Reduction of Nitrate Leaching from Cultivated Soils

It is now general knowledge that an adequate supply of nitrogen is crucial to plant nutrition and cultivation. Nitrogen compounds soluble and/or insoluble in water under in-use conditions are typical ingredients of both organic and inorganic fertilizers. In all the relevant fields, for example agriculture, forestry, care of the countryside and horticulture, nitrogen-based growth aids inter alia are introduced into cultivated soils on a huge scale.

Information on the significance and function of the various types of nitrogen fertilizers in use today can be found in the relevant scientific literature, cf. for example **"Agrarwirtschaft", Grundstufe 1, Fachtheorie für Bodenkunde, Chemie, Pflanzenernährung u.a.**, BLV Verlagsgesellschaft München, Landwirtschaftsverlag Münster-Hiltrup, more particularly pages 110 to 113, subchapter 3.1.3 "Stickstoffdüngemittel (Nitrogen Fertilizers)" and **GARTENBAULICHE BERUFSSCHULE, Vol. 1, Grundwissen des Gärtners**, Verlag Eugen Ulmer, Stuttgart, 7th Edition, more particularly pages 216 to 219, subchapter entitled "Stickstoffdünger (Nitrogen Fertilizers)" and the associated Table 39 on page 218 loc. cit. Most plant varieties absorb the nitrogen predominantly in the form of the readily water-soluble nitrate ion (NO_3^-). Other readily water-soluble or poorly water-soluble formulations undergo complex nitrification processes initiated in particular by bacterial populations after they have been introduced into the soil, so that ultimately all forms of nitrogen are converted into nitrate (often also referred to as saltpeter) in the soil. Although this readily soluble form of nitrogen is crucially important to plant growth, it is also attended by the problem of nitrate wash-off from the plant root zone into deeper layers of soil and ultimately into the ground water. This process, which is already serious environmental pollution and is

therefore undesirable, is the inevitable result of the natural watering and/or irrigation of the plant root zone which is crucial to plant growth.

The teaching of the present invention as described in the following is based on the surprising observation that nitrate wash off from the plant root zone can be substantially reduced by introducing selected ecologically safe surface-active components into the soil, preferably in admixture with other components identified in the following. Before particulars of the teaching according to the invention are discussed in detail, reference is made to the technical teaching of an earlier hitherto unpublished patent application:

Earlier hitherto unpublished German patent application **197 01 127.6** describes low-foaming surfactant concentrates for use in promoting plant growth. More particularly, the patent application in question describes low-foaming wetting aids in the form of a highly concentrated, but flowable and pourable aqueous surfactant-based concentrate for intensifying the penetration and spreading of water in and around plant roots during their watering, these wetting aids contain as an ecologically safe surfactant component alkyl (poly)glycoside compounds of the o/w type – hereinafter also referred to as "APG compounds" – and in admixture therewith olefinically unsaturated fatty alcohols and, optionally, partial esters of fatty acids with polyhydric alcohols as foam suppressors/defoamers and, in addition, lower water-soluble alcohols as viscosity regulators.

In one important embodiment, the technical teaching of the further development disclosed in the following makes use of the principles of the earlier German patent application cited above. Accordingly, the disclosure of this earlier German patent application is hereby specifically included as part of the disclosure of the present invention.

The technical teaching of the earlier patent application cited above is based on the following problem: the seemingly simple measure of watering areas of ground, more particularly areas of ground densely populated by plants, can cause considerable difficulties. One example of this are

grassed areas partly subjected to pedestrian and/or vehicular traffic where relatively small or even relatively large areas of the grass can dry out despite regular watering. If attempts are made to water these areas, the water does not penetrate deeply into the soil and, more particularly, does not penetrate into the root zone of the grass. The result of this is that plants in the areas in question can become undernourished, flat-rooted and unhealthy through overdrying. It is known that better spreading of the aqueous phase throughout the soil and, more particularly, throughout the plant root zone can be achieved by using auxiliaries with the character of wetting agents in the water used for watering. According to the teaching of the earlier application cited above, the surface-active auxiliaries are said to be APG compounds of the o/w type which are known to be used on a wide scale in totally different fields. APG compounds are surface-active auxiliaries for detergents, especially laundry detergents.

