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Effect of Polymeric Soil Conditioners on Seeds Germination*

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Abstract: Polymers used as soil conditioners to enhance the adhesive for protection against erosion of soil are important topics in environmental study. Previous studies showed that the polymer soil conditioners can stabilize the aggregates of soils, increase the infiltration and reduce the runoff and erosion of soil. However the inhibition of seeds germination by the polymers was seldom discussed. In this study the effects of polymers on the germination of Bahia grass seeds are experimental observed. Polyvinyl alcohol and acrylic polymer are used in the experiments. Experimental results showed acrylic polymer, the most often used soil conditioner, would evidently inhibit the plant germination. However with the addition of polyvinyl alcohol to acrylic polymer will increase the germination of the seeds. The percentage germination and germination energy are discussed in this study.

Key words: percentage germination; germination energy; polymeric soil conditioner

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1 Introduction

Soil aggregates were very sensitive to slaking and mechanical breakdown and induced erosion. Ramos et al（2003）had given the effect of raindrop impact and its relationship with aggregate stability to different disaggregation forces. To reduce soil erosion, various soil conditioners were used. It is believed that soil conditioners can increase pore space in soil, increase infiltration, enhance soil aggregation, reduce soil sealing, reduce soil crusting, decrease wind erosion and reduce soil erosion. Many synthetic polymers and surfactants were used in the literatures. For examples, acrylate, polyvinyl alcohol（PVA）and polyvinyl acetate（PVAc）were commonly used. Floyd（1981）used PVAc emulsion as a soil conditioner. Botha and Burer discussed the effect of PVA on the liquid solid contact angles of fine sandy soil. Pini and Vigna（1994）used two uncharged polymers, PVA and Detrans, to study the interaction of water soluble stabilizing agents with soil particles, soil micro-aggregation.

Among the synthetic polymer soil conditioners, PAM was discussed mostly. Levy and Miller（1999）showed that PAM adsorbed on both outer and inner surfaces of large soil aggregates（> 1.0 mm）, and thus enhance the resistance of aggregates to external forces. Chan and Sivapragasam（1996）showed that the addition of an anionic polymer（PAM）would significantly improve soil physical properties, namely increased water stable aggregate, reduction in tensile strength and bulk density. Nadler and Letey（1989）, Malik and Letey（1991）discussed the adsorption of PAM and polysaccharide polymer on soils and suggested that PAM and guar polymers did not penetrate the aggregates. Shainberg et al.（1992）showed that adding PAM to the soil improved aggregate stability and increased the permeability of the seal and aggregate breakdown was suggested as the first step in seal formation, to be followed by surface compaction and clay dispersion. Peferkorn（1999）studied the properties of PAM at soild/liquid interfaces extensively. Nadler et al（1996）used various amount of anionic PAM as soil conditioners to study the stability of dry and wet aggregates. In addition to previous discussed references, there were amount of papers discussed the effect of PAM on the aggregate stability of soil, for examples, Nadler（1996）, Rubio（1992）, Smith（1990）, Wallace（1986）.

Fullen and Cookson（1995）studied the effect of the anion surfactant soil conditioner 'Agri-SC'（a soil conditioner with anionic surfactant）and resulted in statistically significant decreases in soil bulk density values and increases in soil porosity and aggregate stability. Ziegler and

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Sutherland (1998) also used 'Agri-SC' to enhance a soil's resistance to erosion. Sutherland and Ziegler (1998) gave the conclusions that the use of Agri SC would produce a less erodible surface and decreased the transportability of sediment. The reduced erodibility may reflect a preferential absorption of anionic surfactant on the positively charged sites of soils. However, at higher concentrations and higher solution pH values, the availability of positively charged sites might have been reduced and the electrical double layer disrupted and therefore the capacity of erosion prevention reduced.

