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SOIL EROSION CONTROL BY USING DIFFERENT MATERIALS

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ABSTRACT:

Soil erosion is a natural process in which particles of soil are moved by wind and water, and displaced to another location. When erosion occurs naturally, soil is relocated at about the same rate it is created, so no harm is done to the environment. Erosion is one of the biggest concerns of earth's land surface. It has many impacts on agricultural production and also in all engineering and construction industries. Erosion can be caused by multiple reasons, and every situation has a specific solution depending on the severity of the problem. The objective of this report is to highlight the various methods that can be employed to control soil erosion and the soil conservation practices that are needed for problem soils.

Keywords: Soil erosion, geosynthetic, PVC, RECS.

1. INTRODUCTION:

With rapid growth of population and wide request for foodstuffs, doubtless in many areas of the world due to shortage of level lands or lands having little slopes, there is no option other than cultivation on sloping areas. Evidently cultivation on steep slopes without conservative managements leads to land degradation. Therefore, using conservative methods with economical advantages is so important for approaching to sustainable agriculture on agricultural sloping lands. But effectiveness and to be profitable of these methods are unclear yet. Recently, and especially on steeply sloped hillsides, contractors have chosen to establish vegetation by broadcasting seed and covering the seed with a man-made material. Commercially produced man-made erosion control materials that are often used include woven or bonded mats and blankets composed of biodegradable fibers such as excelsior (curled wood fiber), wood, jute, straw, coconut, or a combination of them, and geosynthetic materials such as polypropylene, polyethylene, nylon and polyvinyl chloride

(PVC) which are known as the rolled erosion control systems (RECS) (Krenitsky et al., 1998; Sutherland and Ziegler, 2006). They are designed to reduce the energetics of rainfall and runoff, and at the same time foster an equitable microclimate for subsequent vegetation growth (Ziegler et al., 1997). Numerous studies have shown that dissipation of raindrop energy by any means, natural or artificial, leads to reduce erosion. In particular Ziegler and Sutherland (1998) claimed that some of the rolled erosion control systems (natural and synthetic) are able to reduce runoff and sediment significantly compared with the control. Agassi (1997) used 5 types of geomembranes to reduce runoff and erosion on 50% slope under laboratory and field conditions. The membranes dissipated the drops impact and reduced runoff significantly compared with the control. There was no significant difference among the membranes regarding their effect on the runoff.

2. RELATED STUDY

Soil erosion is a naturally occurring process that affects all landforms. The causes and effects should be studied in order to control soil erosion. Erosion, whether it is by water, wind or tillage, involves three distinct actions – soil detachment, movement and deposition. Erosion takes place all the time naturally. The erosion potential of any surface is determined by four basic factors: soil characteristics, vegetative cover, topography, and climate. Detachment, transport, and deposition are basic processes that occur on upland areas. Detachment of soil particles is a function of the erosive forces of raindrop impact and flowing water. Hydrology, topography, soil erodibility, soil transportability, soil surface cover, incorporated residue, residual land use, subsurface effects, tillage, roughness, and tillage marks are the major factors that affect upland erosion processes. Soil erosion control techniques are theoretically simple and easy but practically tough, time-consuming, laborious and costly. Almost all soil erosion techniques are very much site-specific.

1.1 **Erosion and Sedimentation Problems:** Any changes made in the characteristics of the soil itself, are detrimental to infiltration, runoff patterns, and stream flow characteristics. For Example. if protective vegetation is reduced or eliminated, topsoil is removed and stockpiled, and cuts and fills are made, altering the topography and runoff characteristics of the site. This can increase the rate at which erosion takes place in a region. Uncontrolled runoff and the resulting sediment pollution.

1.2 **Studies needed before attempts:** The existing topographic features of the project site

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and the immediate surrounding area. The types, depth, slope, locations and limitations of the soils. The characteristics of the earth disturbance activity, including the past, present and proposed land uses and the proposed alteration to the project site. The volume and rate of runoff from the project site and its upstream watershed area. The location of all surface waters, which may receive runoff within or from the project site. The preliminary works that are needed here are:

1. Carry out Supporting calculations and measurements.

2. Plan drawings.- Identification of the natural occurring geologic formations or soil conditions that may have the potential to cause pollution during earth disturbance activities.

