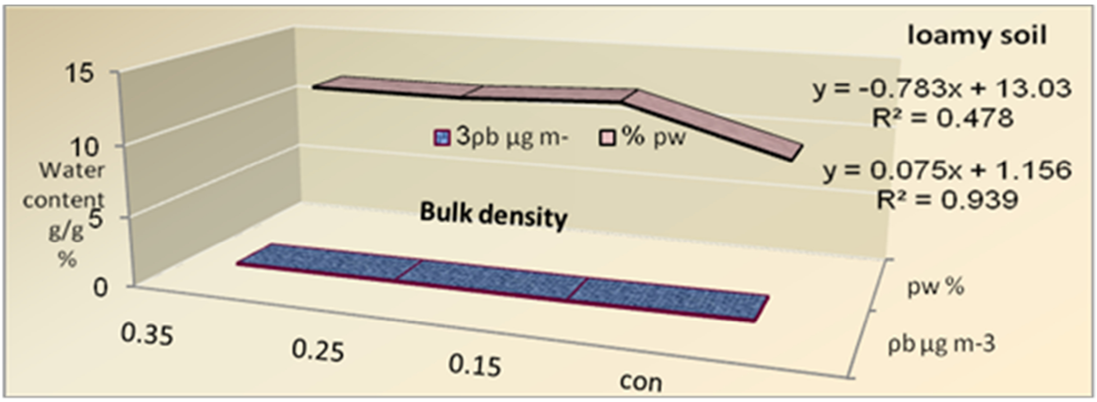


Figure 4. Effects of polymer concentration on soils Bulk density and water content.

Figure 5. Show the effects of poly vinyl alcohol/starch concentration levels on Sunflower seed germination(15) days and growth (25) days in loamy and loamy sand soils. Seed germination was not affected In loam soil with increase concentration levels of polymer ,but seed germination was higher than In loamy sand soil , and seedling increased with increase in level 0.35% of polymer compared with 0.15% and control. The amendment with starch slowed the rate of soil moisture loss that caused a delay in wetting in both soils . The amendment was effective in improving soil moisture availability and thus increased growth after30 days (Table 2) .Under the condition of limited water supply, higher benefits may be achieved by adopting suitable water irrigation and planting techniques (Sharma et al., 1993) .Results from this experiment demonstrate the possibility of using poly vinyl alcohol/starch to greater improvement at lower antecedent soil water content Furthermore, present results show that surface soil needs to be treated with polymer to improve seed germination and therefore improvement can be achieved at fairly low rate (162.5 kg ha^{-1} at a rate of 0.15% to a depth of 1 cm at a bulk density of 1.3 Mg m^{-3}). The polymer acted by improving water content and therefore reducing bulk density of the treated soil after wetting and drying cycles. Seedling increased at higher soil water content, Wallace and Wallace,1986a .

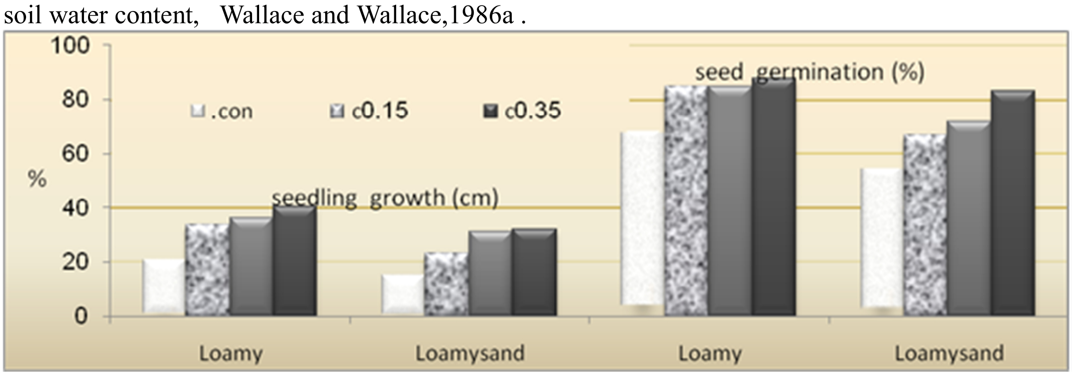


Figure 5. Seed of Sunflower germination and seedling growth in soils with polymer concentration.

Table 2. Effect of polymer on seed germination and seedling growth (30day) of Sunflower in soils.

Seed germination (%)			seedling growth (cm)			
means	**Loamy sand**	**Loamy**	**means**	**Loamy sand**	**Loamy**	
64.0	56	70	19.5	16	23	con.
82.5	67	85	31.55	26	37.1	0.15
84.5	72	85	35.7	34	37.4	0.25
86.5	83	88	37.65	34	41.3	0.35
79.38	69.5 [b]	82 [a]	31.1	27.5 [b]	34.7 [a]	

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