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Assessing effects of the waterholding bioproduct *Lipomycin M* on the amount of effective water in the soil

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Abstract. Biological solution using strain *Lipomyces starkeyi 7.1*, which can produce viscous membranes to improve dry soil is considered to be sustainable for slope land improvement. The results of research on *Lipomycin M* ability to keep effective water in the soil of Me Linh District, Vinh Phuc Province show that in the soil samples cultivated traditional medicinal trees, the total amounts of effective water in the soil fertilized *Lipomycin M* (taken out under pressure pF 2.5-4.2) are always higher than that in control soil plot (without *Lipomycin M*): the amounts of effective water in CT2 account for 24.8%, CT3 - 25.1% in comparison with DC (control plot) - 17.1%. Combination of *Lipomycin M* with NPK and microbial fertilizers makes the amount of effective water in the soil higher than that in the case of using only *Lipomycin M*. Similarly, the amounts of effective water in the soil samples cultivated tea and manured the bioproduct *Lipomycin M* are higher than those for the soil sample DC and proportional to the times of manuring the bioproduct: TN3 - 29%, TN1 - 24.8%, and DC - 22.2%.

Keywords: Waterholding; Bioproduct; *Lipomycin M*; Effective water; pF.

1. Introduction

Water is vital for plants. Plants cannot grow without water. Water accounts for 70-80% of the plant weight. Today, demand for water in life and industry dramatically increases, thus causing fresh water scarcity, surface water pollution and the risk of inability to provide water for life and production. So, it is necessary to find solutions to improve dry soil, uncovered soil and bare hill, and to reduce the amount of water used in production. Biological methods, including applying microorganisms to improve dry soil are considered to be feasible for sustainable production. It can be seen that soil microorganisms are vital for improving soil. They are environmentally effective and friendly solutions because they do not cause a decline in the soil microorganisms and help to enhance the soil biodiversity.

Water holding bioproduct *Lipomycin M* is produced by scientists of Institute of Biological Technology (Vietnam Academy of Science and Technology) from yeast of *Lipomyces starkeyi 7.1* which has ability to

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produce viscous membranes improve several physical, chemical and biological characteristics of slope soil in Me Linh District (Vinh Phuc Province), such as increasing ability of holding water, water capacity and maximum hydroscopic, reducing soil bulk density, and improving pH, organic chemicals, macro nutrients,... [2, 3, 4]. Besides these, *Lipomycin M* is biologically highly safe [4]. Based on findings about ability to improve soil humidity, it is necessary to assess the effects of *Lipomycin M* on the amount of effective water because only the effective water is used by plants. This paper concentrates on assessing the ability of holding effective water (available for plant) of the bioproduct *Lipomycin M*.

2. Materials and methods

2.1. Materials

Studying objects: the holding water bioproduct *Lipomycin M* produced by the Institute of Biological Technology from yeast of *Lipomyces PT 7.1* and the basic compound cassava starch; garden soil cultivated traditional medicinal plants and tea owned by to the station of biodiversity located in Me Linh District, Vinh Phuc Province; fertilizers: multi-functional microbiofertilizer and fertilizer NPK.

2.2. Study method

The experiment was carried out on the garden soil cultivated traditional medicine plants (an area of $500m^2$) and cultivated green tea (approximately 1 ha) with terrain slope of about 20^0 (Table 1).

Table 1. Formula and dosage of the bioproduct in experimental samples

Sample	Formula	Dosage (g/tree)
Plot cultivated traditional medicinal plants		
Control (DC)	Basic compound cassava starch	10
Variant 1 (CT1)	Bioproduct *Lipomycin M*	*Lipomycin M*: 10
Variant 2 (CT2)	Bioproduct *Lipomycin M* + multi-functional biofertilizer	Biofertilizer: 5 *Lipomycin M*: 10
Variant 3 (CT3)	Bioproduct *Lipomycin M* + fertilizer NPK	NPK: 10 *Lipomycin M*: 10
Plot cultivated tea		
Control (DC)	Basic compound massava starch	10
Variant 1 (TN1)	*Lipomycin M* once	10
Variant 2 (TN2)	*Lipomycin M* twice	10 (at 2-months interval)
Variant 3 (TN3)	*Lipomycin M* three times	10 (at 2-months intervals)

3. Results and discussion

3.1. *Effects of Lipomycin M on the amount of effective water in the soil sample cultivated traditional medicine trees*

After saturating soil to reach the moisture of 100% and take out water from saturated soil samples using different pressures, we can determine the rates of water types existing in soil, including: gravity water (to pF: 2.5), effective water (available for plants: pF: 2.5 – 4.2, and not available for plants: pF > 4.2) [4, 5].

