

Introduction 11

2. humic acid in the crop farming 13
 - 2.1. Situation of the use of humic acid in the world 13
 - 2.2. General statements to humic acid 15
 - 2.3. Classification of the humic acid and organization of their parliamentary groups 16
 - 2.4. Molecular characteristic of the humic acid 18
 - 2.5. Production of humic acid 19
 - 2.5.1. Raw materials for the extraction of humic acid and the production of humate 20
 - 2.5.2. extraction methods 22
 - 2.6. humate on basis of the humic acid and their characteristics 24
 - 2.7. Effect of the humic acid 26
 - 2.7.1. Effect on the fertility of grounds and their nutrient availability 27
 - 2.7.2. Effect on growth and the development of the plants 29
 - 2.7.2.1. Effect on physiological processes of the plants 30
 - 2.7.2.2. effect on the nutrient admission of the plants 33
 - 2.7.2.3. effect on the vitality of the plants 36
 - 2.7.2.4. effect on the productivity of the plants 37
 - 2.7.2.5. effect on the internal and outside quality of useful plants 38
 - 2.7.3. Effect of the humic acid on the micro-biological activity 38
 - 2.7.4. The effect of humate in combination with other preparations 39
 - 2.8. Factors of influence on the effectiveness of humic acid preparations 41
 - 2.9. Forms of the practical use of humic acid 44
 - 2.10. Economic and ecological meaning of the employment of humate 46
- 3rd setting of tasks for 47
- 4 material and methods 51
 - 4.1. examined cultivated plants 51
 - 4.2. test set-ups and climatic conditions 52
 - 4.2.1. Greenhouse 52
 - 4.2.2. Climatic chamber 53
 - 4.3. overview to the accomplished attempts 54
 - 4.3.1. attempts with tomato 54
 - 4.3.2. attempts with water spinach 57
 - 4.4. Test ranges 58
 - 4.4.1. Substrate culture 58
 - 4.4.2. tank culture 59
 - 4.4.3. Aeroponic 60
 - 4.5. in the attempts used substrates 61
 - 4.6. applied preparations 63
 - 4.7. attempt methods 64
 - 4.7.1. Methodology to the humate application 64
 - 4.7.2. nutrient supply 67
 - 4.7.3. general description of the attempt organization 69
 - 4.7.4. Collection of growth parameters 70
 - 4.7.5. Chemical analysis methods 71
 - 4.7.6. Statistic methods 71
5. Results and discussion 73
 - 5.1. Effect of humic acid (humate) on growth and development of Tomato plants (*Lycopersicon esculentum* MILL) 73
 - 5.1.1. Investigation to the influence of humic acid preparations on the germinating process and the development of tomatoes seedlings 73
 - 5.1.2. Investigations to the influence of humate on the development and vitality of the tomato plants with different application way as well as frequency 76
 - 5.1.3. Influence of humate on the development of the tomato plants in the perlite as well as an organic substrate 86
 - 5.1.4. Influence of humate on the development of the tomato plants with en ski those organic substrates 89
 - 5.1.5. Influence of humate on the growth of the tomato plants with a tank culture 96
 - 5.1.6. Influence of humic acid preparations, assigned in combination with an alga preparation (Goemar special) on growth of tomato plants 99
 - 5.1.7. Effect of well and K-humate on the growth of the tomato plants with different application times and different substrates 107

5.1.8.	Influence of different humate on the growth and the development of tomato plants under a suboptimal nutrient supply 114
5.1.9.	Investigations to the impact of humate on the vitality of Tomato plants on stress conditions 118
5.1.9.1.	Effect of the humate at temperature 119
5.1.9.2.	Effect of the humate with a reduction of the root weight 121
5.1.9.3.	effect of the humate with a salt stress 124
5.2.	Results for the investigation of the effect of humate on growth and development of water spinach (<i>Ipomoea aquatica</i> FORSSK) 128
5.2.1.	As well as investigation to the influence of humic acid preparations on the germination and the development of seedlings of the water spinach 128
5.2.2.	Influence of NH ₄ , K and Na-humate on water spinach cultivated aeroponic plant in a Ae 131
5.2.3.	Influence of K and Na-humate on water spinach cultivated in a Aeroponic 134
5.2.4.	Effect of Humisolve and fulvic acid, BioMagic' 138
5.2.5.	Investigations to the influence of humic acid on the development and vitality from water spinach at temperature 146
6	general discussion 151
7	conclusions 157
8	summary 161
	Bibliography 163
	Illustration listing 179
	Table index 185
	Appendix tables 189

Abstract

The aim of the experiment was to investigate the effect of different humic acid in form of liquid

NH₄-Humate and K-humate, extracted from brown coal and coconut-fibre, dry humate and fulvic acid, extracted from Leonardite and dry Na-Humate, extracted from peat on the growth and nutrient uptake of tomato (*Lycopersicon esculentum* Mill) and water spinach (*Ipomoea aquatica* Forssk.).

The experiments were carried out in hydroponic cultivation system; Tomato was cultivated in substrate and water culture, Water spinach in Aeroponic and Water culture. In some experiments concentrations and forms of humic acids (K-, Na- and NH₄-humates) were compared. Moreover the influence of humates on the germination of tomato seeds was investigated and the effect of Humates on plant growth under different stress condition in climate chamber was tested.

Humates were applied to the plants with a concentration from 0.1 till 0.005 % and fulvic acid at dilution 1 to 100 from 8 % fulvic acid. The application of humate was undertaken at different frequency regarding the growth stages and intervals. Fulvic acid was used as foliar and root application at the same frequency.

The following conclusions have been drawn:

- Treatments with Humates showed a positive influence on the germination of seeds especially on water spinach seeds.
- The effect of the humates on the growth of water spinach was more legible than these of tomato.

- Effect of humates on the plant growth depends on their origin, solubility, pH value, the content on active humate and on other substance in it.
- K-humate and fulvic acid had an greater effect compared to Na- und NH₄-humate and other.
- By high concentration or frequency of treatments inhibit the humate the plant growth.
- Humates can be used for leaf and root application or for seed treatment as well. Fulvic acid can be used as leaf- and root application
- The effect from humate under stress condition was more distinct than under optimal growth condition.
- Humates have an influence more on the root than on shoot growth
- The treatment with humates have an Effect on a nutrient uptake of tomato and water spinach plant

Seed Germination

5.2.6. Investigation to the influence of humic acid preparations on the germ ability as well as the development of seedlings of the water spinach In the available experiment the goal existed in it, the influence of the fulvic acid Preparation "Fulvic BioMagic" to examine for the germ ability as well as for the development of seedlings. According to the data of FAUST (1999) and LEVINSKY (1996) should the preparation "Fulvic BioMagic" particularly suitably for the seeds treatment of cultivated plants.

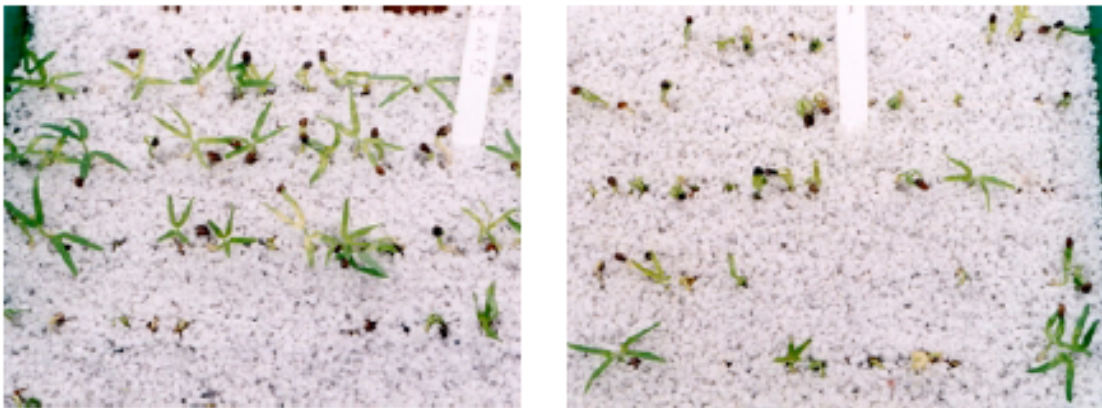


Fig. 5.2.1-1: The difference in the quality of water spinach seedling during a seeds treatment with 0,08% fulvic acid " Biomagic" (left), control (rh) The number of germinated seedlings was also higher than with control, in particular seed with the germ quality A (fig. 5.2.1-2).