3. Create Access roads.

3. METHODOLOGY

Another way of increasing the stability of soil structure is by the use of soil conditioners, which are substances that improve the physical properties of soils, and these include synthetic polymers and natural material like gypsum (Ben-Hur, 2006). Polyacrylamide (PAM) is one of the synthetic polymers with the ability to enhance soil stabilization. This polymer is able to reduce soil detachment, maintain the soil structure and increase infiltration rate early in the rain events. In 1990s has shown that PAM is an effective polymer in reducing erosion in furrow irrigation on fine silt/clay soils (Lado et al., 2004.). Whether used alone or in conjunction with other erosion control practices, PAM is both economical and effective in controlling erosion. Therefore it was found to be a costeffective and safe technology (Roa-Espinosa et al., 2000). Another group of soil conditioners are the cementitious-based binders such as gypsum. Calcium ions are effective at improving soil structure and increasing water infiltration. In addition, calcium and sulfur are important micronutrients for plants. Gypsum ($CaSO_4.2H_2O$) is used commonly used as a soil amendment to provide calcium (an electrolyte source) and sulfur (Alcordo and Rechcigl, 1995). Brauer et al., (2005) demonstrated the usefulness low cost gypsum as soil amendments in reducing runoff and erosion. Tang et al., (2006) reported that because of economical advantages of gypsum, application of PAM along with gypsum can be recommended for increasing their efficiency in increasing aggregate stability and reducing runoff and sediment yield. Similarly Wallace Cochrane et al. (2005) pointed out that due to cheap value and low cost of surface application of gypsum make this material a

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suitable option for erosion control by improving infiltration and reducing surface sealing. Cultivation on sloping hills without doing suitable conservative activities causes irreparable damages to agriculture because of soil degradation and decreasing of crop productivity. The present study was therefore, carried out with objective to evaluate the effect of soil conditioners and man-made erosion control materials on stabilization of sloping hills using rainfall simulator and small flume facilities.

MATERIALS AND METHODS

The site of sampling was in Sarcham village in Zanjan province of Iran which is located on downstream side of Zanjanrood. Sampling was conducted on 15 cm of the soil surface with clay texture taken from one of the sloping lands of this region. After transportation of soil sample to laboratory the experiments was conducted on airdried soil that was passed through an 4.75 mm sieve. Soil texture, determined by the hydrometer method, was 49% clay, 32% silt and 19% sand. Organic mater was nondeductible, saturated paste pH 7.8, saturated paste electrical conductivity (ECe) 17.18 dS m -1 , Na adsorption ratio (SAR) 9.85 and cation exchange capacity (CEC) 14.2 meq 100 g soil -1 . Water used for rainfall simulation experiments had electrical conductivity of 1.4 dS m -1 , pH 8 and sodium adsorption ratio of 2.2. Experimental treatments were consisted of: soil without cover and amendments (control), covering the soil surface with 5 types of man-made erosion control materials, spraying the soil surface with PAM, mixing gypsum with upper 5 mm of the soil surface and applying PAM + gypsum simultaneously. The man-made erosion control materials, rolled erosion control systems (RECS), were composed of woven layers of non-biodegradable geosynthetic materials from polypropylene fabric. 5 of these materials with regular grid network of synthetic fibers of systematically arranged square apertures with diameters of 5.5, 3, 1.5, 1 and 0.5 cm were selected due to segregation of their effectiveness on runoff and sediment reduction. Also % of ground cover by each of them was calculated separately. The man-made erosion control materials that diameter of their apertures was 5.5, 3, 1.5, 1 and 0.5 cm, had the 13, 18, 36, 44 and 55% of ground cover, respectively. Before each run (24 h after complete saturation of soil) RECS was installed on soil surface with U shape steel pins to provide complete contact with the soil surface (Figure 1a). Dry granular anionic PAM copolymer with a molecular weight of about 5 Mg mole -1 was used as well. Before application of PAM this polymer was dissolved in water and

