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(54) Title: PROCESS AND COMPOSITION FOR CONTROLLED NOURISHING OF AGRICULTURAL PLANTS		
(57) Abstract Intensification of cultivation of agricultural plants and their controlled nourishing by a combination of a chemical treatment and a suitable cultivation technology. Agricultural plants are treated with a composition containing 2-chloro-ethane-phosphonic acid, microelements and additives, in a certain stage of their development, in the vegetative phase, nitrogen fertilizer is applied to the plants simultaneously with or prior to the chemical treatment and a fungicidal treatment is carried out, if desired the number of stocks is increased, nitrogen fertilizer is applied in more portions and other technological measures are employed to increase the efficiency of the compositions. The invention provides an excellent possibility for increasing the value of plants and the crop yield.		

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PROCESS AND COMPOSITION FOR CONTROLLED NOURISHING OF AGRICULTURAL PLANTS

The invention relates to a process and a composition by which the cultivation of agricultural plants can be intensified and their nourishing can be controlled.

5 In the cultivation of agricultural plants the planned influence of the biological state of plants plays a more and more important role. There are numerous compositions known for this purpose, including for example 2-chloroethane-phosphonic acid and derivatives thereof
10 as active ingredient. 2-Chloroethane-phosphonic acid is disadvantageous in that if it is applied at a relatively late stage and under bad weather conditions, for example in drought, there is a danger of overdosing, which may cause in certain cases a depression of plant growth and
15 a decrease of the crop yield.

According to the Published German Patent Application 2.640.223 a combination of 2-chloroethane-phosphonic acid and one of the following compounds: N-[(trichloromethyl)-thio]-phthalimide, cis-N-[(trichloromethyl)-thio]-
20 -4-cyclohexene-1-dicarboximide, cis-N-[(1,1,2,2-tetrachloromethyl)-thio]-4-cyclohexene-1,2-dicarboxamide, iron-(III)-dimethyl-dithiocarbamate, manganese-ethylene-bis-dithiocarbamate, zinc-ethylene-ureic acid ethylester and tetrachloroisophthalic acid dinitrile is employed to
25 accelerate plant growth.

In the Published German Patent Application 2.207.575 N,N-dimethyl-piperidinium salts and in the Published German Patent Application 361.410 a combination of N,N,N-trimethyl-N-2-chloroethyl-ammonium chloride
30 and 2-chloroethyne-phosphonic acid is disclosed as plant growth accelerating agent. According to the Published German Patent Application the N,N-dimethyl-piperidinium salts of 2-chloroethane-phosphonic acid can also be employed as plant growth regulators.



- 2 -

Certain synthetic plant growth regulating agents, such as chlorocholine chloride, succinic acid dimethylhydrazide, maleic acid hydrazide, diphenylurea, 2,4-dichlorobenzyl-tributyl-phosphonium chloride, phenoxy-isobutyric acid, etc. are also known in the art. 2-Chloroethane-phosphonic acid and its derivatives, e.g. anhydrides, esters, salts and acid chlorides in addition to their plant growth regulating effect, according to the British Patent Specification 1.334.850 improve the resistance of cultivated plants against certain plant diseases.

The preparation of 2-chloroethane-phosphonic acid is disclosed in the United States Patent Specification 3.787.486. The application of this compound is performed using an aqueous solution by which the whole surface of plants or seedlings is wetted. The solution contains 10-5000 ppm, in particular 100-1000 ppm of active ingredient.

According to the state of art it is generally advantageous to add micro- and mesoelements (e.g. calcium, magnesium, iron, manganese, copper, zinc, molybdenum, cobalt and bor in the form of soluble salts or chelates) as leaf-fertilizers, since they improve the crop yield. It has further been found that the nutrients administered through the leaves affect the metabolism of plants directly, which has particular advantages when the absorption of nutrients via the roots is inhibited for some reason. The lack of microelements results in disorders in the vital process of plants. The supply of microelements should be in a good correlation with the various local circumstances, which is an important factor to be taken into account when selecting the appropriate compositions and route of application.

Generally spoken, it can be concluded that there are numerous attempts to keep the crop yield at a stable high level by using various formulations and employing



- 3 -

different methods, but none of them could so far guarantee full security. To gain a satisfactory control over the complicated vital processes of plants complex measures or active ingredient combinations having a complex effect
5 on the essential factors affecting the crop yields are required.

The elimination of the fluctuation of crop yields and the increase of crop yields belong to the most important goals in the agriculture and require the har-
10 monization of a large number of different factors, such as improving of plant varieties, combining various chemical treatments, use of appropriate cultivation parameters, etc.

The invention relates to a process and a composi-
15 tion by which a controlled nourishment of agricultural plants can be solved with a satisfactory security and the capacity of plants for accomodation to the given soil, wheather and rainfall conditions can be improved.

We have recognized that the compositions con-
20 taining a combination of certain complexes of the salts of microelements, mesoelements, urea and 2-chloroethane-phosphonic acid or a derivative thereof effectively increase the crop yields of agricultural plants without exhibiting any harmful side-effect, such as depression,
25 etc., can minimize the losses due to uncertain and variable cultivation conditions, show no toxicity and fit well into the conventional cultivation procedure. The effect of the compositions containing more active ingredients surpasses the effect shown by its components separately, if the
30 compositions are applied in certain stages of the development of the agricultural plants (in the vegetative phase), nitrogen artifical fertilizer is added simultaneously or before their application, they are combined with a fungicidal treatment and, if desired, the number of stocks in
35 the row is increased, the quantity of nitrogen fertilizer

- 4 -

is partitioned, and optionally deep fertilization is performed.