The results presented in Table 2 show that the total amounts of water taken out under the pressures to pF=4.2 in the soil samples DC and CT1 are similar, 35.54g and 36.74g respectively. This may well reflect that the water which is stored in soil by the bioproduct has a link with soil similar to the case without the bioproduct. At the same time, the amounts of water in the soil samples CT2 and CT3 are higher (38.54g and 39.86g respectively). This means that fertilizing the bioproduct *Lipomycin M* is more efficient when combining with multi-functional biofertilizer and synthetic fertilizer NPK.

Table 2. Amounts of water lost under various pressures in soil samples cultivated traditional medicinal trees (g)

pF	0.6	1.0	1.5	2.0	2.5	2.8	3.0	3.2	3.7	4.2
DC	2.09	4.29	12.54	15.86	18.44	22.05	23.26	24.82	34.92	35.54
CT1	1.04	3.20	12.50	15.14	17.59	21.48	22.70	24.29	34.88	35.74
CT2	1.61	3.84	12.94	16.31	18.97	23.55	25.87	27.22	37.44	38.54
CT3	1.90	3.89	14.23	17.91	19.75	23.54	24.24	25.55	36.56	39.86

Comparison of the percentages of water stored in the soil samples in various forms indicates the role of the bioproduct *Lipomycin M* in holding water and ability to provide water for plants (Table 3).

It can be seen from Table 3 that the percentages of water pushed out from soil under pressure of 2.5 in the soil experimental sample CT are lower than that in the soil sample DC. In the soil sample that is only fertilized by the bioproduct *Lipomycin M*, the amount of water pushed out accounts for 23.5%. In the soil samples CT2 and CT3, these numbers are 24.0% and 24.6% respectively, and lower than that of the soil sample DC (24.8%). It can be suggested from the results that the bioproduct *Lipomycin M* can improve the ability of holding water in soil, thus reducing the percentage of gravity water in the soil samples fertilized by the bioproduct. The total amounts of water stored in the soil samples manured by the bioproduct are higher than that of the soil samples without the bioproduct (DC: 74.17g; CT1: 74,78g; CT2: 79.00g, and CT3: 80.25g). It can be seen the amount of effective water stored by the bioproduct in soil samples from the percentages of water pushed out under the pressure range from 2.5 to 4.2. The percentages of effective water pushed out under the pressure 2.5 – 4.2 in soil samples manured the bioproduct are higher the soil sample DC. In the soil samples with a combination of the bioproduct and multi-functional biofertilizer and synthetic fertilizer NPK, the percentages of effective water are higher than those for the soil samples only manured the bioproduct. This is because of more energy and microorganisms are supplied into soil, thus increasing activity of the soil microorganisms. In fact, the highest percentage was recorded for the sample CT3 (25.1%). The next highest samples were CT2 (24.8%) and CT1 (24.4%). The smallest percentage was recorded for the sample DC, only accounting for 23.1% of the total amount of water stored in saturated soil (the humidity of 100%).