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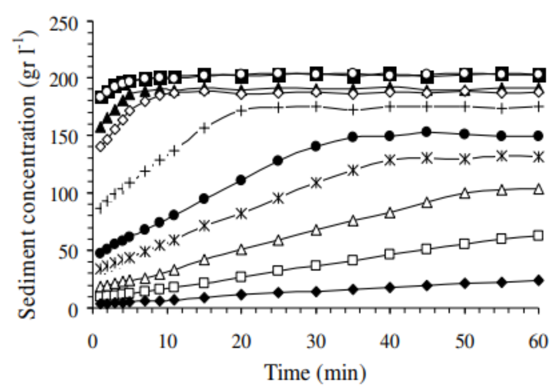
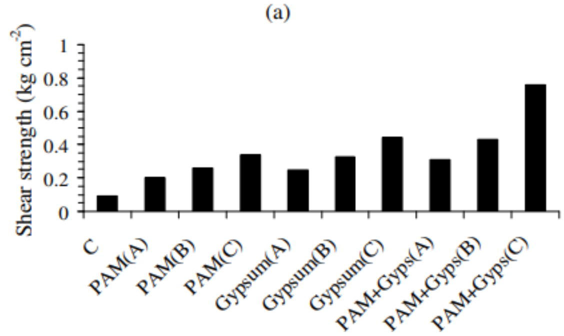
then was sprayed on the soil surface with 3 solution concentration of 25, 50 and 75 kg ha -1 . Also 10, 20 and 30 Mg ha -1 dry powder of natural inorganic gypsum was mixed with upper 5 mm of the soil surface (Figure 1b). Also, combination of 25 kg ha -1 PAM + 10 Mg ha -1 gypsum, 50 kg ha -1 PAM + 20 Mg ha -1 gypsum and 75 kg ha -1 PAM + 30 Mg ha -1 gypsum was investigated in this study. For each of experiments approximately 100 Kg of soil sample was packed in the 1 × 1 m tilting flume's tray (adjustable between 0 to 50% slopes) and leveled manually and investigated with an rainfall simulator with oscillating nozzle (Figure 2). The rainfall simulator was positioned 3 m above the soil surface. Uniformity of rainfall and determination of different rain intensities with necessary variation in angle of nozzle rotation has accomplished. This rainfall simulator was provided a mean drop size of 1.5 mm diameter with a kinetic energy of 15.1 J mm -1 m -2 . In this study soil surface was leveled with the ledge of basin of the flume and saturated with a plastic pipe that was laid in the bottom of basin of flume. After complete exit of gravity water, the action of rainfall simulation in different rain intensities (25, 50 and 75 mm h -1) and different slope (15, 20, 25 and 30%) has done with the electronic control system for all treatments. Runoff water, percolation water, sediment yield, shear strength of soil surface and splash of soil particles was measured for each run. Runoff was collected for each run in different times for 60 min after initiation of runoff. Weight and volume of runoff sample were recorded. Sediment concentrations were determined gravimetrically using the evaporation method (Brakensiek et al., 1979) after drying the samples in the oven with temperature of 105°C after 24 h. Mean value (ultimate) runoff and sediment were measured finally.



(a)



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CONCLUSION

Erosion is the loss of soil. As soil erodes, it loses nutrients, clogs rivers with dirt, and eventually turns the area into a desert. Although erosion happens naturally, human activities can make it much worse. Erosion can turn once healthy, vibrant land into arid, lifeless terrain and further cause landslides and mudslides. Erosion can be controlled easily on a construction site when the right means, tools, and methods are used at the right time. The most natural and effective way to prevent erosion control is by planting vegetation. Roots from plants, especially trees, grip soil and will effectively prevent the excess movement of soil throughout the ground. Another popular erosion control method is the use of a silt fence. A silt fence is a long fabric barrier that is installed along a hill, and collects any stormwater that would carry loose soil Another effective technique used for soil erosion control is erosion control matting. Erosion control matting is laid on top of loose soil and is secured into place.

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