The teaching of the earlier patent application cited above is based on the observation that APG-based aqueous wetting aids are also valuable wetting aids in soil irrigation for stimulating plant growth. However, the following problem remains to be solved in this regard: APG-based nonionic surfactants of the type in question are distinguished by particularly high foaming in aqueous preparations. For use in detergents, this is generally welcomed by the consumer. For the field of application with which the present invention is concerned, however, not only is this undesirable, it can even be a distinct disadvantage. Typical foam-suppressing additives are known in the field of detergents, but are unsuitable for the application with which the present invention is concerned, i.e. promoting healthy plant growth. The technical teaching of the earlier patent application cited above uses selected defoamers or foam suppressors which actually promote rather than impede plant growth in combination with the APG-based surface-active components. The selected defoamers in question are the above-mentioned fatty alcohols and/or partial esters of fatty acids with

lower polyhydric alcohols.

Another problem addressed by the teaching of the earlier patent application was to enable the multicomponent mixture in question to be made up in the form of concentrates readily dilutable with water, the adequate "portionability" of the concentrate even at normal temperatures also having to be ensured. The technical solution provided by the teaching according to the earlier patent application lies in the above-cited multicomponent mixture containing the APG compounds of the o/w type together with selected foam suppressors of the type mentioned in an aqueous concentrate of which the viscosity is controlled through the use of limited amounts of lower water-soluble alcohols.

The further development according to the present invention which is described hereinafter is based on the following additional observation: APG-based wetting aids of the type in question not only promote the penetration of irrigation water into the soil structure and hence, above all, into the plant root zone, the multicomponent aqueous mixture introduced into the soil and/or applied to the above-ground part of the plant also shows an unexpected effect in helping to solve the above-mentioned problem of the unwanted wash-off of water-soluble nitrate into the ground water.

Subject of the Invention

Accordingly, the present invention relates to the use of ecologically safe surfactant compounds from the class of water-soluble alkyl (oligo)glycoside compounds of the o/w type (APG compounds) through their introduction into the soil surface as an auxiliary for controlling nitrate wash-off from the plant root zone of cultivated soils during rain and/or during watering.

Particulars of the Teaching According to the Invention

The class of APG compounds used in accordance with the invention

are ecologically safe surface-active components which, in the embodiment selected in accordance with the invention, are surfactants of the o/w type under the normal conditions of use, particularly at the temperatures normally encountered there, i.e. when mixed with water, convert water-insoluble organic components which flow at temperatures in the range mentioned into the form of oil-in-water preparations.

For the field of application according to the invention, these APG compounds and, in particular, aqueous preparations of these surfactants may be introduced onto or into the soil surface at a different time from and/or at the same time as typical N-containing inorganic and/or organic fertilizers. In the preferred embodiment of the invention, the APG compounds or aqueous preparations thereof are introduced at a different time from and/or preferably at the same time as C sources containing organically bound carbon for promoting the growth of soil microorganism populations and, more particularly, for strengthening the corresponding microorganism flora. As will be explained in detail in the following, particularly suitable carbon sources are both aerobically and anaerobically degradable organic compounds which contain lipophilic saturated and/or olefinically unsaturated hydrocarbon radicals of fatty structure and which are introduced into the soil together with the APG compounds in the form of the above-mentioned o/w emulsions and/or dispersions. In one particularly important embodiment of the teaching according to the invention, the APG compounds are applied to the soil and hence incorporated in the upper soil layers in admixture with fatty alcohols and/or partial esters of fatty acids with lower monohydric alcohols, preferably in the form of the aqueous preparations mentioned. Before these particular embodiments are discussed in detail, the individual components of the multicomponent mixture preferably used will first be identified in detail in the following.

APG compounds of the o/w type

Reference is first made to the extensive scientific knowledge and literature on the production and properties of APG compounds, more particularly APG compounds of the type with which the present invention is concerned, cf. for example the book by Hill et al. entitled **"Alkyl Polyglycosides", VCH-Verlagsgesellschaft mbH, Weinheim 1997**. The disclosure of **EP 0 230 598 B1** also provides detailed information on the production and properties of APG compounds.