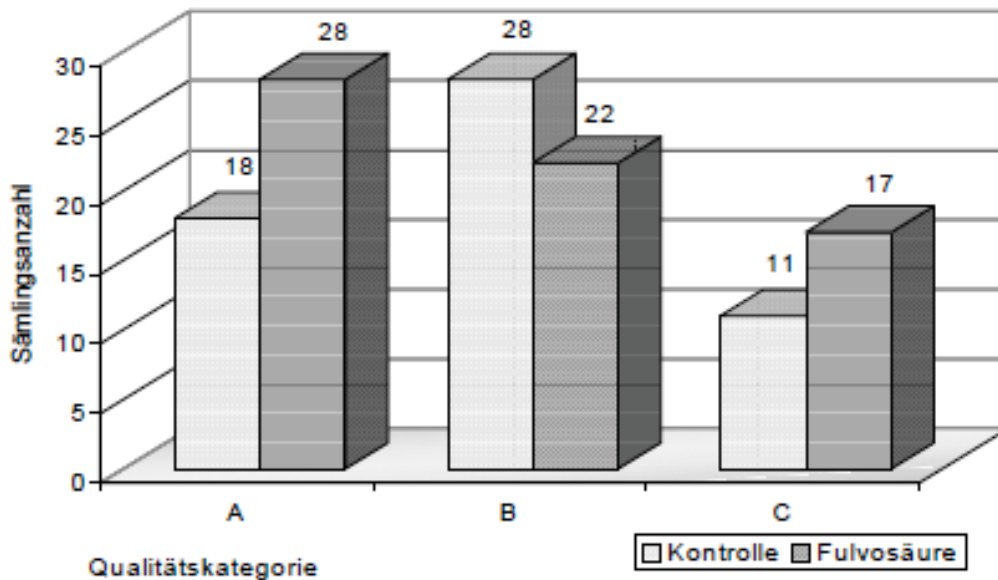


Fig. 5.2.1-2: Number of germinated seeds of water spinach, treated with 0,08% " Fulvic BioMagic", regulatory according to quality category. The illustration 5.2.1-2 shows that fulvic acid solution clearly a positive effect on germinating. The number of seedlings with A quality increased by seeds treatment by 55%, while the increase of the germinated seeds amounted to altogether only 17%. The seeds treatment led both to an improvement of the quality of the seedlings and to one Increase of the number of germinated seeds. Similar result was obtained also with the second attempt (fig. 5.2.1-3). The number of the seedlings with A quality increased by 60% in the comparison with control. The total number of the germinated seeds of the untreated and treated Variant was nearly alike In the second attempt a better germ quality became with same test conditions obtained. It can be accepted therefore that the quality of the seeds was not homogenous. A calibration of the seeds, and/or also different tests regarding its fertility is apparently necessary. In the attempts the seeds not germinated had a very thick seed bowl, thereby the effect of the fulvic acid was obviously impaired.

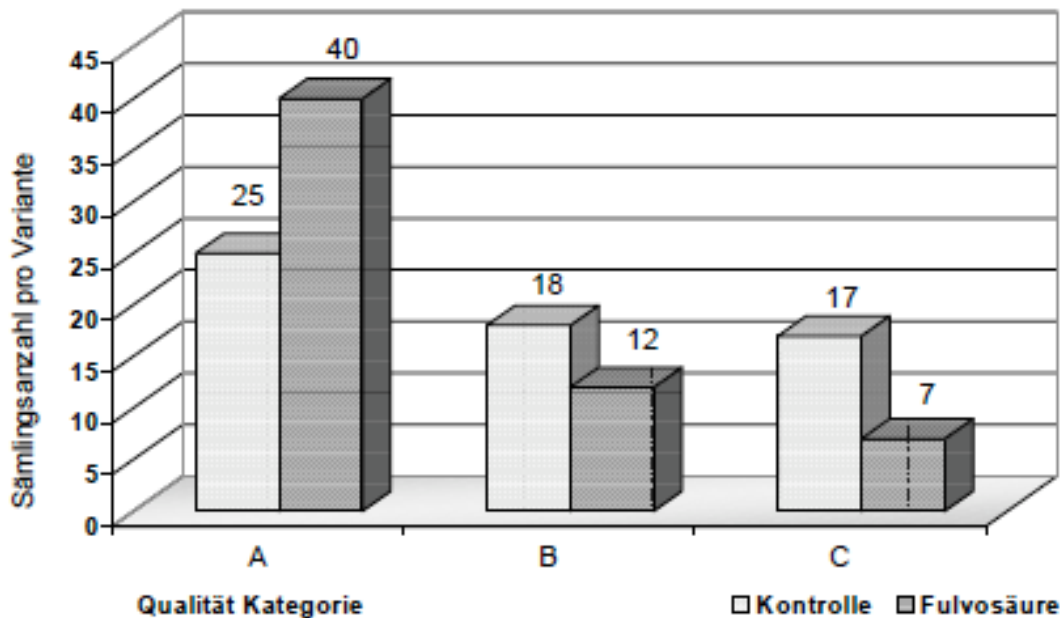


Fig. 5.2.1-3: Number of germinated seeds of water spinach, treated with 0,08% " Fulvic BioMagic", regulatory according to quality category (repetition 2)

Over the positive effect of Humic acid preparations on the germinating process that Seed reported STANTSHEV (1977). He determined that the Humic acid preparations those Germ ability as well as the

germinating energy of the seeds increased. The physiological activity of humic acid stands in close relationship with oxidation processes, which that procedure of the bio-synthesis as well as the dismantling of ATP, ADP and growth modulators (Gibberellin, ascorbic acid) affect. In the result of these processes the germinating energy became, the germ ability as well as growth promoted by seedlings. According to data of FLAIG and HALL, BROOK (1955 in STANTSHEV, 1977) and Christian EH (1962) transfers the quinone group in the humic acid molecules those Function as acceptor of hydrogen atoms as well as activator of oxygen atoms. The transport system of the electrons during the breathing process of the cells becomes stimulated, this leads thereby to a higher energy potential, a higher germ ability of the seeds as well as a higher activity of the physiological biochemical processes in the cells. It shows the test result lake that a seeds treatment with "Fulvic BioMagic" with a concentration of 0,08% and 24 h duration of treatment, the germinating process as well as the growth of water spinach seedlings is promoted. It remains for later attempts reservations, effects of other humate to examine concentrations and treatment.

5.1.9.1 Effects of humate at a temperature stress experimental results.

The attempt consisted of 4 variants, whereby each variant had 10 repetitions. The attempt plan is evident to 1 made of table 5.1.9.1 - Further references to this attempt can be inferred from chapters 4.2.2 and table 4.3.1-2. Table 5.1.9.1 - 1: Attempt variants of the tomato attempt, treats with K-humate Humisolve and "Fulvic BioMagic" under a high temperature stress.

Variante	Art des Humates und Konzentration	Applikationsphase
1	Kontrolle	
2	Humisolve-R 0,05 %	Beim Pikieren; 4-, 9-Blattstadium
3	Humisolve-R 0,1 %	Beim Pikieren; 4-, 9-Blattstadium
4	0,08 % "Fulvic Bio-Magic"	Blattspritzung in o. g. Phasen

Results and discussion

In the case of visual observation it was stated that the plants at the temperature, long stem, very long internode and small leaves with dark-greener color formed. The tomato plants had very weak stature achievement, with approx. 48 cm height weighed them on the average 25 g (ca.120 g) is normal. Further it could be observed that during the temperature stress the plants withered. At the page margin it came to drainages. This symptom was obviously the consequence of a water shortage, caused by the high temperature and low humidity. During the visual estimate no clear difference between the treated variants and control could be determined. Whereas, the effect of the humate application resulted in benefit of the fresh and dry weight.

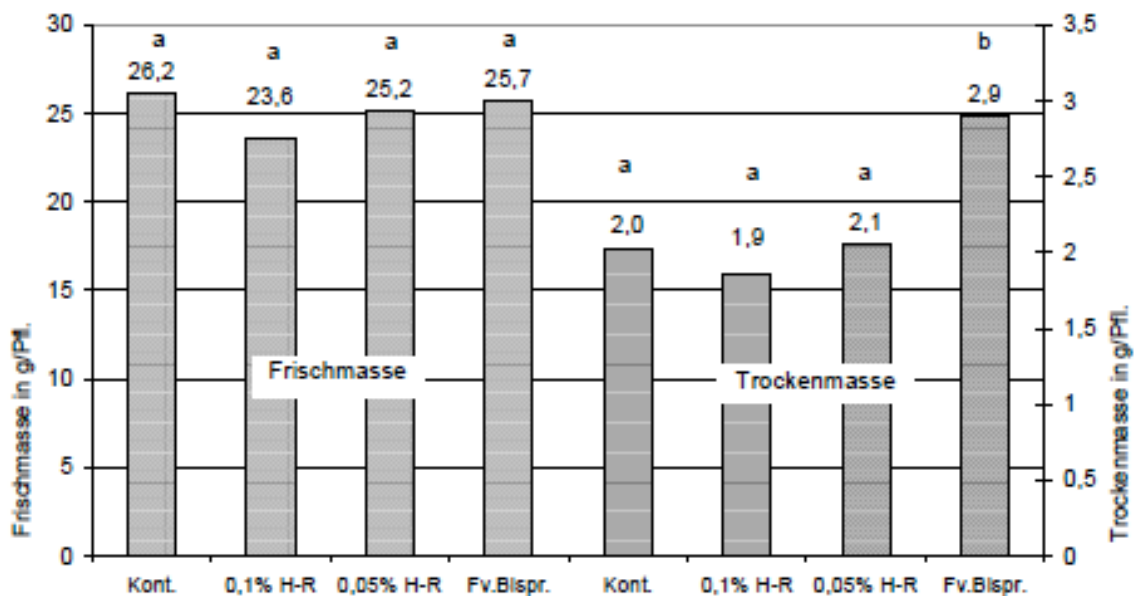


Fig. 5.1.9.1 - 1: Freshness and dry weight of the tomato plants, cultivated in gravel, treat with Huminsolve r and " Fulvic bio Magic" on temperature stress conditions (GD Dunnett test fresh mass = 3.14 GD Dunnett test dry weight = 0.5 with $\alpha = 5\%$). Putting one: Kont.: Control 0.1% HR: treated with 0,1% Huninsolve r 0.05% HR:

treated with 0,05% Huminsolve r Fv-BIspr. Sheet squirting with fulvic acid From the illustration 5.1.9.1 - 1 comes out that no significant differences with that Fresh mass between the variants with humic and fulvic acid treatments and that Control to be determined knew. However a significantly positive effect was proven with the dry weight of the variants treated with fulvic acid. With this variant correlated the evaluated characteristics more strongly with one another i.e. the plants grew evenly as with the others. It was shown repetitive that the effect of the humate with consideration of the different parameters should take place. Every now and then the humate an influence on the cell aspect ratio has and thus on the plant height or root length. The fresh mass results resulting from the number of sheets and their mass from the sheet surface as well as the stem weight. The sheet surface can every now and then also affected by humate become. The dry weight correlates frequently strongly with the fresh mass, however there are apparent due to the humate authority differentiations in the water content of the plants. Under the attempt circumstances mentioned the treatment with a fulvic acid increases Preparation the dry weight of the plants. A higher content of dry substance can do one higher ruggedness against unfavorable influences of environmental factors cause.

5.1.9.2 Effects of humate with a reduction of the root weight problem definition A reduction of the root weight, causes by technological measures how Pikieren, tansplant or mechanical care measures can a stress factor, represent, which growth and the development of the plants negatively affects. In the following attempt one aimed the effect of humate on the development of Tomato young plants under a simulated root loss - examines (S. chapter 4.7.1). Attempt characteristics In order to prove, whether the accomplished root cut for the seedlings represents a stress factor it was selected, a variant without root cut (only in the water for 1 hours). In order to determine in addition, whether immersing seedlings in water before the Pikieren has an influence on plant growth it was included, still another variant without root cut and without immersing in the water thus directly from the seed patch. The attempt consisted accordingly of 7 variants (Tab. 5.1.9.2 - 1). Each variant had 7 repetitions. Table 5.1.9.2 - 1: Attempt variants of the attempt on stress condition - root cut

Varianten	Eingriff	Behandlung mit Humaten
1	Kontrolle 1 ohne allen Eingriff	ohne
2	Kontrolle 2 ohne Wurzelschnitt	Eintauchen in Wasser
3	Kontrolle 3 mit Wurzelschnitt	Eintauchen in Wasser
4	Wurzelschnitt	Eintauchen in 0,08% Fulvosäure Lösung vor für 1 h vor dem Pikieren
5	Wurzelschnitt	Blattspritzung mit 0,08% Fulvosäure (während der Vegetation
6	Wurzelschnitt	Wurzelapplikation mit 0,025 % Huminsolve-R
7	Wurzelschnitt	Wurzelapplikation mit 0,05 % Huminsolve-R

The treatments with humate solution and/or with foliar spraying were made with the transplant/thinning, in 5 - and 7 - the leaf stage

Results and discussion

During a visual estimate during the vegetative phase no substantial differences between the variants 2 to 7 could be determined. Control of 1 had the best stature achievement compared with other variants. This observation is confirmed by the determined parameters plant height and fresh mass.

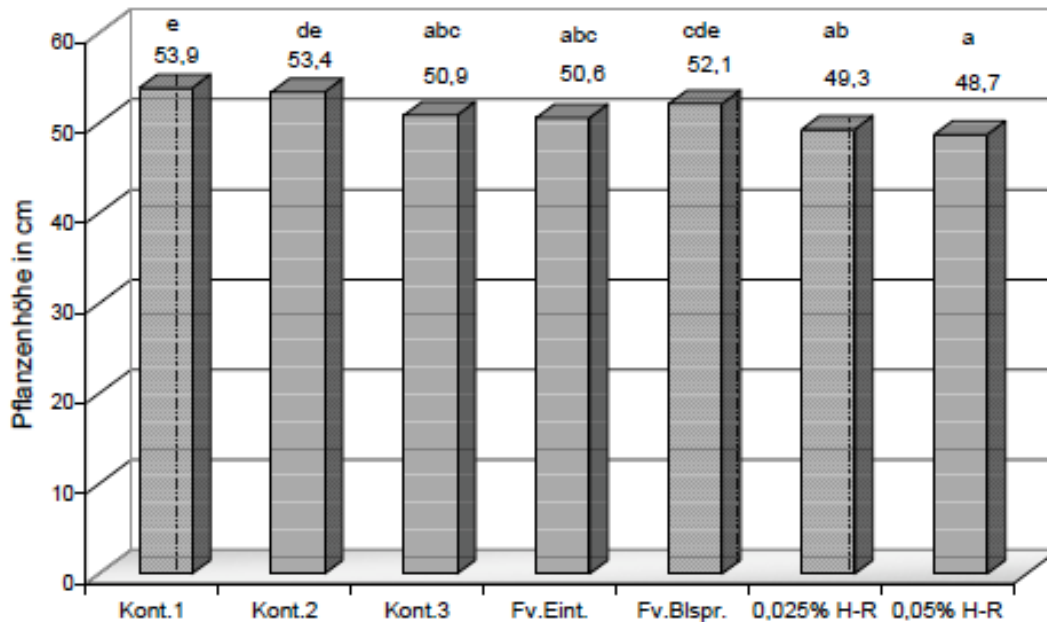
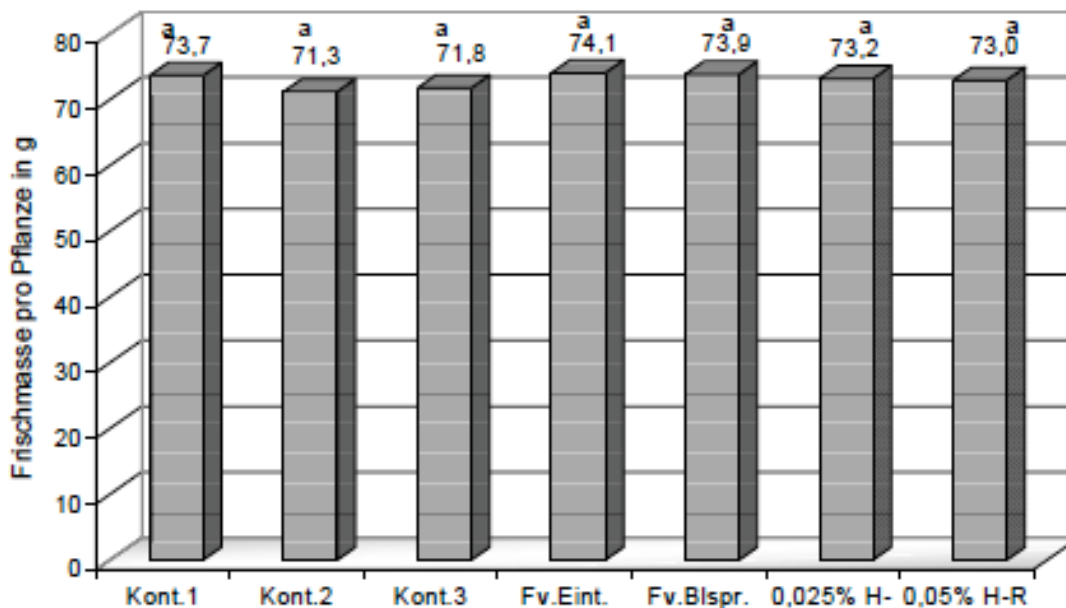


Fig. 5.1.9.2 - 1: Plant height of the tomato young plants, cultivated under stress root cut, treated with Huminsolve r and fulvic acid " Fulvic bio Magic" (GD Dunnett test = 3,61; GD T-test = 2.68 with $\alpha = 5\%$) Putting one (also for 5.1.9-2): Kont. Control Fv.Eint. Dive the root system into fulvic acid solution Fv.Blspr. Sheet squirting with fulvic acid during the vegetation HR root application with Huminsolve r 0.025% - and 0.05% To the result of the statistic evaluation of the parameter plant height and fresh mass (S. appendix table 5.1.9.2 - 2) knew only into small extent significant differences over the effect of the Humic acid to be determined (fig. 5.1.9.2 - 1 and 5.1.9.2 - 2). The simulated root loss caused no statistically significant change in the vegetative growth of the plants. By the treatment with Huminsolve r significantly the plant height was reduced in the comparison as a check (3). With the fresh mass no significant differences could be determined. All humatebehandlungen shows an increase of the fresh mass however in the tendency.