The compositions according to the invention contain a combination of the following components, in
5 an aqueous solution or suspension:

- a) 0.1 to 80 % by mass of a combination of meso- and microelements (expressed in the mass of elements) in the form of complexes of the salts of said meso- and imcroelements, which contains at least
10 $5 \cdot 10^{-3}$ % by mass of zinc,
 $5 \cdot 10^{-4}$ % by mass of bor,
 $1 \cdot 10^{-3}$ % by mass of copper,
 $1 \cdot 10^{-3}$ % by mass of magnesium,
 $1 \cdot 10^{-3}$ % by mass of iron,
15 $1 \cdot 10^{-1}$ % by mass of finely divided sulfur;
b) 0.01 to 25 % by mass of 2-chloroethane-phosphonic acid, esters or salts thereof;
c) 1.0 to 20.0 % by mass of urea.

The complexes of the salts of microelements
20 are chelates, which can be prepared from said salts with citric acid, acetic acid, glycine, ethylenediaminetetraacetic acid and salts thereof, nitrilotriacetic acid and/or a mixture thereof, in a known manner. The total active ingredient concentration in the compositions
25 amounts to 1 to 95 % by mass. The pH of the aqueous compositions is adjusted to 3.5 to 4.0. The finely divided sulfur, used as a mesoelement, has a grain size below 5 microns.

The compositions can be prepared by more al-
30 ternative methods. According to a variant, the mono-chelates of the salts of microelements are first prepared, 2-chloroethane-phosphonic acid is added, the pH is adjusted to 2 to 2.1, sulfur and conventional additives are added, the crude suspension obtained is dis-
35 persed in a colloidal mill or any other humid grinding



- 5 -

equipment, and as soon as the required dispersity grade is achieved, urea is added.

According to another embodiment, to a solution of microelements and 2-chloroethane-phosphonic acid, the pH of which is adjusted to 2 to 2.5, sulfur, urea and the required additives are added prior to application.

According to a third method, the chelates of microelements and 2-chloroethane-phosphonic acid are added to a concentrated suspension of finely divided sulfur, the pH is adjusted to 2.1 to 2.5 and urea and further additives are added to the diluted composition.

According to a fourth method, 2-chloroethane-phosphonic acid is added to the chelates and the finely divided sulfur suspension, the pH is adjusted to 2 to 2.5, and a portion of urea is added. The remaining portion of sulfur suspension and urea as well as the further additives are added after the final dilution.

According to a fifth method, the salt of microelements are added to the diluted, colloidal sulfur suspension, in the solution obtained complexes are formed, by adding the tetrasodium salt of ethylenediaminetetraacetic acid, and the pH is adjusted to 6.5 to 7.0 by hydrochloric acid. To the diluted composition 2-chloroethane-phosphonic acid, colloidal sulfur suspension and urea are added, taking care that the pH should not exceed 4.5. Finally, the composition is supplemented with the conventional further additives.

In addition to the above methods there are numerous further methods, by which the compositions according to the invention can be prepared.

2-Chloroethane-phosphonic acid is employed as an aqueous solution containing 40 to 50 % by mass of active ingredient. The sulfur suspension used preferably contains 900 g./lit. of sulfur, in the form of a colloidal sulfur with a grain size below 5 microns. Suitable



- 6 -

compositions include Sulfur 900 W (Budapesti Vegyimivek), Thiovit (Sandoz AG), Sofril (Rhone Poulenc), Kumulus S WP (BASF), etc.

5 The microelements zinc, magnesium, bor, copper, iron are employed in a suitable form, for example as concentrated solutions containing glycine and/or nitric acid, but complexes with nitrilotriacetic acid are also suitable.

10 Preferred representatives of the derivatives of 2-chloroethane-phosphonic acid include anhydride, acid chloride, mono-2-chloroethyl ester and further esters.

15 Urea is employed as a concentrated aqueous solution or in the form of a crystalline, commercially available composition.

Due to the acidic pH of the compositions, preferably wetting agents with a pH of 2 to 4 are employed. They are generally prepared by combining the following components: alkylbenzenesulfonic acidcalcium
20 salt, alkylphenolpolyglycol ether and propyleneoxide-ethyleneoxide condensate. A suitable commercial product is for example Tensiofix B 7416. Combinations of ox-ethylated alkylphenolphosphate esters and alkyl benzene-sulfonic acid calcium salt are also suitable. The solid
25 phase can generally be dispersed by the aid of mixtures of anionic and non-ionic additives.

The compositions are preferably applied to the plants by air, in an amount of 50 to 80 lit./hectare, but
for example in the case of grains conventional ground
30 agricultural machines can also be employed, and the amount of tank mixture is about 200 to 400 lit./ha.

The compositions according to the invention are particularly suitable for the controlled nourishment of agricultural plants, such as cereals, maize and sun-
35 flower.



- 7 -

In case of cereals the compositions are employed about the end of the period when the plants grow thick (in the F-g and J stage according to Keller-Baggiolini), in an amount of 7 to 15 lit./ha, using 50 to 80 lit/ha. of tank mixture in the case of cereal application and 200 to 350 lit./ha of tank mixture in the case of ground application. Treatment is preferably combined with the application of fungicides and insecticides. If desired, the treatment is repeated, immediately after the appearance of the second nodus of the plant (stage J according to Keller-Baggiolini). 20 to 30 mass parts of the N-fertilizer required is applied in autumn, while the remaining portion in spring, top dressing is repeated 2-3-times.

In the case of short-stem wheat varieties 5-12 lit./ha., for intermediate stem lengths 7-14 lit./ha., for high lengths 8-15 lit./ha. doses are employed by air, applying 50 to 80 lit./ha. of spray on the plants. Ground application is also possible. The treatment improves the stem strength.

If the stems are short, the culture is thin (below 500 plants/m²) and under dry weather conditions no second treatment is necessary, otherwise it is advisable to repeat the treatment. A nutrient supply corresponding to the level of crop yield of the culture treated and a balanced nitrogen supply should be ensured.

If herbicides with a hormone effect are employed, the herbicidal treatment should be carried out 8 days before or after the application of the regulator. In the latter case, about 70 % of the prescribed dose should be employed.

