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In the name of Allah

NOTE

EFFECTS OF IRANIAN PETROLEUM MULCHES ON SOME PHYSICAL PROPERTIES OF A CALCAREOUS SOIL. I. AGGREGATE STABILITY AND WATER HOLDING CAPACITY[1]

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ABSTRACT

Low aggregate stability, leading to degradation of physical properties of surface soil, often reduces seedling emergence. Use of chemical soil conditioners may improve physical properties of some soils. Effects of three National Iranian Oil Company petroleum mulches (cationic, anionic, and clay emulsions) and "Krilium Merloam" (a copolymer of vinyl acetate and maleic acid) at four application rates (0, 0.05, 0.10, and 0.15% on a dry weight basis of soil) on the aggregate stability and water holding capacity of a silty clay soil (Calcixerollic Xerochrept) were studied under the greenhouse conditions. Aggregate stability was significantly increased by incorporation of the cationic and clay emulsions and Krilium. Krilium was 180% more effective than petroleum mulches in increasing aggregation. An average decrease of 1.7% (dry

تحقیقات کشاورزی ایـــــران
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بنام خدا

اثرات مالچهای نفتی ایرانی بـــر روی بعضی خواص فیزیکی یک خاک آهکـــی -۱- پایداری خاکدانه وظرفیت نگهـــداری آب خاک

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خلاصـــه

ناپایداری خاکدانه‌ها که منجر به تخریب خصوصیات فیزیکی خاکهای سطحی میشود سبب کاهش جوانه زدن از خاک میگـــردد. استفاده از اصلاح کننده‌های شیمیائی میتواند خواص فیزیکی اینگونه خاکها را بهبود بخشد. اثرات عمق پاشی سه نـــوع مالچ نفتی ساخت شرکت ملی نفت ایران (آمولسیونهای کاتیونی، آنیونـــی و رسی)و "کریلیوم مرلوم" (کوپلی مـــری از وینیل استات و مالئیک اسید) بـــا مقادیر پاشش صفر، ۰/۰۵، ۰/۱۰ و ۰/۱۵ درصـــد (برمبنای وزن خاک خشک) برروی پایداری خاکدانه وظرفیت نگهداری آب در یـــک خاک رسی سیلیت دار در یک آزمایـــش گلخانه‌ای موردمطالعه قرار گرفـــت. پایداری خاکدانه‌ها در اثر عمق پاشـــی مالچهای نفتی کاتیونی ورسی وکریلیوم مرلوم افزایش یافت واثر کریلیوم مرلـــوم در این رابطه ۱۸۰ درصد بیشتر از مالچهای نفتی بود. در اثر عمق پاشی مالچهای نفتی وکریلیوم مرلوم بطور متوسط ۱/۷ درصـــد (برحسب خاک خشک) از ظرفیت نگهـــداری آب خاک کاسته شد وحداقل مقادیر پاشـــش جهت بهبود پایداری خاکدانه‌ها درتحـــت شرائط این آزمایش برای امولسیـــون کاتیونی ۰/۱۰ درصد، امولسیون رسی ۰/۱۵ درصد وکریلیوم مرلوم ۰/۰۵ درصد بود.

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weight basis) in water holding capacity was obtained due to the incorporation of petroleum mulches and Krilium. Application rates of 0.10, 0.15, and 0.05% of cationic and clay emulsions and Krilium, respectively, were required to improve aggregate stability.

INTRODUCTION

Various aggregating chemicals have been tested as soil conditioners to reduce crust strength and to form water stable aggregates (1, 4, 8, 9, 10). Incorporation application of 1.25% of Humofina B-286, and anionic asphalt emulsion, to some soils in the western plains of Venezuela resulted in the formation of many large and water stable aggregates (8). Haise *et al.* (5) indicated that application of 560, 1120, and 2016 kg/ha of Krilium to a depth of 15 cm appreciably reduced the amount of water retained at 1/3 bar tension as compared with the control. Because of the dearth of published information on the effects of petroleum emulsions on water holding capacity of soils, a greenhouse experiment was undertaken with three different types of Iranian petroleum mulches, and a soil conditioner "Krilium Merloam", at four rates to determine their influence on the aggregate stability and water holding capacity of a silty clay soil.

MATERIALS AND METHODS

The experimental procedure in the greenhouse and field has been described in detail by Moosavi and Sepaskhah (11).

Aggregate Stability

Soil samples (a silty clay, thermic Calcixerollic Xerochrept) of the pots from the greenhouse experiment were used for aggregate stability determination. After harvesting the sugarbeet , the roots were carefully removed from the moist and friable soil. The soil was then air dried and gently passed through a 16 mm sieve (14). Care was taken so that the soil was not powdered during the sieving process. One hundred gram portions of this soil at 2.5% water content were used in the study. Mean weight diameter (MWD) of aggregates were obtained according to the procedure described by the Committee on Physical Analysis (14). Four types of mulches at four rates were used in a completely randomized design with a 4 x 4 factorial arrangement and three replications.

Analysis of variance was performed to determine the differences between the effects of treatments.

Water Holding Capacity

The soils of the pots from the greenhouse experiment were used to study the effects of petroleum mulches and Krilium on the water holding capacity (WHC) of the soil (difference between soil water contents at -1/3 and -15 matric potentials). About 100 g of air-dried soil was taken from each treatment and passed through a 2 mm screen. Soil water content was determined on duplicate 25-g samples by the pressure plate apparatus following the procedure described by Richards (12).