From the comparison of the humate of effects on the characteristics the statement results that the treatment with the humate does not increase the height of the plants probably however the fresh mass. A decrease in the plant height without the fresh mass of the plants to reduce could represent a good condition for a strong growth and higher resistance against other unfavorable environmental condition. Immersing the root system of the seedlings in the water for one hour before the Pikieren furnished no substantial change in the plant height.



In summary can be met the following estimates • The treatment with fulvic acid showed better effect than with Humisolve r in concentration the 0.05% as well as 0.025%. This statement was met also of LEVINSKY, 1996 and FIST, 1999). • The interference in form of the distance of 1/2 of the root system of the seedlings before the

Pikieren causes a reduction in the development of the plants in later phases. • Even longer dipping of the root system into water before the Pikieren can bring a negative influence to the development of the plants. • The treatment with the humate mentioned adjusts the negative effect of the root loss by an increase of the fresh mass and reduction of the plant height.

5.2.4 Influence of humate „Humisolve “ and fulvic acid "BioMagic" on water spinach with uniform plant density.

The goal of this attempt exists in the investigation of the influence of the Humic acid and fulvic acid preparations - „Fulvic BioMagic “and „Humisolve“. This Prä ready became from other raw materials than the preparations used so far gewonnen (S.A. chapter 4.6.). According to the recommendation of FAUST (1999) and LEVINSKY (1996) should the we kung of fulvic acid as foliar application to be examined. The attempt consists of 4 variants, which considers the different preparations and application forms (table 5.2.4-1) like already in chapter 4.7.2 for nutrient supply was described, became the nutritive solution containers master solution course to give twice weekly, in order to supplement nutrient consumption for the plants. The frequency of the application was also adapted to the development of the water spinach. As in chapter 5.2.3 described the Humisolve directly to the roots were applied. The first three Treatments took place with two different concentrations, i.e. with 0,02% and 0,01%. To use recommended by FAUST (1999) fulvic acid as foliar application, this became compared application with the Humisolve.

The plant density amounted to as in the previous attempt (25 Pfl. /m2). Up to the conclusion of the attempt altogether 3 impulse cuts (harvests) were accomplished.

Table: 5.2.4-1: Variants of the attempt for the effect of Humisolve and fulvic acid "BioMagic" variant humate treatment 1 control - 2 fulvic acid 0.08% leaf applied 3 Humisolve 0.005% root application 4 Humisolve 0.01% root application

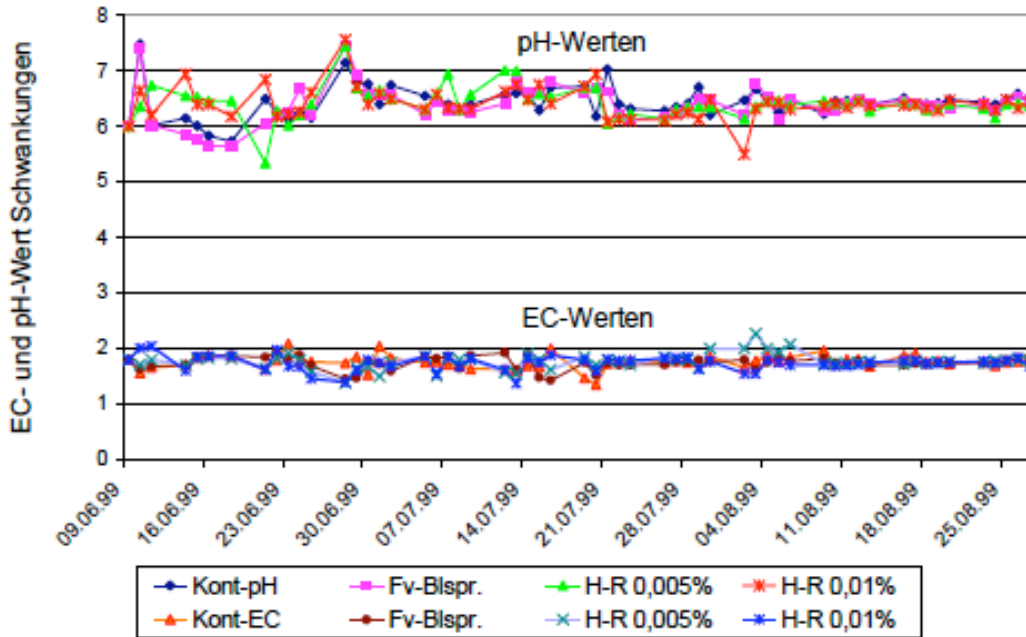
Tabelle: 5.2.4-1: Varianten des Versuches zur Wirkung von Huminsolve-R und Fulvosäure "Biomagic"

Variante	Humate	Behandlung
1	Kontrolle	-
2	Fulvosäure	0,08 % Blattspritzung
3	Huminsolve-R	0,005 % Wurzelapplikation
4	Huminsolve-R	0,01 % Wurzelapplikation

Results and discussion

From preceded the attempts the connection between the pH value became and the effectiveness of the humate clearly. For a balanced nutrient supply außer139 that is the development of the EC of value of importance. The measurement of the pH and EC-values in the four basins shows larger fluctuations at the pH value and smaller with the EC Wert (fig. 5.2.4-1). However are pH values from 6,0 to 6.5 ranges quite favorable for the water spinach. The small humic acid teil did not fear thus as, the pH value over 7 rise to let. On the other hand the effectiveness of the humic acid was despite the relatively small pH value in its effect does not impair.

Fig.5.2.4-1: EC and pH values in the 4 nutritive solution basins of a Aeroponic plant for water spinach, with different treatments Putting one: Kont. Control Fv-Blspr. Variant, treats with fulvic acid by foliar application Humisolve 0.005%: Variant, treats with 0,005% Humisolve 0.01%: Variant, treats with 0,01% Humisolve



des relativ geringen pH-Wertes in ihrer Wirkung nicht beeinträchtigt.

Abb.5.2.4-1: EC- und pH-Werte in den 4 Nährlösungsbecken einer Aeroponik-Anlage für Wasserspinnat, mit verschiedenen Behandlungen

Legende:

Kont.	Kontrolle
Fv-Blspr.	Variante, behandelt mit Fulvosäure durch Blattspritzung
H-R 0,005%:	Variante, behandelt mit 0,005% Huminsolve-R
H-R 0,01%:	Variante, behandelt mit 0,01% Huminsolve-R

The EC-values could be kept stable within a range from 1,7 to 2 with all variants. The EC-value fluctuations developed mainly due to a differentiated Nutrient consumption with the variants. fulvic acid as sheet squirting and the humate Humisolve as root treatment also a concentration of 0,005% led increase of the fresh mass of all cuts to one around 30% igen and/or 48% igen (fig. 5.2.4-2). 0 1 2 3 4 5 6 7 8 09.06.99 16.06.99 23.06.99 30.06.99 07.07.99 14.07.99 21.07.99 28.07.99 04.08.99 11.08.99 18.08.99 25.08.99 EC and pH value fluctuations control pH Fv-Blspr. HR 0.005% HR 0.01%

The EC-values could be kept stable within a range from 1,7 to 2 with all variants. The EC-value fluctuations developed mainly due to a differentiated Nutrient consumption with the variants. fulvic acid as foliar application and the humate Humisolve as root treatment also a concentration of 0,005% led increase of the fresh mass of all cuts to one around 30% igen and/or 48% igen (fig. 5.2.4-2).

With the treatment with 0,02% Humisolve directly by pouring at the root neck to the first harvest and with 0,01% thereafter, the yield was smaller than with control. Obviously the applied humate was too high - concentration.

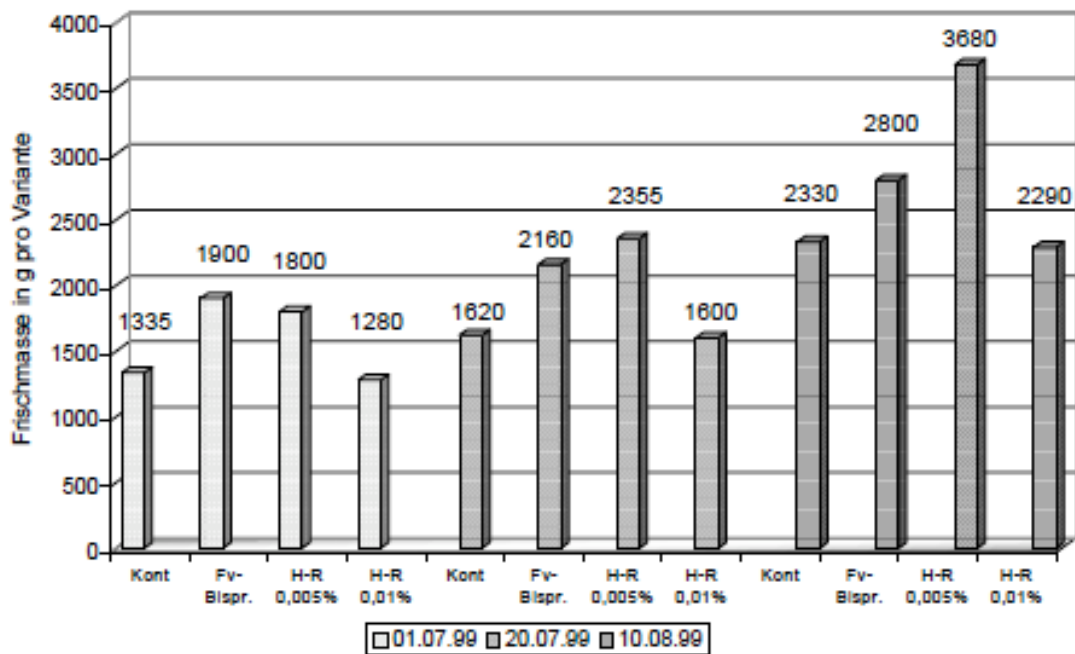


Abb. 5.2.4-2: Frischmasse von Wasserspinat, kultiviert in Aeroponik- Anlage und behandelt mit Huminsolve-R sowie "Fulvic bio-Magic".