In maize cultures, on soils having a good nutrient level the treatment should be carried out on 60 to 100-cm. plants, in a dose of 6-14 lit./ha., using 250 to 350 lit./ha. of tank mixture by air or 50 to 80



- 8 -

lit./ha. on the ground.

If the area is deep, with internal water and the soil is impermeable, maize should be treated in a 60-80-cm. stage, in a dose of 4-14 lit./ha., preferably
5 6 lit./ha.

A nutrient supply corresponding to the crop yield level of the treated culture and a balanced nitrogen supply should be ensured. The number of stocks is about 65-120000 pieces/ha., depending on the required
10 level of crop yield and the moisture. 0 to 40 parts of the required nitrogen fertilizer is applied in autumn, and the remaining part in spring, in one or two portions. Top dressing is also performed.

When choosing the most suitable variety and
15 hybrid, those tolerating a more dense cultivation are preferred.

Sunflower is treated in a 10-12-leaf stage (50-60 cm) by ground or aerial technique, using 250-350 lit./ha. and 50-80 lit./ha. of tank mixture, respectively, as follows:
20

In case of hybrids with a short stem length 6-10 lit./ha., for intermediate stem lengths 8-10 lit./ha. and for long-stem plants 10-15 lit./ha. doses of the composition are applied.

25 A nutrient supply corresponding to the level of crop yield of the culture treated and a balanced nitrogen supply should be ensured. The total amount of nitrogen fertilizer required is applied in spring.

The denseness of the plants should exceed
30 the conventional value by 10 to 25 %, depending on the



- 9 -

crop yield required. Accordingly, varieties and hybrids tolerating a more dense cultivation are preferred.

The following technological conditions are required:

- 5 - nutrient supply (macro- and microelements) corresponding to the desired crop yield, in a suitable quantity, quality, variety and timing;
- 10 - deep fertilization, due to deep roots of plants;
- in case of maize and sunflower a 20-30 % increase of plants, already at seeding, in case of cereals control of the period when the plants grow thick;
- 15 - a proper selection of row and stock distance, since shorter plants require a smaller cultivation area;
- motorization corresponding to the altered technology.

20 Under the above conditions the average crop yields are increased by about 20-40 % related to the control, and the nutritive value of the plants remains unchanged or even improves.

25 The increase of crop yields and the improvement of the quality of the crop is due to the following factors:

- increase of the stamina of plants (resistance to lodging and stem-breaking);
- 30 - increase of drought tolerance, increase of the root surface and the depth of growth, acceleration of the mechanism of the respiratory holes;
- elimination of the harmful side-effects of nitrogen excess (loosening of tissues, lodging, susceptibility to plant diseases, etc.) as
- 35



- 10 -

- a result of which the crop yield increasing and quality improving effects of nitrogen can be made use of;
- 5 - the treated plants show and improved resistance to impermeable soils, which are temporarily covered by water;
 - due to the substantial root remedies the humus content of the soil can be preserved or even increased;
 - 10 - by improving the nutrient uptake capacity of the plants the nutrient supply can also be increased;
 - the resistance to facultative parasites causing necrosis is increased (e.g. various fungi);
 - 15 - due to morphological grounds the plants show an increased resistance to maize moth;
 - the quality and value of the products (e.g. beakery value, protein content, etc.) are substantially improved;
 - 20 - nutrients can be better absorbed through leaves;
 - a more balanced plant culture is obtained;
 - the energy required to keep the treated plants in life is lower than usual;
 - 25 - the efficiency of the photosynthesis is improved.

The results obtained by the cultivation technology according to the invention and the specific tech-
30 nological steps are set forth in the following tables.



- 11 -

Table 1
Change of the nutritive value of wheat 8-10 days after treatment on soils with a good and medium supply expressed in the average of 3 years

Treatment	N	P	K	Na	Mg	Ca	Cu	Fe	Mn	Zn	B	SO ₄
Control	-	-	-	-	-	-	-	-	-	-	-	-
2-chloro-ethyl-phosphonic acid corresponding to the amount in the composition of Example 3	strong decrease	decrease	strong decrease	strong increase	in-crease	de-crease	very strong decrease	strong decrease	de-crease	strong in-crease	decrease	strong decrease
in the leaves												
in the roots	slight in-crease	slight in-crease	slight in-crease	strong in-crease	in-crease	slight in-crease	constant	constant	de-crease	in-crease	increase	constant
Composition of Example 3 in a dose of 9 lit./ha.	constant	slight in-crease	constant	medium	in-crease	constant	slight de-crease	constant	slight de-crease	in-crease	constant	constant
in the leaves												
in the roots	in-crease	slight in-crease	medium in-crease	in-crease	in-crease	in-crease	medium in-crease	increase	in-crease	in-crease	increase	increase



Table 2. The unconventional parameters in the cultivation of the most important culture plants

technological measures and parameters	Wheat		Maize		Sunflower	
	I	T	I	T	I	T
stocks number/ha.	-	-	50-80	65-120	35-55	50-80
ear number (p/acre)	400-600	600-950	-	-	-	-
fertilization quantity related to the conventional	grows		grows		grows	
fertilization in autumn (%)	60-70	20-30	60-75	0-40	40	-
in spring (%)	30-40	70-80	30-40	100-60	60	100
spring fertilization (top dressing: number of starter fertilization)	1-2	3	1	2	1	1
use of composition	once	1-2 times	-	once	-	once
stage of application	II-M ^x	F-G J és K-L	-	5-10 leaf stage	-	4-9 pair of real leaves

Remarks: 1) I = known technology

T = according to the invention

2) x = phenological Keller-Baggiolini Rev. romande Agric. Vitic Arboric. 1954. 10/3/ 17-30

3) the limits depend also on the technology, plant variety, soil.

- 13 -

The biological results obtained according to the invention are further illustrated by the following Examples.