Table 3. Percentages of water forms in the soil samples cultivated traditional medicinal trees

pF	DC Amount of water (g)	DC Percent (%)	CT1 Amount of water (g)	CT1 Percent (%)	CT2 Amount of water (g)	CT2 Percent (%)	CT3 Amount of water (g)	CT3 Percent (%)
<2.5	18.44	24.8	17.59	23.5	18.97	24.0	19.75	24.6
2.5-4.2	*17.10*	*23.1*	*18.15*	*24.4*	*19.57*	*24.8*	*20.11*	*25.1*
4.2 - exhausted dry	38.63	52.1	39.04	52.1	40.46	51.2	40.39	50.3
Total	74.17	100	74.78	100	79.00	100	80.25	100

Table 4. The amount of water poured under various pressures in soil samples cultivated tea (g)

pF	0.6	1.0	1.5	2.0	2.5	2.8	3.0	3.2	3.7	4.2
DC	1.21	3.25	12.82	14.64	15.89	18.07	18.82	20.31	30.97	32.48
TN1	0.48	3.42	12.36	14.15	15.52	17.42	18.24	20.39	32.69	33.91
TN3	1.41	3.25	9.78	11.72	13.39	17.27	19.35	20.75	33.81	35.67

3.2. *Effects of Lipomycin M on the amount of effective water in soil samples cultivated trees*

We carried out the experiment of manuring the bioproduct on the plot cultivated tea to get the most reliable results about the ability to hold effective water of the bioproduct.

One emerging feature of the soil cultivated tea different from one cultivated traditional medicinal trees is that it has higher slope and the amount of organic compounds (plentiful plant carcass).

It can be seen from Table 4 that the amounts of water poured under the pressure pF ≤ 4.2 in the soil samples manured by the bioproducts are higher than those of the soil samplès DC. The amount of water poured from the soil sample TN3 is highest, reaching 35.67g while it is 33.91g for the soil samples TN1. Both of them are higher than that of the soil sample DC (32.48g). The results fortify the claim about the role of the product *Lipomycin M* in holding water.

Table 5. Percentages of water forms in the soil samples cultivated tea

pF	DC Amount of water (g)	DC Percent (%)	TN1 Amount of water (g)	TN1 Percent (%)	TN3 Amount of water (g)	TN3 Percent (%)
<2.5	15.89	21.4	15.52	21.0	13.39	17.4
2.5-4.2	*16.59*	22.2	*18.39*	*24.8*	*22.28*	*29.0*
4.2 - exhausted dry	42.09	56.4	40.35	55.2	41.16	53.6
Total	74.57	100	74.26	100	76.83	100

It can be seen from Table 5 that the percentages of gravity water in the soil samples TN are lower than those in the soil sample DC. This result fortify the role and the ability of holding water of the bioproduct *Lipomycin M* in tea-cultivated soil. A higher percentages of effective water in soil were recorded for the soil samples TN; The soil sample TN3 (manured by the bioproduct three times at 2-months intervals) has the highest percentage of effective water (29.0%). In the soil sample TN1 (manured by the bioproduct only once), the effective water accounted for 24.8% of the total amount of water. Both were higher than the amount of effective water in the soil sample DC (22.2%). It can be suggested from the results that the bioproduct *Lipomycin M* enhances the amount of effective water in soil. However, the bioproduct need to be manured at 2-months intervals to get higher efficiency of holding water and to increase effective water in the soil.

4. Conlusions

1. The holding water bioproduct *Lipomycin M* can improve several physical, chemical and biological characteristics of soil, especially the ability of holding water. Meanwhile, water stored in soil has a relatively high percentage of water available for plants, thus helping plants growth and develop faster.

2. In the soil samples cultivated traditional medicinal trees, the total amount of water in the soil sample control (DC) is smallest (74.17g), and lower than that of the soil sample CT (CT1, CT2 and CT3: 74.78, 79.0, and 80.28g respectively). Meanwhile, the percentages of effective water (taken out under the pF: 2.5 – 4.2) in the soil samples manured by the bioproduct are higher than those of the soil sample DC. In fact, in the soil samples CT2 and CT3, the amounts of effective water account for 24.8% and 25.1% respectively, compared with 17.1% for the soil sample DC. Combination of the bioproduct, biofertilizer and NPK creates a higher amount of effective water than that in case of using only the bioproduct.

3. The amounts of effective water in the soil samples cultivated tea and manured by the bioproduct are higher than those for the soil sample DC and proportional to the time of manuring the bioproduct. In fact, the highest percentage of effective water is recored for the soil sample TN3 with 20.9%. The next is 24.8% for the soil sample TN1. The smallest percentage are recorded for the soil sample control (DC) with 22.2%.

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