2290 0 500 1000 1500 2000 2500 3000 3500 4000 Fresh mass in g per variant control Fulvic Blspr. HR 0.005% HR 0.01% control Fulvic Blspr. HR 0.005% HR 0.01% control Fulvic Blspr. HR 0.005% HR 0.01% □□□□ 01.07.99 □□□□ 20.07.99 □□□□ 10.08.99 With the treatment with 0,02% Humisolve directly by pouring at the root neck to to the first harvest and with 0,01% thereafter, the yield was smaller than with control. Obviously the applied humate was too high - concentration.

Fig. 5.2.4-2: Fresh mass of water spinach, cultivates plant in Aeroponic and treats with Humisolve as well as " Fulvic BioMagic".

Altogether with the variants the following fresh-weight yields were obtained:

- Control: 5258 g
- fulvic acid 0.008% as sheet squirting: 6860 g
- Humisolve 0.005% root application: 7835 g
- Humisolve 0.01% root application: 5170 g

It appeared again meaningful the content of mineral elements to examine in the water spinach. With this attempt the contents of the elements became potassium and magnesium analyzed, in order a better overview of the need during the vegetation to receive, the analyses took place with each impulse cut (fig. 5.2.4-4). The results concerning the K-content showed that contents with each cut the different was. A clear influence of the K-content by fulvic acid or humate cannot be determined. In the first two analyses the K-content was higher with all treatments, with the analysis after the third cut however lower than with control.

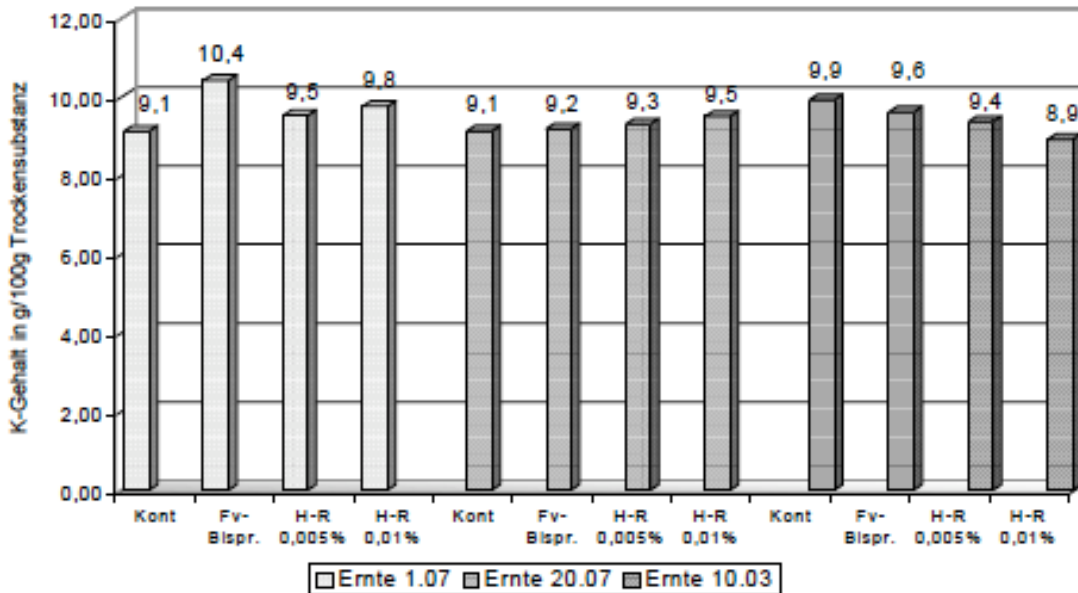


Abb. 5.2.4-3: K-Gehalt des Wasserspinats bei unterschiedlichen Zeitpunkten der Probeentnahme

Fig. 5.2.4-3: K-content of the water spinach at different times that Sampling A differentiated nutrient admission to the three analysis data, could be determined also with the magnesium (fig. 5.2.4-5). In the samples of the first cut more mg became all variants with fulvic acid or humate treated were analyzed. On the other hand the mg contents were substantially smaller with the second and third cut with all variants with fulvic acid or humate treatment. To similar results it came also with that preceding attempts, with which no clear influence of the mineral material content could be also proven by humate, although the fresh-weights usually than with control were substantially higher. The nutrient utilization seems to be more effective thus by the treatment with humate.

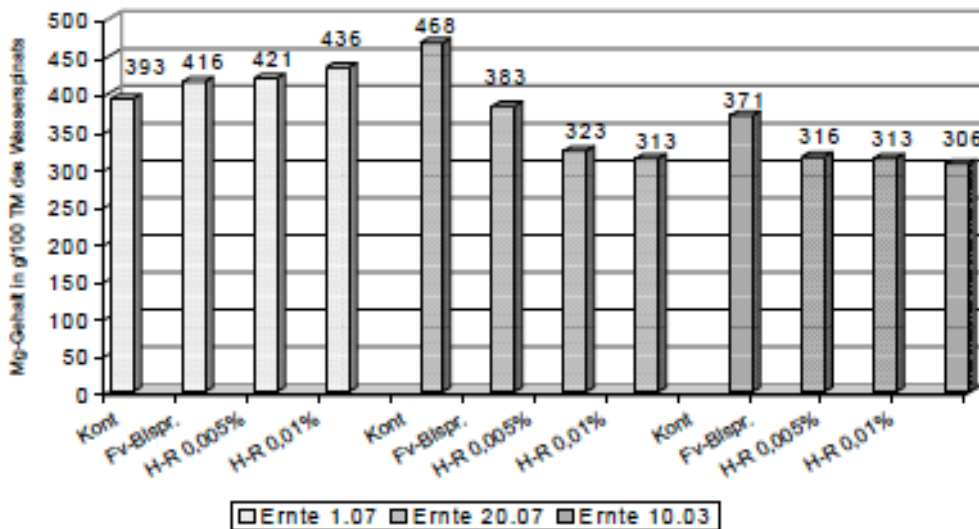


Abb. 5.2.4-4: Mg-Gehalt des Wasserspinats bei unterschiedlichen Zeitpunkten der Probeentnahme

Fig. 5.2.4-4: Mg content of the water spinach at different times of Sampling

(pg142)

To what extent the admission of the nutrients by the humate application in the root area possibly one obstructed, is to be still clarified. It is remarkable that with the foliar application with fulvic acid similar results were obtained, as with the humate, in that Rhizosphere applications. The humate "Himisolve" and the fulvic acid "Fulvic BioMagic" showed a clear influence on growth and the development of the water spinach, whereby

high humate growth restrained. The application of "Fulvic BioMagic" as foliar as well as of "Humisolve" furnished a clear increase in yield of water spinach. Thus the acceptance could concerning the favorable effect of fulvic acid as foliar application (FAUST, 1999) to be confirmed.

Water spinach with different plant densities

The positive effect of the treatment with fulvic acid foliar spraying referred to it, that fulvic acid molecules are able to penetrate by the leaf membrane and tissue in plant cells. It should be examined now, which effect with the fulvic acid - preparation with a root application compared with a foliar spraying reaches will can. From the previous attempt the most favorable treatment concentration with „Humisolve“ selected, thus covered the attempt 3 treatment variants and control (Tab 5.2.4-2). Further from technological view three different plant distances were examined in the Aeroponic system. The condition widths amounted to 10 cm x 10 cm (100 plants m²); 20cm x 15cm (33 plants m²) and 20cm x 20cm (25 plants m²).