APG compounds preferred for the purposes of the present invention are characterized in that alkyl (oligo)glucoside compounds of which the alkyl group is derived at least predominantly from straight-chain fatty alcohols are at least partly and, more particularly, at least predominantly used. Compounds of this type are surface-active auxiliaries used for a wide range of applications. A number of factors are of importance to their use on an industrial scale. It is known that APG-based wetting agents can be based entirely on natural materials. They are obtained as products of the reaction of fatty alcohols with mono-, oligo- and/or polysaccharides. Where polysaccharides and/or higher oligosaccharides are used with the fatty alcohols, depolymerization is first initiated by hydrolysis and/or alcoholysis in the course of the acid-catalyzed reaction before the required APG compounds are formed. Preferred saccharide components for the formation of APG compounds are glucose and corresponding oligo- and polyglucoses. However, other suitable reactants are saccharide compounds based on mannose, galactose, arabinose and other comparable mono-, oligo- and/or polyglycosides.

APG compounds of the type suitable for the purposes of the invention are obtained as reaction products with the general formula $R\text{-}O\text{-}(G)_x$, where R is a primary, preferably straight-chain aliphatic hydrocarbon radical containing at least 6 carbon atoms, preferably 8 to 24 carbon atoms and more preferably 8 to 18 carbon atoms and G is a glycose unit

containing 5 or 6 carbon atoms, preferably glucose. In the class of surfactants with which the invention is concerned, the degree of oligomerization x and hence the so-called DP value, which indicates the distribution of monoglycosides and oligoglycosides, is normally a number of 1 to 10, for example a number of about 1.2 to 5, preferably a number of about 1.2 to 4 and more preferably a number of 1.2 to 2.

APG compounds of the o/w type, i.e. surface-active components of the type mentioned which are capable of forming oil-in-water emulsions – are known to be distinguished by comparatively high HLB values, i.e. by HLB values above 7 and, preferably, above 8 or 9, particular significance being attributed to HLB values in the range from 10 to 18.

The fatty alcohols used in accordance with the invention

As mentioned above, multifunctional significance attaches to these components of the multicomponent mixtures used in accordance with the invention. On the one hand, they are valuable as foam suppressors in the practical application of the multicomponent mixtures in water-diluted preparations, on the other hand they act as a carbon source for microorganism growth and, more particularly, for promoting the growth of organotrophic microorganisms when used in the soil and, more particularly, in the vicinity of plant roots. Fatty alcohols are both aerobically and anaerobically degradable by natural processes. As a carbon source crucial to organotrophic growth in accordance with the invention, they show lipophilic hydrocarbon radicals of fatty structure in their molecular structure and, hence, a comparatively high concentration of the energy-giving C-H groups.

According to the invention, preferred fatty alcohols in the multicomponent mixture are distinguished by at least 6 to 8 carbon atoms in the molecule, monoolefinically and/or polyolefinically unsaturated fatty alcohols containing 10 to 28 carbon atoms and, more particularly,

corresponding fatty alcohols containing 12 to 24 carbon atoms being particularly preferred. Another preferred parameter for the choice of suitable fatty alcohols lies in the solidification ranges of these components of the multicomponent mixture. Corresponding components with solidification ranges of 20°C or lower and, more particularly, 10 to 15°C or lower are preferred.

Although it is preferred in accordance with the invention to use fatty alcohols based on natural materials of the type under discussion here, the teaching according to the invention is not confined to such fatty alcohols. Fatty alcohols of synthetic origin, which may even have branched chains, are also suitable mixture components in the context of the teaching according to the invention. In particular, the assignment of the solidification ranges of these alcohol component(s) can be influenced in this way.