Shulga et al. (2001) used amino-containing soil conditioners based on lignosulphonate and concluded that the lignin-based interpolymer complexes in which polyamines or oligomer amines were used as their component may be offered as soil conditioners for the creation of an artificial soil structure as well as fro erosion control due to the stabilization of the surface layers on sandy soil. Bouranis et al (1995) gave a detail discussion on synthetic materials that are were designed to function as soil conditioners and discussed the combination of materials and/or properties. In this study acrylic polymer was used to be aggregate agent to reduce soil erosion.

There are seldom studies concerning the effect of polymer soil conditioners on the plant germination. Hsu et al. gave experimental study on this topic. Rigas etal (1999) discussed the effects of polymeric soil conditioner on the growth of sunflowers. Wallace et al (1986) studied the effects of PAL on the iron status of soybean plants. In this study, the effect of PAL, PVA and their mixtures with various concentrations on Bahia grass germination is discussed.

2 Experiments

2.1 Materials:

a. soil conditioners:

The physical properties of PVA (Mw = 30000-50000) and acrylic polymer (PAL) (Mw: 80000-100000) used in this study are shown as table 1. Surface tensions of the mixtures are depicted in table 2. The viscosities for both polymers are near1 cp and change with concentration as shown in figure 1. PVA, PAL and their mixtures with various concentrations are used.

Tab 1 Physical properties of PVA and PAM

Name	Polyvinyl alcohol	Acrylic polymer
Appearance	Clear colloid	Milkiness liquid
density	1.02±0.1	1.01±0.1
pH	6.5±0.5	6.3±0.5
water contents	49.5%	27.5%

Tab 2 Surface tension of PVA and PAL mixtures

Polyvinyl alcohol (%)	Acrylic polymer (%)	VALUE(mN/m)	TEMP(℃)
2	2	45.93	26.8
2	4	44.75	26.3
2	15	44.37	26.4
2	50	43.29	26.2
4	2	42.99	26.4
4	4	44.17	26.3
4	15	41.06	23.3
4	50	43.20	23.7
15	2	46.95	23.9
15	4	45.02	24.0
15	15	43.94	28.3
15	50	42.61	28.1
50	2	42.30	28.1
50	4	42.34	28.0
50	15	43.29	27.8
50	50	35.16	27.6
100	0	38.84	26.5
0	100	37.96	28.2

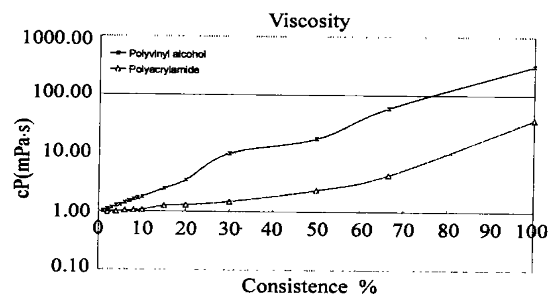

Fig 1 Viscosity changes of PVA and PAL mixtures

b. plant seeds:

Bahia grass seeds are used in the experiments.

2.2 Procedures:

The seeds were chosen following "International Rules for Seed Testing" of ISTA. Germination was following the T. P. method. They were then placed on a filter paper as shown in figure 2. Temperature was kept in the range of

Fig 2 Picture of seeds germination apparatus

20-30 ℃. Number of germinated seeds were counted and recorded every day during the experimental periods (30 days). Two important indices, germination energy and percentage germination, were calculated. The definitions of germination energy and percentage are

$$GE = \frac{\sum_{1}^{N} A_n}{\sum_{1}^{N} A_n T_n}$$

$$GP = \frac{\sum_{1}^{N} A_n}{N_t}$$

Where A_n is number of seeds germination in the n-th day, T_n is the n-th day and N_t is total number of seeds used in a batch experiment.

3 Results and Discussions

Figure 3 shows the experimental results of seeds germination. The germination percentage of seeds of antithesis is 35%. After treated with PVA and PAL, the percentage germination reduces to about 28% and 0% individually. The mixtures of PVA and PAL give the fact that the percentage germination decreases with the increase of PAL. Therefore it is apparent that PAL is not a suitable to be a soil conditioner for plant cultivation. However as described in previous section, PAL is mostly used soil conditioner to stabilize the soil aggregates. To conquer this problem, the addition of PVA is proposed in this study.