Tabelle 5.2.4-2: Varianten des Versuches zur Wirkung von Huminsolve-R und Fulvosäure "Biomagic" bei verschiedenen Pflanzenabständen

Variante	Humatbehandlung	Abstände/Pflanzenbesatz
1. Kontrolle	-	
2.	Varianten mit Fulvosäure als Blatt-spritzung	20cm x 20cm (25 Pfl. m ²)
3.	Varianten mit Fulvosäure als Wur-zelapplikation	20cm x 15cm (35 Pfl. m ²)
4.	Varianten mit 0,005% Huminsolve-R Behandlung	10cm x 10cm (100 Pfl. m ²)

Table 5.2.4-2: Variants of the attempt for the effect of Huminsolve r and fulvic acid " Biomagic" with different plant distances Variant humate applications of distances/plant trimming 1. Control - 2. Variants with fulvic acid as foliar spraying 3. Variants with fulvic acid as root application 4. Variants with 0,005% "Huminsolve" Treatment 20cm x 20cm (25 Pfl. m²) 20cm x 15cm (35 Pfl. m²) 10cm x 10cm (100 Pfl. m²)

Results and discussion The fresh mass of the individual cuts as well as the entire harvest was growth-promoting with all fulvic acid, and humate industry. With this attempt the root application with fulvic acid had the highest effect, which FM could do by 56% in relation to control is increased. With the variants with fulvic acid foliar spraying the FM increase 44% amounted to and with "Humisolve" treatment - 30%.

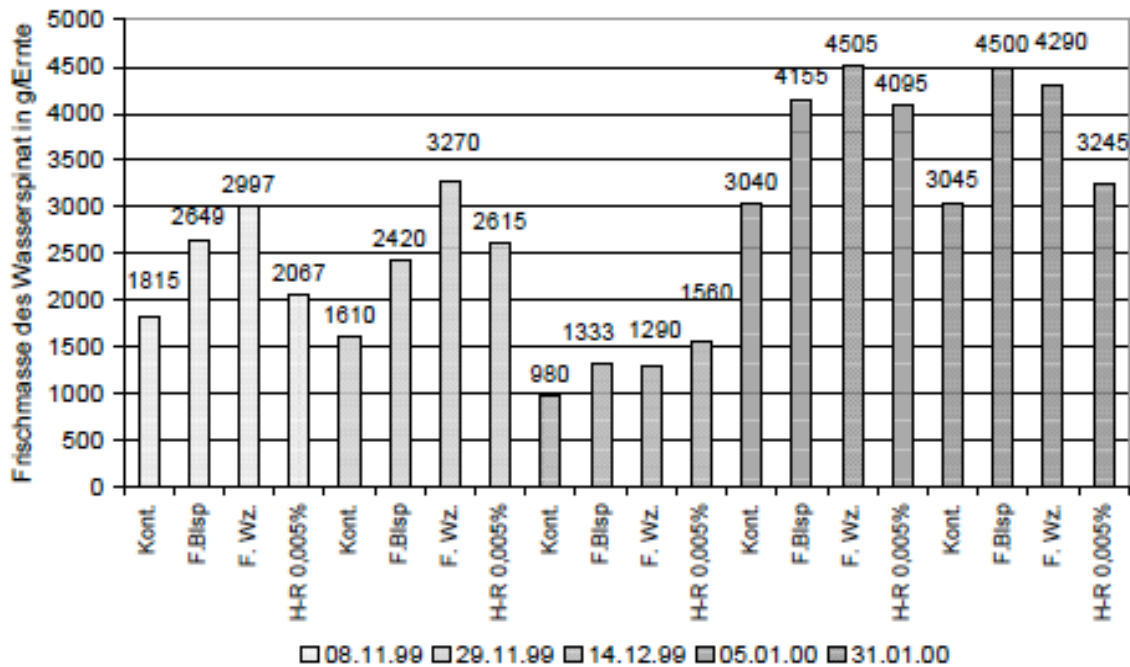


Abb. 5.2.4-5: Frischmasse von Wasserspinat, bei verschiedenen Ernteterminen kultiviert in Aeroponik- Anlage und behandelt mit "Huminsolve-R" sowie "Fulvic bio-Magic".
 Legende (auch für 5.2.4-7,8):

Kont.	Kontrolle
F.Blsp.	Varianten mit Fulvosäure als Blattspritzung
F.Wz.	Varianten mit Fulvosäure als Wurzelapplikation
H-R 0,005%	Varianten mit 0,005% Huminsolve-R Behandlung

Fig. 5.2.4-5: Fresh mass by water spinach, cultivated with different harvest dates in Aeroponic plant and treated with "Humisolve" as well as "Fulvic BioMagic". Putting one (also for 5.2.4-7,8): Control Fulvic Blsp. Variants with fulvic acid as foliar spraying F.Wz. Variants with fulvic acid as root application HR 0.005% variants with 0,005% Humisolve treatment Altogether with the variants the following fresh mass yields were obtained: • Control: 10,490 g • fulvic acid 0.08% as sheet squirting: 15.060g • fulvic acid 0.08% root application: 16,350 g • Humisolve 0.005% root application: 13,580 g The results with the treatment with the fulvic acid preparation as root application are thus even more favorable, than the foliar spraying recommended of FAUST (1999).

The visual Bonitur of the water spinach, cultivates with a high plant trimming (100 Pfl. m²) showed upright growing impulses with good quality. The rung were more tender than with the higher plant distances and exhibited no root formations to the lower sprouting hurrying. The fresh masses were at a number of plants of 100 per m² with all variants most highly, followed of the number of plants 35 per m² and 25 per m² (fig. 5.2.4-7). It is remarkable that the FM with both treatments with fulvic acid the same trend the three plant distances exhibit. Both affect more strongly the FM with the plant trimming 100 pieces per m², than the other variants.

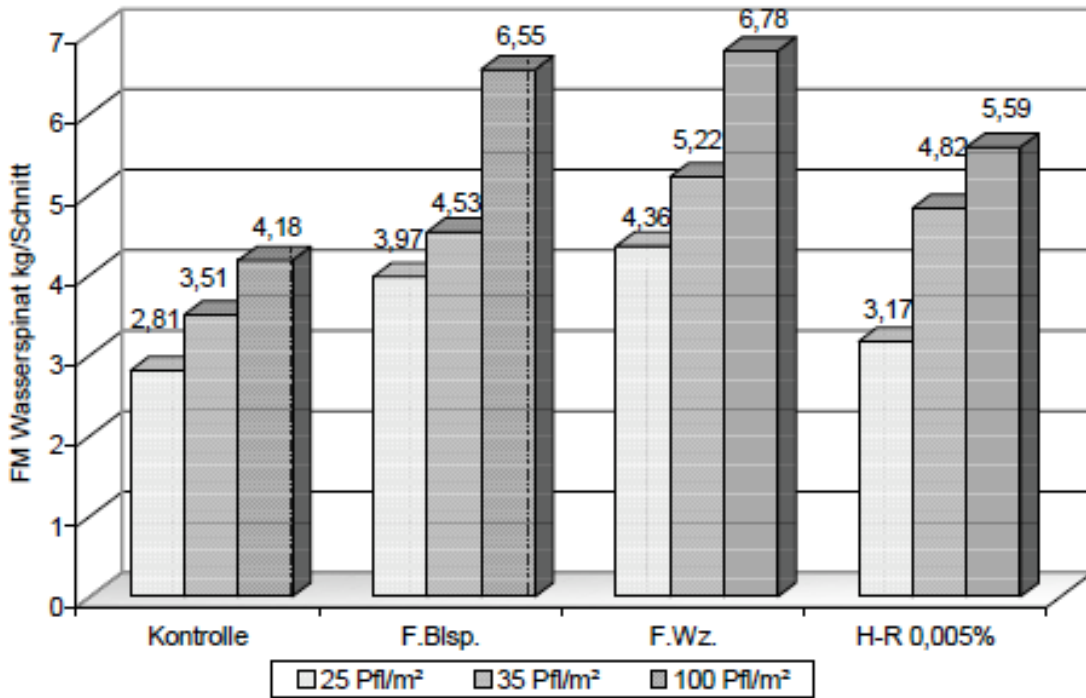


Abb. 5.2.4-6: Vergleich der Frischmasse (Ernten) von Wasserspinat bei verschiedenen Pflanzenabständen von Wasserspinat, kultiviert in einer Aeroponik-Anlage, behandelt mit Fulvosäure und Humat

Fig. 5.2.4-6: Comparison of the fresh mass (harvests) of water spinach with different Plant distances of water spinach, cultivated in a Aeroponic plant, treats with fulvic acid and humate From this attempt it becomes clear that approx. 100 plants for each m is ² the most favorable plant trimming for water spinach. It became again the influence of the fulvic acid and humate industry on the development the pH and the EC-value examines. The fluctuations of the pH value were this time more largely, in particular with the treatment variants. At a value of on the average 6 also 4, 8 to 7 was measured. It is remarkable that obviously also the humate „Humisolve“ at low pH value worked. This feature could not be observed with the preceding attempts with tomatoes in this measure. Altogether were 145 0 1 2 3 4 5 6 7 8 12.10.99 19.10.99 26.10.99 02.11.99 09.11.99 16.11.99 23.11.99 30.11.99 07.12.99 14.12.99 21.12.99 28.12.99 04.01.00 11.01.00 18.01.00 Changes in EC and pH values PH-control PH-F.Blsp pH F. CR. pH HR 0.005% EC-Kont. EC-F.Blsp EC-F. CR. EC-H-R 0.005% EC-values pH values the EC-values with this attempt lower than with the preceding. The fluctuations around the average value of 1,8 were not very substantial. It can be accepted that the plants used the available nutrients better. That particularly shows up with the fulvic acid root application and the humate applications. Because the low EC-values the treatments correlate with the fresh mass production.