Fatty acid partial esters suitable for the purposes of the invention

In addition to and/or instead of the fatty alcohols defined above, fatty acid partial esters of – in particular – lower monohydric alcohols can also be important mixture components in the context of the teaching according to the invention. On the lower polyhydric alcohol side in particular, corresponding compounds containing 2 to 6 carbon atoms and, more particularly, 3 to 5 carbon atoms are suitable. Particular significance attaches in this regard to corresponding glycerol partial esters simply by virtue of their ready accessibility as a natural material. The fatty acids of the class of partial esters in question are normally assigned to corresponding compounds containing 10 to 24 carbon atoms, corresponding C_{12-20} monocarboxylic acids being particularly suitable. It is known that fatty acids of the type in question here are commercially obtainable on a large scale as starting materials from natural sources. In this case, too, it can be of particular advantage to use monoolefinically and/or polyolefinically unsaturated fatty acids. A particularly suitable class

of the active substances in question are partial esters of glycerol with olefinically unsaturated $C_{16/18}$ monocarboxylic acids, particular significance again attaching to corresponding monoesters. A fatty acid ester of this type technologically available on a wide scale is glycerol monooleate.

In the same way as the fatty alcohols described above, fatty acid esters with the constitution described here are both aerobically and anaerobically degradable in the soil by natural processes. They are also crucial carbon sources for the organotrophic growth of microorganisms in the immediate vicinity of plant roots. Their use also indirectly strengthens plant growth by stimulating soil microorganism growth.

Further particulars of the teaching according to the invention

According to the invention, it is possible to use either only fatty alcohols or only fatty acid partial esters as mixture components together with the APG compounds. However, one embodiment is characterized by the use of combinations of fatty alcohols and fatty acid partial esters. Preferred mixing ratios – based on parts by weight of the water-free components – are in the range from about 1:1 to 1:10. The fatty alcohols and fatty acid partial esters are preferably mixed in ratios (parts by weight of the water-free components) of 1:1 to 1:5 and more preferably in ratios of 1:1 to 1:3.

In the multicomponent mixture used in accordance with the invention, the APG components are used in at least substantially equal quantities by weight, based on fatty alcohols and/or partial esters, mixing ratios of APG to fatty alcohol and/or partial ester of 1:1 to 5:1, preferably 1:1 to 3:1 and, more preferably 1.5 to 2.5:1 being preferred. These figures represent parts by weight of the mixture, based on water-free mixture component(s).

However, the teaching according to the invention is not confined to the use of APG components in excess. Mixtures with a corresponding

excess of the fatty alcohols and/or fatty acid partial esters used as foam suppressors also fall within the scope of the teaching according to the invention.

According to earlier German patent application 197 01 127.6 cited above, multicomponent mixtures of the type with which the invention is concerned are normally marketed and supplied to the consumer in the form of flowable aqueous concentrates. The user then dilutes the concentrate as required with more water for applying the multicomponent mixture to the soil and to the plants. To enable the multicomponent mixture to be made up in the form of concentrates readily dilutable with water, its adequate "portionability" even at normal temperature has to be guaranteed. The teaching of the earlier application cited above makes it clear that, when aqueous APG concentrates are mixed with the above-mentioned foam suppressors/defoamers based on fatty alcohol and/or partial ester, thickened gels, i.e. gels which no longer flow freely, are readily formed. Accordingly, it is proposed in that earlier application to guarantee flowability and pourability, even at room temperature, by adding limited quantities of lower monohydric alcohols and, more particularly, by adding limited quantities of ethanol. The same applies to these mixtures in the context of their use in accordance with the invention. Preferred lower monohydric alcohols are corresponding compounds containing up to 4 carbon atoms.