RESULTS AND DISCUSSION

Aggregate Stability

Effects of different types of petroleum mulches and Krilium applied at various rates on mean weight diameter (MWD) of the soil aggregates are shown in Table 1. Application of cationic and clay emulsion and Krilium increased MWD of the aggregates significantly and, in general, a progressive increase in MWD was obtained with increased rates of the petroleum mulches and Krilium. However, anionic emulsions were not effective. Average increases of 127, 265, and 326% in MWD were obtained by application of the petroleum mulches and Krilium at rates of 0.05, 0.10, and 0.15%, respectively.

Different types of conditioners at the various rates of application did not have similar effects on increasing the

Table 1. Mean weight diameter of aggregates, soil water content at the -1/3 bar matric potential, and soil water holding capacity as affected by incorporation of different rates of petroleum mulches and Krilium into the soil.

Rate of application (%)	Anionic emulsion	Cationic emulsion	Clay emulsion	Krilium	Mean
		Mean weight diameter (mm)			
0.00	0.200a*	0.134b	0.153b	0.188d	0.169d
0.05	0.398a	0.307ab	0.272ab	0.560c	0.384c
0.10	0.325a	0.507a	0.360ab	1.274b	0.616b
0.15	0.401a	0.462ab	0.505a	1.754a	0.781a
		Soil water content at -1/3 bar (% dry wt.)			
0.00	24.8a	26.0a	27.1a	25.1a	25.8a
0.05	24.4ab	25.7a	24.4b	24.2ab	24.7b
0.10	23.3b	25.5a	24.0b	25.0a	24.5b
0.15	23.1b	25.4a	25.2b	22.8b	24.1b
		Soil water holding capacity (% dry wt.)			
0.00	8.5	9.6	9.6	8.3	9.0a
0.05	6.6	8.1	6.3	8.1	7.3b
0.10	6.6	9.2	6.8	7.8	7.6b
0.15	5.9	8.5	8.2	5.8	7.1b
Mean	6.9(b)	8.9(a)	7.7(ab)	7.5(b)	

*Means followed by the same letter in each column and followed by the same letter in parantheses in the last row of the last group are not significantly different at the 5% level of probability (Duncan's Multiple Range Test).

MWD of the aggregates. Krilium was significantly more effective than the petroleum mulches (Table 1). The ratio of the average MWD obtained from different rates of Krilium (0.94 mm) to that obtained from petroleum mulches (0.335 mm) was 2.8. This indicates that Krilium increased MWD 180% more than the petroleum mulches. Disregarding the effect of Krilium on soil aggregation, application rates of 0.05, 0.10, and 0.15% of petroleum mulches resulted in increases of 101, 145, and 175% in aggregation of the soil, respectively. The results of analysis of variance showed a positive interaction between types of soil conditioners and rates of application. The minimum application rates required for a significant increase in MWD were 0.10, 0.15, 0.05, and more than 0.15% of cationic, and clay emulsions, Krilium, and anionic emulsion, respectively.

The results of this experiment confirm the findings of previous investigators (3, 8, 9, 10). The high aggregation ability of Krilium has been reported by Bennett *et al.* (1). Application of petroleum emulsion to the soil may cause the linkage of soil particles by the asphalt micelles and encourage aggregate formation (4). Although Krilium was much more effective than petroleum mulches in producing larger aggregates, its agricultural application is questionable because of high expenses. De Boodt (2) reported that the cost of Krilium to treat one hectare at the rate of 0.10% can exceed $2,200. Therefore, in oil producing countries, the use of petroleum emulsions may be preferable to their synthetic soil conditioners in spite of their lower aggregate formation abilities.

Water Holding Capacity

Water content of the mulched treated and untreated soil samples at -1/3 matric potential are presented in Table 1. Application of anionic and clay mulches and Krilium decreased water content of the soil at the matric potential of

-1/3 bar; the average decrease was 1.4%. However, cationic emulsions had no significant effect. This may be partly due to the lower hydrophobic effect of cationic emulsion, although this mulch has been claimed to be moderately hydrophobic by the National Iranian Oil Company (11). The effect of anionic and clay emulsions and Krilium on soil water content at -1/3 bar potential was significantly different (Table 1). The effective rates of anionic and clay emulsions and Krilium were 0.10, 0.05, and 0.15 %, respectively. Analysis of variance showed a significant interaction of types of mulch and rates of application.

Application of petroleum emulsion and Krilium did not have any significant effect on water content of the soil at -15 bar matric potential (on average 17.2 vs. 16.8 percent dry weight).

Petroleum mulches and Krilium significantly decreased WHC of the soil at all application rates; the average decrease being 1.7%. Anionic and clay emulsion and Krilium showed similar effect on WHC of the soil (Table 1). However, the effect of cationic emulsion was significantly different from the anionic emulsion and Krilium, but showed a similar effect as clay emulsion. Analysis of variance did not show a significant interaction between types of mulches and rates of application.

The results of this experiment were similar to those of Haise *et al.* (5). They reported that addition of soil conditioners such as Krilium decreased WHC of the soil through their effect on soil structure. The finding that the structural improvement of soil had no effect on soil water content at -15 bar matric potential has also been reported by Young (15). The influence of the conditioners used in this experiment on WHC of the soil was in part due to their effect on the formation of larger intra-aggregate macropores (3). Hammerton (6, 7) reported that the quantity of available water decreased with increasing soil particle size. In conclusion, it appears that application of petroleum mulches and Krilium decreases WHC of the soil used in this study through their effects on soil aggregation and some degree of hydrophobicity (11). However, incorporation of cationic and clay emulsions and Krilium improves the stability of soil aggregates.

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