5 Preparation of compositions

Example 1

An aqueous suspension containing the necessary additives in addition to the active ingredients is prepared. The composition is generally applied by plane
10 or ground technique, in 50 and 300 lit. of water, respectively. When applied as a tank mixture the composition can be supplemented with urea. The volume weight of the composition is adjusted to 1.65-1.70.

15	Components	Concentration (v/w %)	
		in the composition	in a tank mixture (ground application)
20	Zn	0.128	0.0060
	B	0.024	0.0008
	Cu	0.145	0.005
	Mg	0.145	0.005
	Fe	0.210	0.008
25	2-chloroethane-phosphonic acid	0.500	0.025
	elementary sulfur	66.600	2.360
	urea	-	1.260
	ethyleneglycol	3.600	0.13
30	Ultrasin NA	1.8	0.06
	Rodopol 23	0.12	0.0044
	Tensiofix XN6	0.54	0.020



- 14 -

To prepare 1 lit. of the above composition 8.4 g. of citric acid and 25 ml. of a 96 % acetic acid are employed. 2-chloroethane-phosphonic acid is added to the solution after the addition of the complex-forming acids, whereupon the pH of the solution is adjusted to 2-2.5 by ammonium hydroxide. Thereafter sulfur is added in a crude disperse form, followed by the addition of the further additives, and the final volume is made up to 1 lit. The obtained crude dispersion is dispersed in a colloidal mill or any other wet milling equipment until the grain size of sulfur is suitable.

Example 2

An aqueous suspension having the following composition is prepared:

Components	Concentration (v/w %)	
	in the composition	in a tank mixture (ground application)
Zn	1.15	0.03
B	0.38	0.01
Cu	1.15	0.03
Mg	0.72	0.02
Fe	1.18	0.035
2-chloroethane-phosphonic acid	15.20	0.500
elementary sulfur	-	2.400
urea	-	1.200
Ultrasin NA	-	0.23
Tensiofix XH6	-	0.002
volume weight:	1.31	



- 15 -

First the citric acid/acetic acid complexes of the microelements are prepared as described in Example 1. Instead of the salts of the microelements zinc and iron an equivalent amount of Sequestren Na_2Zn (powder, chelate
 5 formed with ethylenediamine-tetraacetic acid, containing 6 mass % of zinc) or Sequestren 330 Fe (containing 10 mass % of iron) in the form of ethylenediamine-tetraacetic acid chelate, Ciba Geigy, Switzerland) can also be employed. Thereafter 2-chloroethane-phosphonic acid
 10 is added to the composition, and the pH is adjusted to 2.1 by ammonium hydroxide. To the tank mixture the necessary amounts of sulfur (Sulfur 900 FW) and urea are added.

Example 3

15 An aqueous suspension having the following composition is prepared:

Components	Concentration (w/w %)	
	in the composition	in a tank mixture (ground application)
20 Zn	0.81	0.023
B	0.08	0.0023
Cu	0.54	0.015
25 Fe	0.63	0.020
2-chloroethane-phosphonic acid	7.23	0.21
elementary sulfur	31.60	0.90
Mg	0.54	0.015
urea	-	0.17
30 Ultrasin NA	6.9	0.17
Rodopol 23	0.47	0.13
Tensiofix XN6	1.0	0.28
volume weight:	1.3	



- 16 -

To prepare 1 lit. of the above composition 150 ml. of water are added to 456 ml. of an aqueous sulfur suspension, whereupon the citric acid/acetic acid complexes of the microelements are prepared as described in Example 1. As a complexing agent 26.5 g. of citric acid, 80 ml. of a 96 % acetic acid and 12.1 g. of ethylenediamine-tetraacetic acid-sodium are employed. Instead of the salts of iron and zinc the Sequestren compositions given in Example 2 may also be used. To the composition obtained 94.1 g. of 2-chloroethane-phosphonic acid are added, and the pH of the suspension is adjusted to 2,1-2,4 with aqueous ammonium hydroxide. The volume of the suspension is made up to 1 lit. with water, and in case of tank mixture the necessary urea is added separately.

Example 4

An aqueous dispersion of the following composition is prepared:



- 17 -

Components	Concentration (w/w%)	
	in the composition	in a tank mixture (ground application)
5		
Zn	0.58	0.015
B	0.16	0.004
Cu	0.42	0.011
Mg	0.65	0.020
10 Fe	0.50	0.013
2-chloroethane-phosphonic acid	12.20	0.330
elementary sulfur	8.13	0.91
urea	16.30	1.20
15 Ultrasil NA	7,3	0.17
Rodopol 23	0.5	0.13
Tensiofix XN6	1.05	0.28
volume weight: 1.23		

20 To prepare 1 lit. of the above composition 250 ml. of water are added to 110 ml. of an aqueous sulfur suspension, followed by the addition of the citric acid/ acetic acid complexes of the microelements. As a complexing agent 21 g. of citric acid, 64 ml. of a 96 % acetic

25 acid and 8.8 g. of ethylenediamine-tetraacetic acid-Na are employed. Thereafter 150 g. of 2-chloroethane-phosphonic acid is added, and the pH is adjusted to 2.0-2.1 by aqueous ammonium hydroxide. To the composition 200 g. of urea are added, and it is made up to 1 lit. with

30 water.

To a tank mixture sulfur and a further portion of urea are also added to ensure the required concentrations.



- 18 -

Example 5

An aqueous dispersion having the following composition is prepared:

5	Components	Concentration (w/w %)	
		in the composition	in a tank mixture (ground application)
	Zn	0.57	0.015
10	B	0.13	0.004
	Cu	0.41	0.011
	Mg	0.64	0.020
	Fe	0.49	0.013
15	2-chloroethane-phosphonic acid	-	0.33
	elementary sulfur	8.00	0.91
	urea	-	1.20
	Ultrasin NA	4.80	0.12
	Rodopol 23	0.50	0.013
20	Tensiofix XN6	1.04	0.028
	volume weight: 1.25		

To prepare 1 lit. of the above composition 250 ml. water are added to 110 ml. of an aqueous sulfur suspension, and the salts of the microelements are dissolved in the suspension obtained. The salts of the microelements are converted into the corresponding complexes by ethylenediamine-tetraacetic acid-Na. The pH is adjusted to 6.5 to 7.0 by hydrochloric acid of technical grade.