In one important embodiment, the teaching according to the invention is characterized in that lower monohydric alcohols and, more particularly, lower polyhydric alcohols flowable at room temperature are used as mixture components in addition to the above-mentioned components of the multicomponent mixture. Multifunctional significance thus also attaches to these polyhydric alcohols in the context of the multicomponent mixture. As liquid mixture components with comparatively high boiling points, they promote the flowability required in particular for handling the concentrate and hence the portionability of the concentrate;

on the other hand, these components – after introduction into the soil – act as a nutrient in the form of an additional carbon source for microorganism growth, above all in the rhizosphere and/or the micorrhiza region. Preferred polyhydric alcohols are corresponding compounds containing 2 to 6 carbon atoms and preferably 2 to 4 carbon atoms, particular significance attaching to glycerol and/or glycol. The high solubility in water of the components in question here can also be useful in the practical application of the multicomponent mixtures. Preferred quantities for the mixture components under discussion here are normally at most 30 to 35% by weight, preferably at most 20 to 25% by weight and, more preferably, in the range from 5 to 15% by weight (percentages by weight based on the muticomponent mixture in the form of the above-mentioned concentrate which is subsequently diluted with water for application to the areas of soil to be treated).

In addition to or instead of the unsaturated fatty alcohols described above as a component of the mixture, olefinically unsaturated terpene alcohols are also suitable as foam suppressors/defoamers. Terpene alcohols are acyclic or monocyclic, bicyclic or tricyclic, polyolefinically unsaturated alcohols of vegetable origin which contain between 10 and 40 carbon atoms. The terpene alcohols are preferably used in the form of their naturally occurring mixtures as foam suppressors/defoamers. A particularly preferred representative is pine oil which is a mixture of various terpinols, such as α-and β-terpineol, α-fenchyl alcohol, borneol and isoborneol, as described in Römpp's **Chemielexikon, page 3451, Vol. 4, 9th Edition 1991**. Pine oil additionally contains small quantities of other non-alcohol compounds, for example camphor, anethol and estragol. Pine oil is obtained from resin-containing stubs and the root wood of various pine species by extraction with, for example, white spirit or chloroform and subsequent fractionation and distillation.

As mentioned above, the defoamer components are normally

present in smaller quantities than the APG component, based on active substance. Mixtures in which the defoamer components may be used in distinctly smaller quantities are preferred. Thus, multicomponent concentrates with a defoamer content of about 10 to 25% by weight and preferably of about 15 to 20% by weight are suitable for the purposes of the invention.

The lower water-soluble monohydric alcohols used as viscosity regulators are determined in regard to type and quantity by the principal components mentioned above, by the lower water-soluble polyhydric alcohols optionally used and by the total amount of water present in the multicomponent mixture. Additions of the viscosity regulator of at least about 5 to 7% by weight as a lower limit and 12 to 25% by weight as an upper limit are particularly suitable. Additions of ethanol of about 5 to 20% by weight and, more particularly, 10 to 15% by weight generally have a sufficient influence on viscosity in the direction of the desired flowability and pourability of the multicomponent mixture, even at room temperature.

The water content of the multicomponent concentrates is generally at most about 50% by weight and, in preferred embodiments, assumes lower values. Thus, maximum values of about 30 to 45% by weight are particularly suitable for the water content of the multicomponent mixture. In general, the water content of the multicomponent mixture will be far lower than this, for example in the range from 10 to 20% by weight and preferably in the range from 10 to 15% by weight.

In practice, the surfactant-containing multicomponent mixtures according to the invention are applied to the soils to be treated in water-diluted form in such quantities that at least about 0.5 to 1 g/m² and preferably at least about 3 to 5 g/m² of the APG-containing multicomponent mixture – based on water-free mixture – is introduced onto or into the soil. Preferred upper limits to the quantity of multicomponent mixture applied, again based on water-free mixture, are 25 to 30 g/m², although the use of

larger quantities, for example up to 40 g/m² or even up to 50 g/m², are also important embodiments of the teaching according to the invention.

The surfactant-containing multicomponent combinations according to the invention may be applied either once or even several times a year, particularly during the growth phase. More particularly, the time selected for application of the multicomponent mixtures according to the invention may be co-ordinated in terms of type and quantity with the particular process of soil fertilization to be undertaken. The prophylaxis of the unwanted nitrate wash-off by using the auxiliaries according to the invention is understandably also influenced in particular by the quantity of nitrate available for washing off in each individual case on the basis of general expert knowledge. Although there is as yet no clear explanation of the technical effect on which the teaching according to the invention is based, it may presumably be assumed that the horizontal spreading and hence fine distribution of even the water-soluble nitrate component in the upper soil structure under the influence of the surfactant-based multicomponent mixture introduced in accordance with the invention is jointly responsible for the desired positive effects.

