

Description

Title of Invention: SPRAY-GREENING MATERIAL AND SPRAY-GREENING
METHOD

5 Technical Field

[0001] The present invention relates to a spray-greening material and a spray-greening method for spraying on a ground surface such as a slope for greening.

Background Art

10 [0002] A spray-greening method is known in which a spray-greening material is sprayed on a ground surface such as a slope to green the ground surface. For example, Patent Literature 1 describes that soil erosion is prevented when a ground surface is covered at an early stage by a sterile
15 annual plant and a green area is formed. This is achieved by a spray-greening method performed by spraying a slurry mixture over the ground surface with a soil-dressing spray apparatus, this slurry mixture being obtained by placing a Kurapia cut seedling, a sterile annual plant, soil dressing, a soil
20 erosion prevention material, an adhesive, a fertilizer, and water in a mixer, and mixing.

[0003] In addition, Patent Literature 1 describes that, for example, the product name "Kuricoat (Registered Trademark) C-710" that is composed mainly of a synthetic resin emulsion
25 is used as the soil erosion prevention material, that, for

example, the product name "Kuricoat C-402" that is composed mainly of a water-soluble synthetic macromolecule is used as the adhesive, and that it is suitable to use 96 (g/m²) of Kurapia, 12 (g/m²) of the soil dressing, 24 (g/m²) of the soil erosion prevention material, 0.6 (g/m²) of the adhesive, 60 (g/m²) of the fertilizer, and 15 to 30 (g/m²) of the sterile annual plant seeds as the mixing amount per spray area of the spray-greening material.

Citation List

10 Patent Literature

[0004] PTL 1: Japanese Patent Application Laid-Open No. 2021-122265

Summary of Invention

Technical Problem

15 [0005] As described above, it is well known that greening is effective for preventing erosion. However, recent rainfall caused by abnormal weather such as torrential rains and large typhoons can cause spray-greening materials to be washed away or eroded before plants begin to grow.

20 Accordingly, an object of the present invention is to provide a spray-greening material and a spray-greening method that improve resistance to soil loss and erosion caused by rainfall even before plans begin to grow.

Solution to Problem

25 [0006] The spray-greening material of the present

invention is a spray-greening material obtained by mixing a soil erosion inhibitor, a fiber, an adhesive, a fertilizer, and a seed, wherein the soil erosion inhibitor contains a synthetic resin emulsion as a main component, has a viscosity

5 η that satisfies $1000 \text{ mPa}\cdot\text{s} < \eta \leq 3200 \text{ mPa}\cdot\text{s}$, and is mixed in an amount of 60 to 200 g per spray area of 1 m^2 , and the fiber is mixed in an amount of 80 to 170 g per spray area of 1 m^2 .

In the present specification, a numerical range represented by "A to B" means a numerical range with the numerical values A and B before and after "to" set as the lower limit value and the upper limit value, respectively.

[0007] The soil erosion inhibitor, which contains a synthetic resin emulsion as a main component and has a viscosity η that satisfies $1000 \text{ mPa}\cdot\text{s} < \eta \leq 3200 \text{ mPa}\cdot\text{s}$, is

15 originally a chemical that forms a strong consolidated layer on the bare ground surface of a landfill or developed land to prevent sandstorms, dust-storms, and erosion. The consolidated layer formed by such a soil erosion inhibitor is excellent in strength and weather resistance, and thus can prevent

20 sandstorms for a long period of time. However, the soil erosion inhibitor having a viscosity η that satisfies $1000 \text{ mPa}\cdot\text{s} < \eta \leq 3200 \text{ mPa}\cdot\text{s}$ consolidates the soil and inhibits the growth of plants, and thus cannot be used for spray-greening.