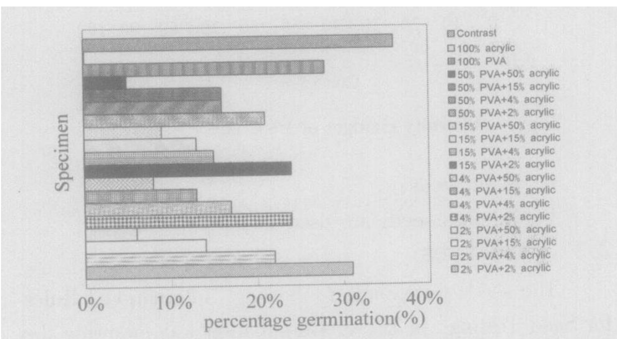

Fig 3 Percentage germination

Figure 4 gives the number of budding day in the experimental period. Most of the mixtures had budding day about 20 days. Mixtures with high PAL (about 50%) have lower budding day compared with that of another solutions.

Figure 5 to figure 8 shows that most of the antithesis samples germinated during period of 11-24 days, samples treated with PVA germination occurs during the period 10—18 days. It gives the evidence that PVA has little effect on the germination of the seeds and the addition of PAL will delay the germination.

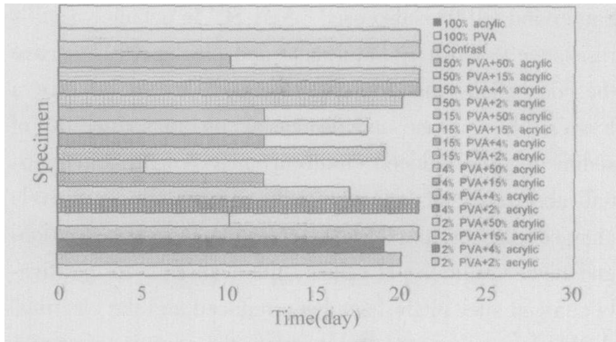

Fig 4 Budding time

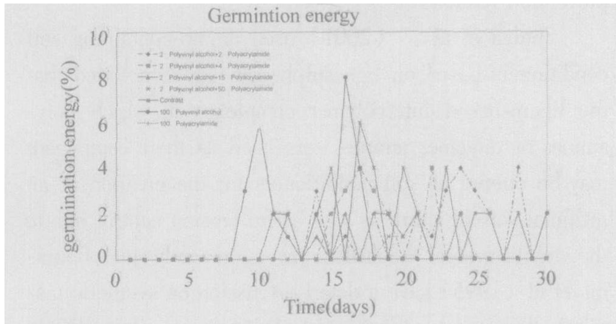

Fig 5 Germination energy of 2% PVA mixtures

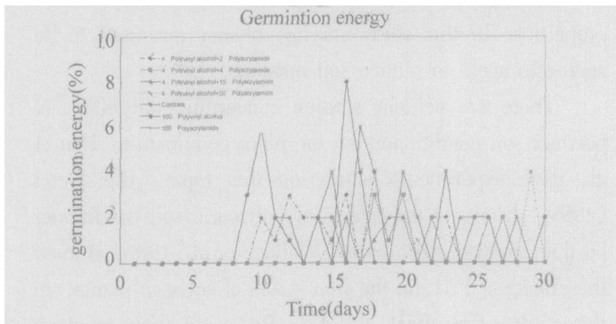

Fig 6 Germination energy of 2% PVA mixtures

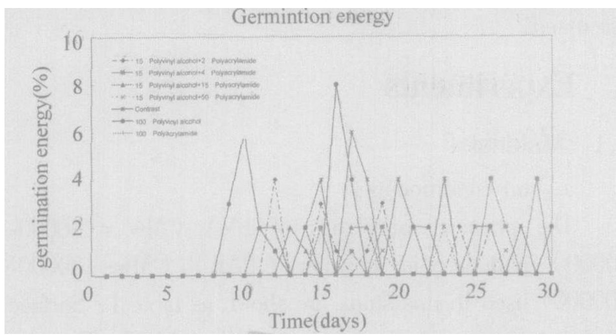

Fig 7 Germination energy of 2% PVA mixtures

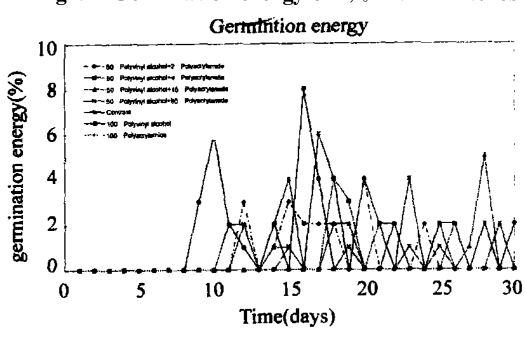

Fig 8 Germination energy of 2% PVA mixtures