Examples

Comparative tests in which the elution behavior of aqueous solutions in regard to nitrate wash-off from agricultural soil is determined under identical working conditions and the results of these tests are reported in the following Examples.

Aqueous preparations of the commercial product marketed by Henkel KGaA under the registered name of "Magic Wet" are used as APG compounds of the o/w type in accordance with the teaching of the invention. Magic Wet is a multicomponent mixture of the type defined above which contains foam suppressors selected from fatty alcohols and fatty acid partial esters together with a viscosity regulator in addition to the

surface-active APG compounds of the o/w type in the form of an aqueous concentrate.

In comparison tests carried out under otherwise identical working conditions, the elution behavior of aqueous APG preparations with different APG concentrations in regard to nitrate wash-off is determined. These tests are compared with the use of APG-free tap water as eluent.

Two further tests use on the one hand an aqueous preparation of a commercially available liquid fertilizer and, on the other hand, the same aqueous liquid phase additionally containing Magic Wet as aqueous eluents. The liquid fertilizer used is Substral® which is characterized by an $N : P_2O_5 : K_2O$ ratio of 6 : 4 : 4. The liquid fertilizer was used in the form of a 3% by weight aqueous preparation in the tests.

The following procedure was adopted:

Moist, freshly introduced agricultural loess soil is homogenized in a mortar and sieved through a 5 mm mesh sieve. From its previous history, the soil used contains nitrogen, more particularly soluble nitrate. The soil used has a dry weight of 86.5% by weight. Quantities of 50 g of the moist soil are introduced into 10 cm long glass frits which are vertically fixed to stands so that the particular test solution used can be dripped or poured onto each glass frit from above. The particular eluates accumulating are collected beneath the glass frits.

1 ml of test solution is dripped from above and 5 ml of water or multicomponent solution poured from above onto each glass frit. Within 5 to 10 minutes, this volume of liquid has penetrated through and been absorbed by the soil in the glass frit.

The subsequent elution step is carried out by applying 5 ml of water to the head of the particular glass frit to be eluted. The eluate is collected. The quantity of eluate collected and the nitrate concentration in the eluate in mg/l are determined.

Each series of tests of Examples 1 to 6 below is repeated three

times at different times. A first series of tests determines the elution of liquid immediately after application and distribution of the particular test solution used in the soil accommodated in the particular glass frit. A second series of tests is carried out seven days after application and introduction of the particular test solution. Finally, the third series of tests increases the period between introduction of the test solution into the soil and subsequent elution to 14 days. More particularly:

Example 1: blank test in which pure tap water is used as the test solution.

Example 2: a 1.25% by weight aqueous Magic Wet solution is used as the test solution.

Example 3: an aqueous 2.5% by weight Magic Wet solution is used as the test solution.

Example 4: a 5.0% by weight aqueous Magic Wet solution is used as the test solution.

Example 5: a 3% by weight aqueous Substral solution is used as the test solution.

Example 6: the above-mentioned aqueous Substral solution containing 1.25% by weight of Magic Wet is used as the test solution.

Whereas, in Examples 1 to 4, no additional nitrogen is introduced into the particular soil sample to be investigated, Examples 5 and 6 use a 9 mg addition of nitrogen per 50 g of soil.

In a first determination, the elution behavior is determined in ml after 0 day, 7 days and 14 days. The following results are obtained:

Table 1

Example	Elution volume in ml		
	After 0 day	After 7 days	After 14 days
1	5	3.3	3.0
2	6.5	2.3	2.1
3	6.5	2.0	3.1
4	6.5	2.4	2.4
5	6.0	3.0	2.8
6	6.5	2.1	2.2

The elutable water volume, i.e. the water retaining capacity of the soil, is slightly higher in Examples 2 to 6 than in Comparison Example 1 immediately after application of the particular test solutions. After 7 days and after 14 days, this effect is no longer in evidence.