[0008] Therefore, the fiber is mixed in the spray-greening

25 material of the present invention together with the soil

erosion inhibitor. The fiber is a fiber (pulp) extracted from wood, grass, or the like, and a main component thereof is cellulose. Cellulose has a property of being bound together by hydrogen bonding. The fiber is mixed in an amount of 80 to 170 g per spray area of 1 m² with respect to 60 to 200 g of the soil erosion inhibitor, which has a viscosity η that satisfies $1000 \text{ mPa}\cdot\text{s} < \eta \leq 3200 \text{ mPa}\cdot\text{s}$, per spray area of 1 m². Thus, the fiber imparts connectedness to the consolidated layer formed by the soil erosion inhibitor, so that the layer is consolidated in a well-balanced manner to the extent that the growth of plants is not inhibited.

[0009] The mixing amount of the soil erosion inhibitor is preferably equal to or more than 80 g and equal to or less than 180 g, more preferably equal to or less than 160 g. When the mixing amount of the soil erosion inhibitor is less than 60 g per spray area of 1 m², the consolidated layer becomes weak, and there is a possibility that part of the consolidated layer on a flat surface flows out. In addition, there is a problem in that the soil loss frequency increases on a slope having a steep gradient (about 1:1.0). On the other hand, when the mixing amount of the soil erosion inhibitor exceeds 200 g per spray area of 1 m², the consolidated layer may be too strong, causing germination failure.

[0010] The mixing amount of the fiber is preferably equal to or more than 100 g or equal to or more than 120 g, and

equal to or less than 160 g. When the mixing amount of the fiber is less than 80 g per spray area of 1 m², there is a possibility that the connectedness with respect to the consolidated layer becomes insufficient and the balance

5 becomes poor, thereby causing germination failure. On the other hand, when the mixing amount of the fiber exceeds 170 g per spray area of 1 m², the balance between the consolidated layer and the connectedness becomes poor.

[0011] The mixing amount of the adhesive is preferably
10 0.100 to 0.175 g, more preferably 0.125 to 0.150 g, per spray area of 1 m². The soil erosion inhibitor used in the spray-greening material of the present invention has a high viscosity η that satisfies $1000 \text{ mPa}\cdot\text{s} < \eta \leq 3200 \text{ mPa}\cdot\text{s}$. Therefore, the soil erosion inhibitor is difficult to mix and
15 tends to harden when mixed. Therefore, by setting the mixing amount of the adhesive to 0.100 to 0.175 g per spray area of 1 m², the spray-greening material can be uniformly mixed.

Advantageous Effects of Invention

[0012] (1) The spray-greening material is obtained by
20 mixing a soil erosion inhibitor, a fiber, an adhesive, a fertilizer, and a seed. The soil erosion inhibitor contains a synthetic resin emulsion as a main component, has a viscosity η that satisfies $1000 \text{ mPa}\cdot\text{s} < \eta \leq 3200 \text{ mPa}\cdot\text{s}$, and is mixed in an amount of 60 to 200 g per spray area of 1 m², and the fiber
25 is mixed in an amount of 80 to 170 g per spray area of 1 m².

With such a spray-greening material, greening can be achieved by forming a consolidated layer that is consolidated in a well-balanced manner to the extent that the growth of the plants is not inhibited, and resistance to soil loss and erosion caused by rainfall is improved. After the plants have grown, the further developed plants synergistically enhance the erosion prevention effect through water flow attenuation, resulting in a more reinforced ground surface.

[0013] (2) By setting the mixing amount of the adhesive to 0.100 to 0.175 g per spray area of 1 m², the spray-greening material can be uniformly mixed and stable spraying can be performed.

Description of Embodiments

[0014] The spray-greening material in embodiments of the present invention is used for spraying on a ground surface such as a slope or a flat surface for greening. The spray-greening material in the present embodiments is obtained by mixing a soil erosion inhibitor, a fiber, an adhesive, a fertilizer, and a seed. In the spray-greening method in the present embodiment, the spray-greening material in the present embodiment is sprayed on a ground surface by a spraying machine such as a hydroseeder or a soil spraying machine.