Figure 9 is the results of field test. The mixture of PAL and PVA with a ratio about 1to 3 was used. Seeds germinated well.

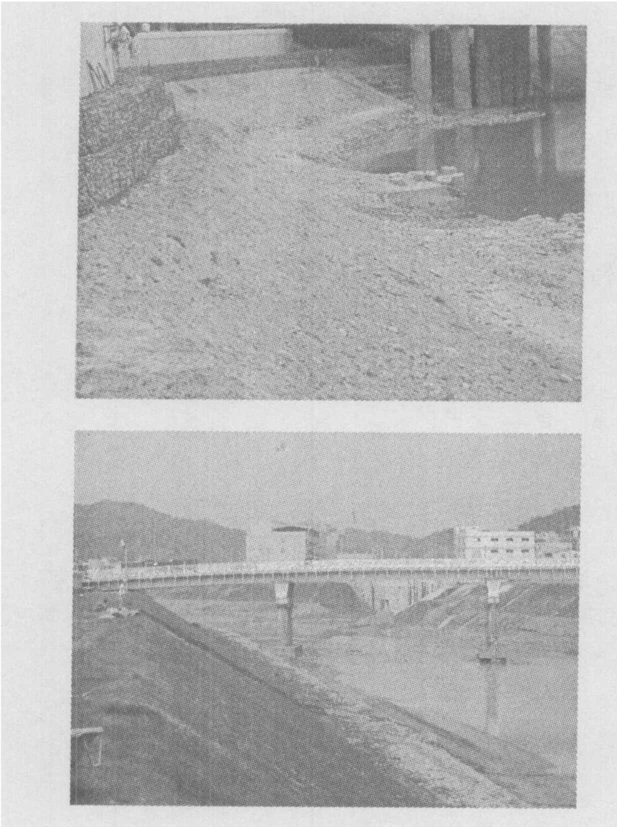

Fig 9　The results of field test

There are two problems to be studied in the future: the decomposition of the soil conditioners when subjected to UV and the stabilized ability for the soil aggregates.

4　Conclusions

(1) Acrylic polymers can stabilize the soil aggregates and reduces erosion. However, both percentage germination and germination energy show that it will inhibit seeds germination.

(2) Polyvinyl alcohol will not reduce seeds germination. With the addition of polyvinyl alcohol to acrylic polymer will increase the germination of the seeds.

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高分子土壤改良剂对种籽萌芽之影响研究

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摘 要：以高分子材料为土壤改良剂可使土壤团粒化，增加水份入渗效率，减少土壤冲蚀，为研究环境问题之重要课题。但此类土壤改良剂可能抑制植物种籽萌芽，为使用此种材料的一大问题。以压克力与聚乙烯醇对Bahia种籽做一系列萌芽实验探讨。实验结果发现，压克力对种籽萌芽率与萌芽势能有严重之抑制作用。但适量之聚乙烯醇添加可克服此问题。

关键词：萌芽率；萌芽势能；高分子土壤改良剂
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