In the eluates obtained in accordance with the data of Table 1, the nitrate content effectively washed off in the particular individual case is analytically determined. Table 2 below summarizes the results obtained in the same order as in Table 1.

Table 2

Example	Nitrate content determined in mg		
	Eluted after 0 day	Eluted after 7 days	Eluted after 14 days
1	0.2	0.132	0.21
2	0.065	0.03	0.95
3	0.013	0.012	0.028
4	0.013	0.012	0.02
5	13.5	6.513	7.08
6	12.35	4.032	4.33

Comparison of the results shows that the quantity of nitrate washed

off with the elution water is successfully reduced by the addition of Magic Wet. For example, the nitrate wash-off of 0.2 mg in the control sample of Example 1 (after 0 day) is reduced to 0.065 mg and hence to 32% of the original nitrate wash-off by using the 1.25% by weight Magic wet solution. This effect can be even further improved by using larger quantities of Magic Wet, for example to 6.5% of the original nitrate wash-off with 2.5% by weight Magic Wet solution.

Nitrogen additionally introduced by a liquid fertilizer (9 mg N per 50 g soil, corresponding to 30.6 mg NO_3) is also retained in the soil to a greater extent by the use of Magic Wet in the elution liquid phase (cf. the comparison of the numerical data of Examples 5 and 6).

Example 7

Another test in the form of a leaching test was carried out to investigate various fertilizers for their nitrogen release capacity and to study the effectiveness of the mixture according to the invention in reducing wash-off. To this end, blocks (columns) of soil were removed almost intact from agricultural land and stored in a 1-meter long lysimeter - with a drainage layer of gravel - in the ground. The soil was classified as light soil (sl = sandy loam). Two conventional granular fertilizers (nitrochalk and Floranid Master) were used. In both cases, the quantity applied amounted to 200 kg pure nitrogen per hectare. Each variant was repeated several times. The mixture according to the invention marketed by applicants under the name of "Magic Wet" was applied in a quantity of 2 g/m² (20 kg/ha) with ten times the quantity of water. Unfertilized columns of soil with a natural nitrogen content were used as controls. Throughout the test, the containers were exposed to natural weathering. The day and night temperatures were respectively 15-25°C and 14-18°C. At the beginning of the test, the fertilizers and/or the test substance according to the invention were applied to the surface of the soil columns and watered in.

Precipitation of 40 mm rain per week was simulated. The drainage water was collected. 10, 20 and 30 days after the beginning of the test, the drainage water was analyzed for nitrate (flow injection analysis) and the average nitrate release was determined.

The drainage water of the nitrochalk-fertilized blocks/columns had distinctly higher nitrate contents than that the Floranid Master-fertilized blocks/columns and the unfertilized controls (Table 3).

In any event, a single application of the "Magic Wet" mixture according to the invention led to a drastic reduction in the level of nitrate in the drainage water. For example, the nitrate wash-off of blocks/columns fertilized with Floranid Master was reduced from 58 mg NO_3/l to 45 mg NO_3/l.

Table 3

Nitrate in mg/l drainage water	**Without Magic Wet**	**With Magic Wet**	**Reduction to**
"Unfertilized" control	44.2	25.6	58%
Floranid Master	58.6	45.2	77%
Nitrochalk	64.8	52.1	80%

The test substrate is a naturally grown, agriculturally used soil. It was demonstrated that the mixture according to the invention was also able to reduce nitrate wash-off on agricultural land. On the one hand, this protects the ground water against further nitrate pollution; on the other hand, it keeps expensive fertilizers in the root zone of cultivated plants and contributes towards the more effective utilization of fertilizers.

CLAIMS

1. The use of ecologically safe surfactant compounds from the class of water-soluble alkyl (oligo)glycoside compounds of the o/w type (APG compounds) through their introduction into the soil surface as an auxiliary for controlling nitrate wash-off from the plant root zone of cultivated soils during rain and/or during watering.

2. The use claimed in claim 1, characterized in that the APG compounds are introduced onto or into the soil surface at a different time from and/or at the same time as N-containing inorganic and/or organic fertilizers.