To prepare a tank mixture to the necessary amount of 2-chloroethane-phosphonic acid the above suspension is added, followed by the addition the necessary amounts of colloidal sulfur and urea. The pH of the tank mixture is about 4.5.



- 19 -

Biological ExamplesExample 6

The composition according to Example 3 was employed to increase the crop yield of autumn wheat.
5 4-9 lit./ha. doses of the composition were applied to the plants in the stage F-G and J, by spraying twice.

Phosphorus and potassium fertilizers should be applied in autumn, in an amount corresponding to the desired crop yield. In fields where the Zn and Cu concentration of soil is low, these and if desired, further
10 microelements should be supplemented by a single fertilization, in an amount corresponding to the desired crop yield. If the Zn and Cu concentration is extremely low, they can be supplemented also in spring by leaf-fertilization.
15 zation.

About 20 to 30 % of the nitrogen corresponding to the desired crop yield should be applied to the fields as a basis-fertilizer. After papilionaceae this treatment can be omitted, while after maize and sunflower the nitrogen amount required to decompose the remaining organic
20 materials is advantageously added in autumn.

On impermeable and sandy soils, to avoid denitrification and washing off, nitrogen is preferably applied in the autumn, in the form of urea. (nitrogen
25 stabilizers are preferably also employed, e.g. N-Serve, DOW Chemical, USA).

The nutrient supply of the deeper layers of soil and deep fertilization are of utmost importance. It is further important that the desired crops yields can be
30 increased by 10 to 30 %, preferably 20 to 25 % related to the usual levels. On good soil having a high nutrient concentration, when a variety providing a good crop yield is selected, even a yield of 10 tones/ha. can be achieved for 950 stocks/m².

35 The remaining portion of nitrogen fertilizer



- 20 -

is applied in spring, as a top dressing. The first top dressing should be carried out several days before the start of the spring vegetation, depending on the number of stocks which have lived through the winter and the
5 nitrogen supply of the soil:

- in a thin culture (3-4.5 millions of stocks/ha.) about 40 to 45 % of the total calculated nitrogen amount should be applied, depending on the nitrogen supply of the soil;
- 10 - at a stock number of 4.5 to 6.0 millions/ha. 35 to 40 % of the total nitrogen demand should be applied;
- over a stock number of 6.0 millions/ha. 30-36 % of the calculated nitrogen demand
15 should be applied to the plants.

The first chemical treatment with a composition according to Example 3 should be carried out in the E-G stage according to Keller-Baggiolini, after the first top dressing, using 7-12, preferably 9.0 lit./ha. of the
20 composition (or a corresponding amount of active ingredients). The composition can be applied to the plants by ground or areal technique as well, using 200-300 and 50-90 lit./ha. tank mixture, respectively.

The second top dressing is performed in the
25 stage I of the wheat development according to Keller-Baggiolini, before the second chemical treatment. By this second top dressing the remaining portion of the total nitrogen amount required is applied.

The second chemical treatment can be carried
30 out directly after the appearance of the second nodus of wheat, when the small, opened ear of corn is about 1.5-2.0 cm. (according to Keller-Baggiolini in the J stage of wheat development) 4-9, preferably 5 lit./ha. doses are employed.

35 For varieties with a short stem length only



- 21 -

the first treatment is necessary.

For varieties with a medium stem length, over 600 ear/m², in rainy weather, for rich soil with a good nitrogen supply two chemical treatments are necessary.

5 In case of varieties with a long stem length the second chemical treatment should be omitted only in extrem drought. The composition should be applied by air, using 50-90 lit./ha. of a tank mixture but ground techniques can also be employed.

10 It is very advantageous to carry out this treatment directly after a bigger rainfall.

The third top dressing is carried out in the K-L stage of the development of wheat (Keller-Baggiolini); taking into account the nitrogen supply, denseness and
15 crop yield about 30-35 kg./ha. of nitrogen are employed, over the calculated value, if the nitrogen supply of the soil is not satisfactory for some reason.

The plant protection is carried out according to modern agricultural techniques, corresponding to the
20 situation and the number of weeds. If a hormon-like herbicide is employed, the chemical weed-killing is performed 7 days before or after treatment with the composition according to Example 3. If the herbicide treatment is carried out after the treatment with the composition
25 of Example 3, about 70 % of the usual herbicide dose should be employed.

Protection against pathogenes, in particular mildew, fusarium and rusts should be carried out with special care. On fields, where wheat is cultivated in more
30 subsequent years, a Benomyl-containing tank mixture or any other fungicide generally used for this purpose should be employed, when the plants grow thick.

The necessary fungicide and insecticide treatments can be carried out simultaneously with the composition of Example 3. It is, however, advisable to inves-
35



- 22 -

tigate before admixture, whether the various components are freely admissible.

The results are illustrated in Table 3.

5

Table 3

Increase in crop yields of autumn wheat

Variety	Treated		Control	
	area (ha)	average crop yield (tones/ha)	area (ha)	average crop yield (tones/ha)
Száva	3+3	7.23	3+3	6.10
GK-Szeged	3+3	7.30	3+3	5.60

15

Example 7

The composition according to Example 3 was employed to increase the crop yield of autumn barley. The barley was treated in the stages F-G and J, using the prescribed doses.

20

The P and K fertilizers were applied in an amount corresponding to the desired crop yield, as a basic fertilizer. On fields, where the soil has a low Zn and Cu concentration, these and further necessary micro-elements should be supplemented, simultaneously with the basic fertilization, in an amount harmonized with the desired crop yield. If the soil has a great Zn and Cu deficiency, the demand of plants can be met in spring-time, in the form of leaf-fertilization.