[0015] The soil erosion inhibitor contains a synthetic resin emulsion as a main component. The soil erosion inhibitor used has a viscosity η that satisfies $1000 \text{ mPa}\cdot\text{s} < \eta \leq 3200$

mPa·s, more preferably equal to or more than 1100 mPa·s, and more preferably equal to or more than 1200 mPa·s. As the soil erosion inhibitor, for example, Kuricoat (registered trademark) U-228 Green (Kurita Water Industries Ltd.), which
5 is a penetrating and consolidating type sandstorms/dust-storms/erosion inhibitor, can be used.

[0016] The physical properties of Kuricoat U-228 Green are as follows: main component: synthetic resin emulsion, appearance: green milky liquid, pH (25°C): 6.0 to 8.0
10 (neutral), viscosity η (25°C): 500 to 2000 mPa·s, specific gravity (25°C): 1.04 to 1.06. The viscosity η of Kuricoat U-228 Green for use as the soil erosion preventing material is adjusted to a viscosity that satisfies $1000 \text{ mPa}\cdot\text{s} < \eta \leq 2000 \text{ mPa}\cdot\text{s}$, preferably a viscosity that satisfies $1100 \text{ mPa}\cdot\text{s} \leq \eta \leq$
15 $2000 \text{ mPa}\cdot\text{s}$, more preferably a viscosity that satisfies $1200 \text{ mPa}\cdot\text{s} \leq \eta \leq 2000 \text{ mPa}\cdot\text{s}$. A soil erosion preventing material having a viscosity η exceeding 1000 mPa·s is higher in viscosity than Kuricoat C-710, which is a soil erosion inhibitor for slope greening that contains a synthetic resin
20 emulsion as a main component and that has a viscosity of 200 to 1000 mPa·s (23°C), and, in general, it is not used for spray-greening because it consolidates the soil and inhibits the growth of plants.

[0017] The fiber is a fiber (pulp) extracted from wood,
25 grass, or the like, and the main component thereof is

cellulose. As the fiber, for example, Oji fiber (product name) or Fujimi fiber (product name), which is a seed spray covering material, can be used.

[0018] The adhesive contains a water-soluble synthetic

5 macromolecule as a main component. As the adhesive, for example, Kuricoat C-402 (Kurita Water Industries Ltd.), which is an adhesive for greening work, can be used. The physical properties of Kuricoat C-402 are as follows: main component: water-soluble synthetic macromolecule, appearance: white
10 granular powder, pH (20°C): 6.8 to 8.0 (0.4% solution), viscosity (30°C): 200 to 500 mPa·s (0.4% solution), and bulk specific gravity: 0.65 to 0.85.

[0019] As the fertilizer, a chemical fertilizer can be used. In particular, it is desirable to use, as the

15 fertilizer, an advanced chemical fertilizer, among chemical fertilizers, in which the summed content of nitrogen, phosphoric acid, and potassium as main components exceeds 30%. As the advanced chemical fertilizer, for example, a fertilizer with 15% each of nitrogen, phosphoric acid, and potassium as
20 main components (All 15) can be used.

[0020] The spray-greening material in the present embodiment is formed as a slurry mixture obtained by placing, in a mixer, a fertilizer, seeds, water, and the like, in addition to the soil erosion inhibitor, the fiber, and the

25 adhesive. At this time, the mixing amount of the soil erosion

inhibitor is 60 to 200 g per spray area of 1 m², and the mixing amount of the fiber is 80 to 170 g per spray area of 1 m². The mixing amount of the adhesive is 0.100 to 0.175 g per spray area of 1 m². The mixing amount of the adhesive is adjusted depending on the soil quality.

[0021] In the spray-greening material in the present embodiment, the mixing amount of the seed is 7.5 to 20.0 g, more preferably 10.0 to 17.5 g, per spray area of 1 m², and the mixing amount of the fertilizer is 20 to 50 g, more preferably 30 to 40 g, per spray area of 1 m². Furthermore, in the spray-greening material in the present embodiment, a color powder is mixed in an amount of 0.300 to 0.750 g, more preferably 0.400 to 0.600 g, per spray area of 1 m².