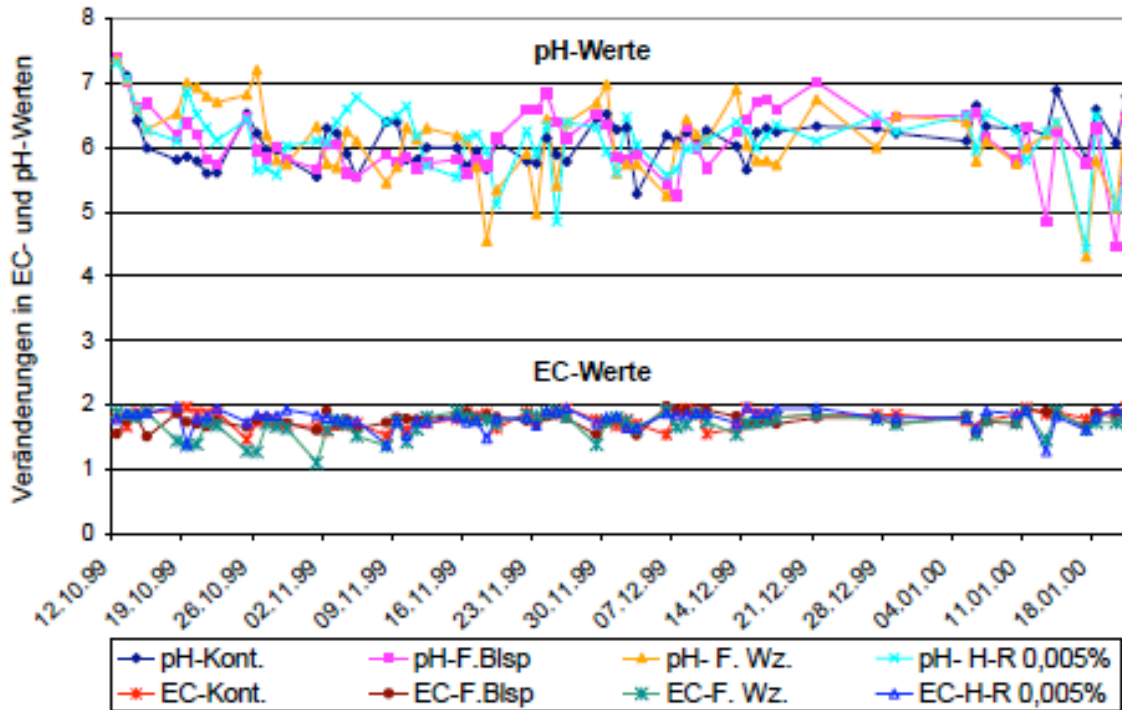


Abb. 5.2.4-7: Veränderung von EC-Werten der Nährlösung von Wasserspinat, kultiviert in Aeroponik-Anlage, behandelt mit "Huminsolve-R" sowie "Fulvic bio-Magic".

Fig. 5.2.4-7: Change of EC-values of the nutritive solution of water spinach, cultivated in Aeroponic plant, treated with "Huminsolve" as well as "Fulvic bio Magic". This time the content of macro-nutrients was examined for the conclusion of the attempts (Tab. 5.2.4-3). The admission at potassium was higher with control around approx. 15%, than with the treatments. This observation could be made also with other attempts. The approx.-admission was not affected at all slightly by the treatments (over approx. 10%), the mg admission against it. As also with the previous attempts, the treatments worked on the phosphorus admission, in particular by fulvic acid as page handling and "Huminsolve". Also in this attempt an interrelation between the admission of the cations (STEINER, 1984), i.e. between potassium, calcium and magnesium became. In later investigations it remains clarifying why the humate in some cases the admission of calcium promotes and to others the admission of potassium or magnesium.

Tabelle 5.2.4-3: Gehalt an Mineralien von Wasserspinat bei verschiedenen Zeitpunkt der Probenentnahme

Varianten	Untersuchten Elementen			
	K in g/100g TM	Ca in g/100g TM	Mg in mg/100g TM	P in mg/100g TM
Kont.	10,14	1,17	324	796
F.Blsp.	8,45	1,34	337	873
F. Wz.	8,48	1,39	327	765
H-R 0,005%	8,62	1,36	332	913

Table 5.2.4-3: Content of minerals of water spinach at different time of the sampling Examined elements Variants K in g/100g TM Approx. in g/100g TM Mg in mg/100g TM P in mg/100g TM Kont. 10,14 1.17 324,796 F.Blsp. 8,45 1.34 337,873 F. CR. 8,48 1.39 327,765 HR 0.005% 8.62 1.36 332,913 5.2.5 investigations to the influence of humic acid on the development and vitality of water spinach at temperature temperature From several authors became on the special effectiveness of humic acid Preparations on the growth and the vitality of cultivated plants on stress conditions referred to (S.A. chapter 2.7.2.3). From the different stress factors

unfavorable temperature conditions represent a frequent problem for an optimal development of the plants. Earlier statements to the influence of humate on temperature stress with tomatoes (BÖHME, 1997) and in this work, chapter 5.1.9.1, should be examined with the water spinach. This attempt took place in a climatic chamber (S.A. chapter 4.2.2).

Influence of humate at temperature temperature simulates in a climatic chamber

With this attempt the effect of two humate was examined (Tab. 5.2.5-1).

For the estimate of the effect of the humate the fresh mass was determined to each impulse cut. Altogether 3 harvests took place with this attempt. Table 5.2.5-1: Variants of the attempt for the effect of k and well humate on water spinach at temperature temperature Variant humatebehandlung 1. Control - 2. Treated with 0,005% well-humate 3. Treated with 0,005% K-humate The fresh mass with each harvest, as well as the entire yield are shown in Abb.5.2.5-1

Tabelle 5.2.5-1: Varianten des Versuches zur Wirkung von K- und Na Humat auf Wasserspinaat bei Temperaturstress

Variante	Humatbehandlung
1. Kontrolle	-
2.	Behandelt mit 0,005% Na-Humat
3.	Behandelt mit 0,005% K-Humat

Fig. 5.2.5-1: Fresh mass cultivated by water spinach, in climatic chamber under a temperature stress, treats with well and K-humate. Out of the illustration 5.2.5-1 it is to be taken that the application partly decreased of humate the negative effect simulated temperature stress on growth and the vitality of water spinach. A particularly clear effect was observed with the treatment with K-humate. Altogether the FM increase amounted to with the variant appliziertem with K-humate 41% and with well-humatebehandlung the 23%, in the comparison with control. Also the masses of all plants were seized by each variant. (Fig. 5.2.5-2).

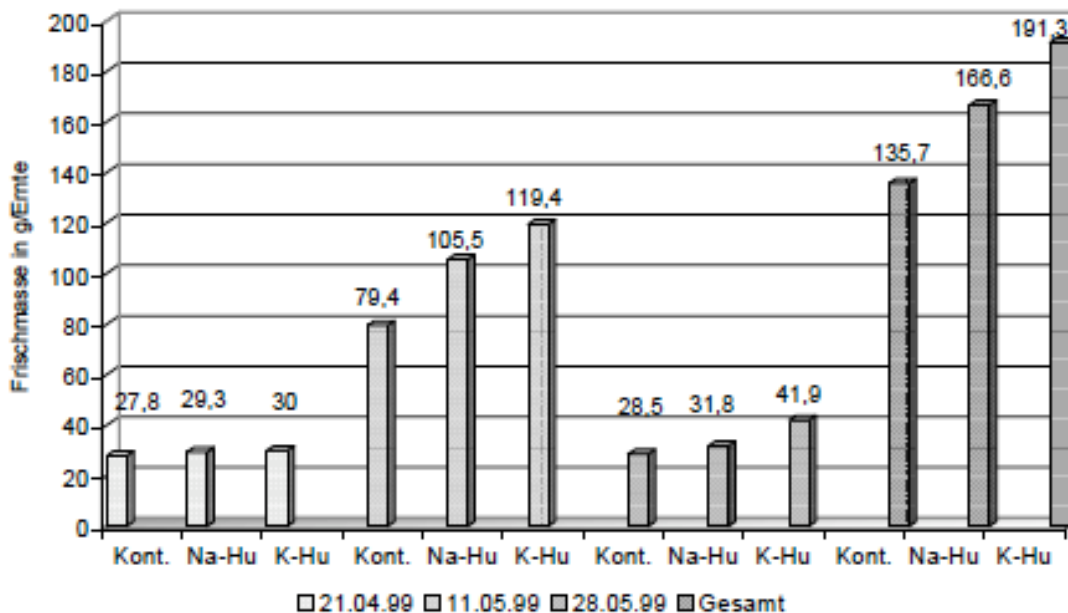


Abb. 5.2.5-1: Frischmasse von Wasserspinaat, kultiviert in Klimakammer unter einem Temperaturstress, behandelt mit Na- und K-Humat.