3. The use claimed in claims 1 and 2, characterized in that the APG compounds are introduced at a different time from and/or preferably at the same time as C sources containing organically bound carbon for promoting the growth of soil microorganism populations, more especially for strengthening the corresponding microorganism flora.

4. The use claimed in claims 1 to 3, characterized in that aqueous preparations of APG compounds and the C sources are introduced into the soil surface.

5. The use claimed in claims 1 to 4, characterized in that the APG compounds are introduced into the soil together with aerobically and anaerobically degradable organic compounds containing lipophilic saturated and/or olefinically unsaturated hydrocarbon radicals of fatty structure.

6. The use claimed in claims 1 to 5, characterized in that the APG compounds are applied to the soil in admixture with fatty alcohols and/or partial esters of fatty acids with lower polyhydric alcohols, preferably in the form of aqueous preparations.

7. The use claimed in claims 1 to 6, characterized in that APG compounds based on at least substantially saturated C_{8-14} head-fractionated fatty alcohols are used, APG compounds at least

predominantly containing $C_{8/10}$ fatty alcohols in the APG molecular structure being preferred.

8. The use claimed in claims 1 to 7, characterized in that alkyl oligoglucosides, preferably with DP values of 1.2 to 5 and HLB values of 10 to 18, are used as the APG compounds.

9. The use claimed in claims 1 to 8, characterized in that fatty alcohols containing at least 6 to 8 carbon atoms in the molecule and preferably mono- and/or polyolefinically unsaturated fatty alcohols containing 10 to 28 carbon atoms and more particularly 12 to 24 carbon atoms are used in the multicomponent mixture containing APG compounds.

10. The use claimed in claims 1 to 9, characterized in that fatty alcohols with solidification ranges of 20°C or lower and preferably 10 to 15°C or lower are used.

11. The use claimed in claims 1 to 10, characterized in that fatty acid partial esters of polyhydric alcohols containing 2 to 6 carbon atoms and preferably 3 to 5 carbon atoms, more especially glycerol partial esters, are used in the multicomponent mixture.

12. The use claimed in claims 1 to 11, characterized in that the fatty acid partial esters are derived from C_{10-24} and more especially from C_{12-20} fatty acids, monoolefinically and/or polyolefinically unsaturated fatty acids again being preferred.

13. The use claimed in claims 1 to 12, characterized in that partial esters of glycerol with olefinically unsaturated $C_{16/18}$ monocarboxylic acids, more particularly glycerol monooleate, are used.

14. The use claimed in claims 1 to 13, characterized in that the fatty alcohols and the partial esters and preferably the APG compounds also are based on natural materials.

15. The use claimed in claims 1 to 14, characterized in that, where fatty alcohols and fatty acid partial esters are simultaneously used, they are used in mixing ratios (parts by weight of the water-free components) of 1:1

to 1:10, preferably 1:1 to 1:5 and more preferably 1:1 to 1:3.

16. The use claimed in claims 1 to 15, characterized in that the APG compounds are used in at least substantially equal quantities by weight, based on fatty alcohols and/or partial esters, mixing ratios of APG:fatty alcohol and/or partial ester of 1:1 to 5:1, preferably 1:1 to 3:1 and more preferably 1.5 to 2.5:1 – parts by weight, based on water-free mixture components – being preferred.

17. The use claimed in claims 1 to 16, characterized in that lower polyhydric alcohols preferably containing 2 to 6 carbon atoms and more preferably 2 to 4 carbon atoms, more particularly glycerol and/or glycol, have been added to the multicomponent mixtures.

18. The use claimed in claims 1 to 17, characterized in that dilute aqueous preparations which have been obtained from flowable concentrates of the multicomponent mixtures containing lower monohydric alcohols preferably containing 1 to 4 carbon atoms, more particularly ethanol, as additional viscosity regulators are used.

19. The use claimed in claims 1 to 18, characterized in that the APG-containing multicomponent mixtures are applied, preferably by fine spraying in the form of aqueous emulsions/dispersions, in quantities of 1 to 50 g/m² and preferably 3 to 40 g/m², based on water-free mixture.

* C L M S *