[0022] On the ground surface to which the spray-greening material in the present embodiment has been sprayed, a consolidated layer is consolidated in a well-balanced manner to the extent that the growth of plants is not inhibited and thus, the ground is greened. On this ground surface, even before the plants begin to grow, the consolidated layer improves the resistance to soil loss and erosion caused by rainfall, and after the plants have grown, the further developed plants synergistically enhance the erosion prevention effect through water flow attenuation, resulting in a more reinforced ground surface.

25 EXAMPLES

[0023] A construction experiment was conducted on the spray-greening material in the above-described embodiment.

Table 1 shows what is considered the best mixing amount of the spray-greening material of the present invention, according to the results of the construction experiment.

[0024] [Table 1]

Type	Product name	Amount per 1 m ²	Effect
Fiber	Oji fiber	120 g	It is possible to provide the consolidated layer and surface reinforcement in a balanced manner and also ensure water-holding capacity.
Fertilizer	All 15	30 g	No signs of fertilizer burn but well-balanced germination and growth are confirmed.
Soil erosion inhibitor	Kuricoat U228G	80 g	Hardness and thickness of the consolidated layer are sufficient to prevent erosion while allowing root growth.
Adhesive	Kuricoat C402	0.125 g	Solution can be stirred evenly without impairing performance.
Color powder	Matsumin Neo Color MB	0.55 g	Concentration that allows for differentiation of concentrations during spraying work
Seed	Mixed seeds	15 g	Mixing amount that can ensure both coverage and density

[0025] In addition, to examine the application range (80 to 170 g per spray area of 1 m²) for the fiber mixing amount of the present invention, construction experiments were conducted in which only the fiber mixing amount was changed from the mixing amount thereof in Table 1 as a reference to either a smaller amount (70 g) or a larger amount (180 g). Table 2 shows the results.

[0026] [Table 2]

Type	Product name	Amount per 1 m ²	Effect
① Smaller amount			
Fiber	Oji fiber	70 g	Surface reinforcement effect is weak. With only the strength from the soil consolidation, erosion can be visually confirmed when rainfall is 50 mm/day. Water retention effect is also weak, so growth ability is weakened in highly permeable decomposed granite soils.
② Larger amount			
Fiber	Oji fiber	180 g	A large amount of solution sticks to fibers, reducing the amount distributed to the consolidated layer and decreasing erosion prevention capability. Water retention improves, but the soil remains highly humid and does not dry out, making erosion more likely even with small amounts of rain that followed.

[0027] In addition, to examine the application range (20 to 50 g per spray area of 1 m²) of the fertilizer mixing amount of the present invention, construction experiments were

5 conducted in which only the fertilizer mixing amount was changed from the mixing amount thereof in Table 1 as a reference to either a smaller amount (10 g) or a larger amount (60 g). Table 3 shows the results.

[0028] [Table 3]

Type	Product name	Amount per 1 m ²	Effect
① Smaller amount			
Fertilizer	All 15	10 g	Although the effect varies based on the condition of the base soil, coverage and density decrease significantly in nutrient-deficient soils such as decomposed granite soils.
② Larger amount			
Fertilizer	All 15	60 g	Contrary to the case with a small amount, fertilizer burn is observed in some cases in nutrient-rich black soil. In general, this mixing amount does not create problems, but it seems excessive in terms of cost.

[0029] In addition, to examine the application range (60 to 200 g per spray area of 1 m²) of the mixing amount of the soil erosion inhibitor of the present invention, construction experiments were conducted in which only the mixing amount of the soil erosion inhibitor was changed from the mixing amount thereof in Table 1 as a reference to either a smaller amount (50 g) or a larger amount (210 g). Table 4 shows the results.