25

20-30 % of nitrogen necessary to achieve the desired crop yield is applied also as a basic fertilizer. After papilionaceae this treatment can be omitted, but after maize or sunflower a nitrogen amount required to decompose the remaining organic materials, should also be added in autumn.

30

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- 23 -

On impermeable or sandy soils, due to the danger of denitrification and washing off, nitrogen is preferably applied in autumn, in the form of urea (the use of nitrogen stabilizers, e.g. N-Serve, DOW Chemical, USA is advisable).

The deeper layers of soil should preferably have a good nutrient supply, which can be improved by deep fertilization. In this manner crop yields exceeding the conventional results by 10-30 %, preferably 20-35 % can be achieved. On rich soils, using carefully selected varieties, ensuring a good yield, even crop yields exceeding the above limits can be achieved.

The remaining portion of nitrogen is applied in spring, as a top dressing.

The first top dressing should be carried out several days before the start of the spring vegetation, depending on the number of stocks which have lived through the winter, and the nitrogen supply of the soil:

- in a thin culture (3-4.5 millions of stocks/ha.) about 40-45 % of the total calculated nitrogen amount should be applied, depending on the nitrogen supply of the soil;
- at a stock number of 4.5 to 6.0 millions/ha. 35 to 40 % of the total nitrogen demand should be applied;
- over a stock number of 6.0 millions/ha. 30 to 36 % of the calculated nitrogen demand should be applied to the plants.

The first chemical treatment with a composition according to Example 3 should be carried out in the E - G stage according to Keller-Baggiolini, after the first top dressing, using 8-12, preferably 8-9 lit./ha. of the composition (or a corresponding amount of active ingredients). The composition can be applied to the plants by ground technique or by air as well, using 200-300 and



- 24 -

50-90 lit./ha. tank mixture, respectively.

The second top dressing is performed in the I stage of barley development, according to Keller-Baggiolini, before the second chemical treatment. By this
5 second top dressing the remaining portion of the total nitrogen amount required is applied.

The second chemical treatment with the composition according to Example 3 is carried out directly after the appearance of the second nodus of barley, when
10 the small, opened ear of corn is about 2.0 to 2.5 cm (stage J according to Keller-Baggiolini). 4-10, preferably 5-6 lit./ha. doses are employed, using 50 to 90 lit./ha. of tank mixture when applied by air.

When spraying the soil should be humid enough.
15 It is therefore advantageous to carry out the treatment after a bigger rainfall.

The third top dressing is carried out in the K-L stage of development (Keller-Baggiolini); taking into account the nitrogen supply, denseness and crop yield
20 about 30-35 kg./ha. of nitrogen are employed, over the calculated value, if the nitrogen supply of the soil is not satisfactory for some reason.

Plant protection is carried out according to modern agricultural methods, corresponding to the situa-
25 tion and the number of weeds.

If a herbicide is employed, the chemical weed-killing is performed 7 days before or after the treatment with a composition according to Example 3. If the herbicide treatment is carried out after the treatment with the composition of Example 3, about 70 % of the usual herbicide dose
30 should be employed from a hormon-like herbicide.

Protection against pathogenes, in particular mildew should be carried out with special care.

The necessary fungicide and insecticide treat-
35 ments can be carried out simultaneously with the chemical



- 25 -

treatments. It is, however, advisable to establish before admixture, that the various components are freely admiscible.

The results are shown in Table 4.

5

Table 4

Increase in crop yields of autumn barley

Variety	Treated		Control	
	area (ha)	average crop yield (tones/ha)	area (ha)	average crop yield (tones/ha)
early "Kompolti"	3+3	8.50	50	6.20 ^x

15

x = barley has shown a strong lodging

Example 8

A composition according to Example 3 was employed to increase the crop yield of maize. Maize was treated with a 9 lit./ha. dose of the composition in a 10-leaf stage. The number of stocks was adjusted to 65000-120000/ha.

The crop yield can be adjusted to 7-17 tones, depending on the stock number, variety or hybrid, fertility of the soil and the employed cultivation technology.

As a basic fertilizer P and K fertilizers are used in an amount, corresponding to the desired crop yield. They are applied in autumn. On fields with a medium Zn and Cu supply or a low Zn and Cu concentration due to the N-Cu and P-Zn ion antagonism, Zn and Cu is supplemented parallel with the basic fertilization.

0-40 % of the total N-demand should be applied as a basic fertilizer, either in the form of urea



- 26 -

or as ammonium nitrate. (On the basis of soil investigations also other nitrogen fertilizers can be employed.) After maize or sunflower it is advisable to carry out a basic fertilization with nitrogen in autumn.

5 Deep fertilization has an important role, too.

The remaining portion (100-60 %) of the nitrogen fertilizer can be applied in one portion, in spring. To ensure a continuous nitrogen supply nitrogen stabilizers (e.g. N-serve) are preferably employed.

10 It is advisable to apply the spring nitrogen in two portions, a larger portion before sowing and the remaining portion when the maize plants are 50-70 cm. high.

15 Maize is treated with the composition according to Example 3, taking into account the type of the soil, the nutrient supply of soil, plant variety or hybrid, stock number and the desired crop yield, in a dose of 5-12 lit./ha., preferably 6-8 lit./ha., in a 5-10-leaf stage.

20 The treatment is always combined with the use of a 46 % urea, in an amount of 5 kg./ha.

Treatment can be performed by air or by ground techniques. The uniform distribution is an important requirement.

25 The results obtained are illustrated by Table 5.

Table 5

Increase in the crop yield of maize

Variety	Treated		Control	
	area (ha)	average yield (tones/ha.)	area (ha)	average yield (tones/ha.)
MV-580	0.5	8.20	1.0	6.40 ^x
U-530	0.5	9.20	1.0	8.40

35 x = seriously infected with Fusarium



- 27 -

Example 9

The composition according to Example 3 was used to increase the crop yield of sunflower. 50-60-cm. sunflower plants were sprayed with a dose of 11 lit./ha.

5 Stock number is adjusted to 50000-80000/ha.

The desired crop yield can be between 2.5 and 4.5 tones, depending on the stock number, variety or hybrid, fertility of the soil and the cultivation technology employed.

10 Basic fertilization (P and K) is applied in autumn, in an amount corresponding to the desired crop yield.

As a spring basic fertilizer nitrogen is applied in a dose of 80-150 kg./ha. of active ingredient, 15 depending on the nitrogen supply of the soil and the desired crop yield. If nitrogen supply is poor or the desired crop yield is high, 150 kg./ha. amounts are used.

On impermeable soils nitrogen is preferably employed in the form of urea or as ammonium nitrate.

20 Chemical treatment with the composition according to Example 3 is performed on 50-60 cm. high sunflower plants (4-9 pairs of developed leaves), in a dose of 5-11 lit./ha. by air or by ground technique. It is important to ensure a uniform distribution of the tank 25 mixture.

Treatment is carried out by applying nitrogen in an amount of 5 kg./ha., preferably in the form of urea and 1-2 lit. of a sulfur composition in the form of sulfate (e.g. Fitohorm 325) or 2 kg. or lit. or a composition 30 containing elementary sulfur, simultaneously in the form of a tank mixture.

The results are set forth in Table 6.



- 28 -

Table 6
Increase in the crop yield of sunflower

Variety	Treated		Control	
	area (ha)	average yield (tones/ha.)	area (ha)	average yield (tones/ha.)
Sorem 80	3	2.40	60	1.70
	2+2	2.60	6	1.80

Example 10

The composition according to Example 5 was used to increase the crop yield of autumn barley. Plants were treated in the stages F-G and J, with a dose of 10 lit./ha. twice. Otherwise the procedure described in Example 7 was followed. The results obtained are summarized in Table 7.

Table 7
Increase of crop yield of autumn barley

Variety	Treated		Control	
	area (ha)	average yield (tones/ha.)	area (ha)	average yield (tones/ha.)
"Kompolti" early	100	6.60 ^x	6	5.20 ^x

x = the control plants lodged in the middle of May,
the treated ones at the beginning of June

Example 11

The composition according to Example 5 was employed to increase the crop yield of autumn wheat. Száva and GK-Szeged varieties were treated in a dose of 2 x 8 lit./ha., Partizanka in a dose of 2 x 9 lit./ha., MV-8 first with a dose of 9 lit./ha. and then 8 lit./ha., in



- 29 -

stages F-G and J. Otherwise the procedure described in Example 6 was followed. The results are shown in Table 8.

Table 8

5 Increase in crop yield of autumn wheat

10	Variety	Treated		Control	
		area (ha)	average yield (tones/ha.)	area (ha)	average yield (tones/ha.)
	Száva	43	8.20	104	6.80
		35	8.80	1	6.90
		16	8.50	2	5.80 ^x
	GK-Szeged	8	8.30	40	7.10
15	Partizánka	11	7.30	8	5.40
	MV-8	32	7.25	17	5.20
		3 + 3	9.50	6	6.80 ^x

x = the plants lodged in early May.

20

Example 12

The composition according to Example 3 was employed to increase the crop yield of maize. Maize plants were treated in a 10-leaf stage, using a 12 lit./ha. dose.

25

Otherwise the procedure described in Example 8 was followed. The results obtained are shown in Table 9.

Table 9

Increase in crop yield of maize

30	Variety	Treated		Control	
		area (ha.)	average yield (tones/ha.)	area (ha.)	average yield (tones/ha.)
35	Pionir 3709 ^x	3+3+3	9.70	31	8



- 30 -

Table 9
(continuation)

Variety	Treated		Control	
	area (ha.)	average yield (tones/ha.)	area (ha.)	average yield (tones/ha.)
5	3+3+3	9.70	111	8.90
	3+3+3		71	
10 Pionir 3780	3	8.80	6	8.20
U-530 ^x	1+1	9.60	42	9.10
JX-92	1+1	10.30		9.60
Pionir 3732	3+3	13.40	57	10.40

x = harvesting with combine

Example 13

By the composition according to Example 3
 20 50-60 cm. sunflower plants were treated in a dose of
 11 lit./ha. Otherwise the procedure described in Example
 9 was followed. The results obtained are shown in Table
 10.

Table 10

25 Increase in crop yield of sunflower

Variety	Treated		Control	
	area (ha.)	average yield (tones/ha.)	area (ha.)	average yield (tones/ha.)
30 NSH-27	2+2	2.70	20	1.80
	2+2	2.40	28	1.70
Iregi striped	1+1	2.60	40	1.90

35



- 31 -

Example 14

Autumn wheat was treated with the composition according to Example 5 in a stage defined in the previous examples. For comparison in a test only 2-chloroethane-phosphonic acid was employed, in a dose corresponding to the composition according to Example 5. The results obtained are shown in Table 11.

Table 11

10 Effect of a composition according to the invention on the increase in crop yield of autumn wheat

Treatments	Dose (lit./ha.)	Time of spraying		Average crop yield (tones/ha.)
		1.	2.	
15 Control	-			6.7
2-chloroethane-phosphonic acid	3.0	April 3	May 6	6.6
composition according to Example 5	9.0	April 3	May 6	7.6
20				

Example 15

The growth of maize was examined under the effect of 2-chloroethane-phosphonic acid alone or in a composition according to Example 5. The results obtained are shown in Table 12.