[0030] [Table 4]

Type	Product name	Amount per 1 m ²	Effect
① Smaller amount			
Soil erosion inhibitor	Kuricoat U228G	50 g	Due to insufficient consolidation capability, it is unable to achieve its main function of preventing erosion. Even with rainfall of around 20 mm/day, erosion occurs at the catchment area.
② Larger amount			
Soil erosion inhibitor	Kuricoat U228G	210 g	Due to too-high consolidation capability, germination is significantly reduced. The ability to consolidate sandy soil can be ensured, but, even if fiber is increased, the hardness itself is too high, resulting in a reduction in the germination layer.

10 [0031] In addition, to examine the application range (0.100 to 0.175 g per spray area of 1 m²) of the adhesive mixing amount of the present invention, construction experiments were conducted in which only the adhesive mixing amount was changed from the mixing amount thereof in Table 1 as a reference to either a smaller amount (0.075 g) or a larger amount (0.200 g). Table 5 shows the results.

[0032] [Table 5]

Type	Product name	Amount per 1 m ²	Effect
① Smaller amount			
Adhesive	Kuricoat C402	0.075 g	No effect and uneven mixing
② Larger amount			
Adhesive	Kuricoat C402	0.200 g	Effective for stirring, but excessive cost.

[0033] In addition, to examine the application range (0.300 to 0.750 g per spray area of 1 m²) of the mixing amount of the color powder of the present invention, construction experiments were conducted in which only the mixing amount of the color powder was changed from the mixing amount thereof in Table 1 as a reference to either a smaller amount (0.250 g) or a larger amount (0.800 g). Table 6 shows the results.

[0034]

10 [Table 6]

Type	Product name	Amount per 1 m ²	Effect
① Smaller amount			
Color powder	Matsumin Neo Color MB	0.250 g	Visibility is reduced during spraying work, resulting in excessive spray volume of the mixture per unit area. There is no effect on erosion or germination performance.
② Larger amount			
Color powder	Matsumin Neo Color MB	0.800 g	Contrary to the above, the amount sprayed becomes insufficient due to color becoming darker. There is no effect on erosion or germination performance.

[0035] In addition, to examine the application range (7.5 to 20.0 g per spray area of 1 m²) of the seed mixing amount of the present invention, construction experiments were conducted in which only the seed mixing amount was changed from the mixing amount thereof in Table 1 as a reference to either a

smaller amount (5 g) or a larger amount (25 g). Table 7 shows the results.

[0036]

[Table 7]

Type	Product name	Amount per 1 m ²	Effect
① Smaller amount			
Seed	Mixed seeds	5 g	The mixing amount directly affects the result, and the amount of vegetation is insufficient. Thus, the secondary effect, which is the ultimate goal, for preventing erosion will be weakened.
② Larger amount			
Seed	Mixed seeds	25 g	Although the density of vegetation is sufficient to prevent erosion, the number of plants per unit area is considered excessive.

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Industrial Applicability

[0037] The present invention is useful as a spray-greening material and a spray-greening method for spraying on a ground surface such as a slope for greening. In particular, the present invention is suitable as a spray-greening material and a spray-greening method with which resistance to soil loss and erosion caused by rainfall is improved even before the plants begin to grow.

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Claims

[Claim 1] A spray-greening material obtained by mixing a soil erosion inhibitor, a fiber, an adhesive, a fertilizer, and a seed, wherein:

5 the soil erosion inhibitor contains a synthetic resin emulsion as a main component, has a viscosity η that satisfies $1000 \text{ mPa}\cdot\text{s} < \eta \leq 3200 \text{ mPa}\cdot\text{s}$, and is mixed in an amount of 60 to 200 g per spray area of 1 m^2 ; and

 the fiber is mixed in an amount of 80 to 170 g per spray
10 area of 1 m^2 .

[Claim 2] The spray-greening material according to claim 1, wherein the adhesive is mixed in an amount of 0.100 to 0.175 g per spray area of 1 m^2 .

[Claim 3] A spray-greening method comprising spraying the
15 spray-greening material according to claim 1 or 2 on a ground surface by a spraying machine.