- 32 -

Table 12

Effect of a composition according to the invention on
the growth of maize

5	Treatments	Dose (lit./ha.)	Time of spraying	Average crop yield (tones/ha.)	Remark
	Control	-	-	9.6	
10	2-chloroethane- phosphonic acid	3.0	June 18	9.8	the stock number was 105 thousands when using the composi- tion of Example 5 and 85 thousands for the control
15	Composition of Example 5	11.5	June 18	11.9	

The trial was performed on plots of 3 hectares,
20 in one repetition.

Example 16

The effect of the composition according to
Example 4 on the crop yield of sunflower was compared to
25 the effect of an equivalent dose of 2-chloroethane-
-phosphonic acid. Sunflowers were sprayed with the cor-
responding compositions in a stage described in the pre-
vious example. The results obtained are shown in Table 13.



- 33 -

Table 13

The effect of a composition according to the invention
on the crop yield of sunflower

5	Treatments	Dose (lit./ha.)	Time of spraying	Average crop yield (tones/ha.)
	Control	-	-	18.5
10	2-chloroethane- phosphonic acid	3.0	June 14	20.4
	composition of Example 4	8.0	June 14	24.6

The trials were performed on plots of 3 hectares, in two repetitions.



- 34 -

Claims

1. Composition for controlled nourishing of agricultural plants, in particular cereals, maize and sunflower and for the intensification of their cultivation, which comprises in an aqueous solution or suspension a combination of
- 5
- a) 0.1 to 80 % by mass of a mixture of meso- and microelements in the form of the complexes of their salts, expressed in elements, which contains at least
- 10
- 5.10⁻³ % by mass of zinc,
5.10⁻⁴ % by mass of bor,
1.10⁻³ % by mass of copper,
15 1.10⁻³ % by mass of magnesium,
1.10⁻³ % by mass of iron,
1.10⁻¹ % by mass of finely divided sulfur;
- b) 0.01 to 25 % by mass of 2-chloroethane-phosphonic acid or esters or salts thereof; and
- 20 c) 1.0 to 20.0 % by mass of urea,
in a total amount of 1.0 to 95.0 % by mass, in admixture with additives suitable for the flotation and/or dispersion of the solid phase and wetting agents.
2. A composition according to claim 1, which comprises as complexes of the salts of microelements metal chelates, preferably monochelates.
- 25
3. A composition as claimed in claim 1 or claim 2, which comprises chelates prepared from microelement salts by citric acid, acetic acid, glycine, ethylenediaminetetraacetic acid or salts thereof, nit-
30 rilotriacetic acid and/or mixtures thereof.
4. A composition as claimed in claim 1, in which the pH of the aqueous composition is below 4.0.
5. A composition as claimed in claim 1, in
35 which the grain size of the finely divided sulfur is



- 35 -

below 5 microns.

6. A composition as claimed in claim 1, in which the additives suitable for dispersing are acidic and preferably are alkylbenzenesulfonic acid salts, 5 alkylphenol-polyglycol ethers or ethyleneoxide-propylene-oxide condensates.

7. A process for the controlled nourishment of agricultural plants, preferably cereals, maize and sunflower and for the intensification of their cultivation, which comprises treating the agricultural plants 10 with a composition according to any one of claims 1 to 6, in the vegetative phase, in a determined stage of development, adding nitrogen and carrying out a fungicidal treatment simultaneously with or prior to the chemical 15 treatment, if desired, increasing the stock number of the plants to be cultivated and dividing the total quantity of nitrogen fertilizer to more portions and optionally carrying out a deep fertilization.

8. A process as claimed in claim 7 for the 20 cultivation of wheat or autumn barley, in which 20-30 mass parts of the nitrogen fertilizer to be employed are added in autumn, while the remaining part is applied in spring, top dressing is repeated two-three-times, plants are treated with any one of the compositions 25 according to claims 1 to 6 in a stage E-G and J (according to Keller-Baggiolini) once or twice, preferably in combination with a fungicidal and insecticidal treatment.

9. A process as claimed in claim 7 for the 30 cultivation of maize, in which 0-40 mass parts of the nitrogen fertilizer are applied in autumn and the remaining portion in spring, the stock number is increased to 65-120 thousand/ha., top dressing is carried out and maize is treated with a composition according to any 35 one of claims 1 to 6 in a 5-10-leaf stage.



- 36 -

10. A process as claimed in claim 7 for the cultivation of sunflower, in which the total amount of the nitrogen fertilizer is applied to the soil in spring, the stock number is increased by 10-25 % and
5 the plants are treated with composition according to any one of claims 1 to 6 in a stage, when they have 4 to 9 pairs of leaves.



INTERNATIONAL SEARCH REPORT

International Application No PCT/HU83/00008

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC		
A01N 59/20, A01N 57/20, A01N 25/04, A01B 79/02, A01N 55/02		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
IPC ³	A01N 25/00, 25/02, 25/04, 25/06, 25/30, A01N 57/00, 57/10, 57/12, 57/18, 57/20, A01N 59/00, 59/02, 59/06, 59/14, 59/16, 59/20, A01G 21/00, A01B 79/00, 79/02, A01N 55/02	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category ⁶	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
A	GB, A, 1554928 (ROBERT ERIC HOLM and HAN SAN KU), 31 October 1979 (31.10.79)	1
A	SU, A, 824927 (Verner Kochmann et al), 30 April 1981 (30.04.81)	1,8
A	"Agrotekhnika vysokoproductivnykh sortov zernovykh kultur", Moscow, "Kolos", 1977, see page 229	9
A	M.F. Stikhin et al "Ozimaya rozh i pshenitsa v Nechernozemnoi polose", Leningrad, "Kolos", 1977, see pages 223-226	8
A	V.D. Golubev "Primenenie udobreny na oroshaemykh zemlyakh", Moscow, "Kolos", 1977, pages 154-156	10
¹⁵ Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "A" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search ¹	Date of Mailing of this International Search Report ²	
28 April 1983 (28.04.83)	27 May 1983 (27.05.83)	
International Searching Authority ¹	Signature of Authorized Officer ²	
ISA/SU	(L. Komarova)	