The brief temperature stress of 10 °C affected growth and the development of the water spinach very strongly. The plants with all variants had thereby a very weak growth. With the variant treated with K-humate however a significant increase of the fresh mass of individual plants was determined. Temperature stress under conditions in line with standard usage in the greenhouse This attempt was accomplished in the greenhouse with natural conditions. The stress factors resulted from the period of at the end of of Septembers up to at the beginning of of Decembers, unfavorable for the growth of water spinach. The unfavorable growth factors were characterized by relatively low temperatures, low air humidity and small light intensity. The optimal conditions for growth and the development from water spinach are at a temperature from 27 to 30 °C, with an air humidity of 75-85% as well as with a light intensity from at least 13,000 to 15,000 lx. In the greenhouse against it an average temperature of 18°C, humidity of 45% as well as light intensity of less than 5000 was lx. With this attempt fulvic acid and humate were used to positively affect with the goal the vitality and growth of water spinach. The variants are evident in table 5.2.5-2.

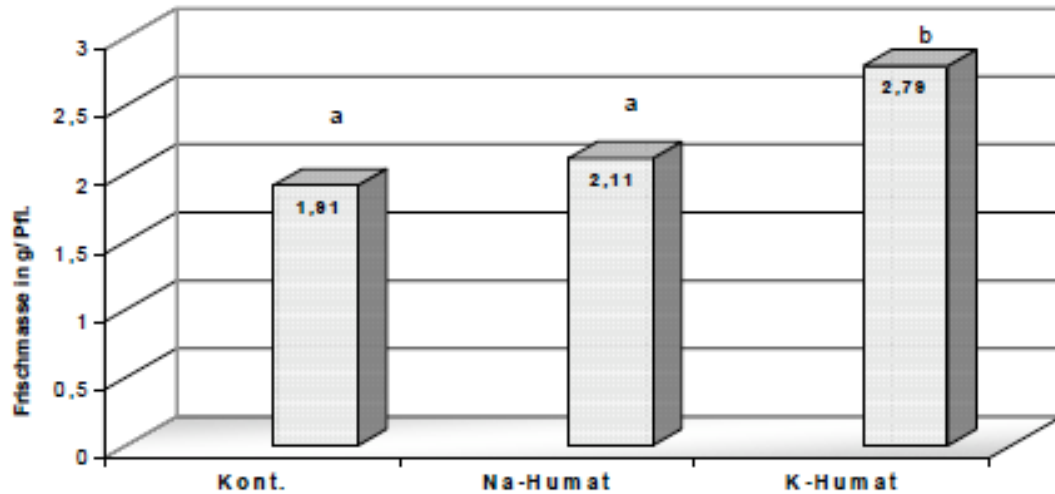


Abb. 5.2.5-2: Durchschnittliche Masse der Einzelpflanzen von Wasserspinat bei einem Temperaturstress, behandelt mit Na- und K-Humat (GD_{T-Test} = 0,52; bei $\alpha = 5\%$).

Table 5.2.5-2: Variants of the attempt to the effect of „Humiko“, „Huminsolve r“ and fulvic acid „Biomagic“ on water spinach at temperature temperature Variant humatebehandlung 1. Control - 2. Sheet squirting with 0,08% „Biomagic“ 3. Pour with 0,025% „Huminsolve r“ 4 pouring with 0,005% „Huminko“

Tabelle 5.2.5-2: Varianten des Versuches zur Wirkung von „Humiko“, „Huminsolve-R“ und Fulvosäure „Biomagic“ auf Wasserspinat bei Temperaturstress

Variante	Humatbehandlung
1. Kontrolle	-
2.	Blattspritzung mit 0,08 % „Biomagic“
3.	Gießen mit 0,025 % „Huminsolve-R“
4	Gießen mit 0,005 % „Huminko“

Results The natural climatic conditions in the period mentioned were for that Growth of water spinach so unfavorably that the plants had formed only small hard rung with light green sheets within 2 months development. The fresh mass in the illustration 5.2.5-3 one represents.

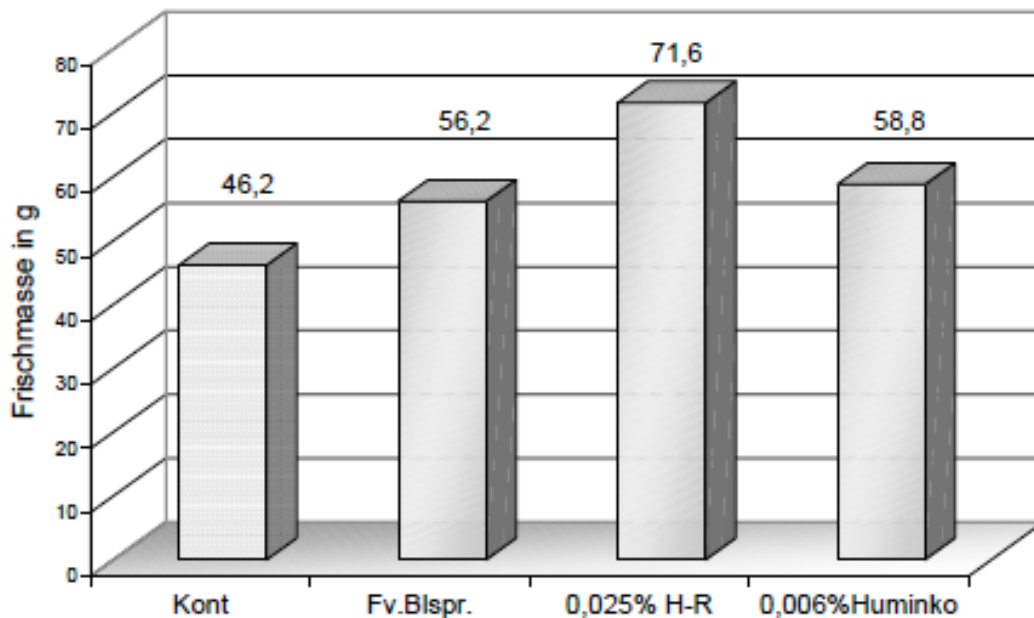


Abb. 5.2.5-3: Frischmasse von Wasserspinat, kultiviert in Perlit, appliziert mit "Huminsolve-R", "Fulvic bio-magic" sowie Humat aus Kokosmaterial unter einem Temperaturstress.

Fig. 5.2.5-3: Fresh mass cultivated by water spinach, in perlite, applied with "Humisolve", "Fulvic BioMagic" as well as humate from Kokosmaterial under a temperature stress. Under the test conditions mentioned, the application of humate had a clearly positive effect on growth as well as the vitality of the water spinach. The effect was particularly pronounced with the treatment with 0,025% „Humisolve r“. The increase in fresh mass 54%, with „Huminko“ 27% and with fulvic acid amounted to 21% in the comparison with control. With this attempt very well a practical area of application could be worked out by humate. The effect of stress-producing factors, like strong variations in temperature, low humidity and little light can relatively simply by treatments with humate or fulvic acid to be decreased.

(pg151)

6. General discussion

The individual results of the attempts were already discussed in the respective chapter. Therefore only a general is according to discussion the emphasis in this chapter setting of tasks take place. The general question of this work was, which effect has humic acid on plant growth under different cultivation and growth conditions. In the test results some statements of the literature could, some had to be corrected and could also new statements are confirmed to Effect of the humic acid to be met. The effect of the humate and fulvic acid was much differentiates as a function of the kind of vegetable, the cultural procedure, the substrate and the application conditions. In the following the emphasis worked out in setting of tasks becomes in connection with the reached test results discusses: Procedure of cultivation The use of humate with the different hydroponischen cultural procedures appears to be meaningful. humate applications took place with tomatoes, with the substrate culture and as well as the tank culture were cultivated with water spinach, which was cultivated with the tank culture and in a Aeroponicanlage. With each hydroponischen procedure however the different edaphischen growth conditions for the plants must be considered. The effect of the humate on the root system with the substrate culture seems more favourable to be as the constant contact of the humic acid with the roots with the tank culture. This Statement refers in particular to humate, K-humate and NH₄-humate, for a good Solubility a pH value over 7,5 need. With the water spinach both cultural procedures for a humateapplikation appear to be suitable. Causes could in the better acceptance higher pH values lie, and/or also the use of humate („Humisolve r“ and fulvic acid.), which exhibited even at lower pH values a good solubility and thus effectiveness. For the effectiveness of the humate and fulvic acid with the different Procedures are therefore the kind of the humates, the concentration with that it applied becomes crucial and the frequency of application.

humic acid preparations Five different humic acid and fulvic acid preparations were used, from three different origins and raw materials in the attempts. These differ in the 152 Composition, i.e. the portion of humic acid,

and/or fulvic acid. Thus unequal portions of active humic acid molecules became effective, which an exact estimate that Effect characteristic makes more difficult. As already mentions, a substantial difference between the humate existed also in their solubility in the water, and/or in the nutritive solutions. A classification of the humate regarding the sources of raw material and the active humic acid and/or fulvic acidanteile, how they were represented of LEVINSKY (1996), appear to be meaningful. Although not all humate could be compared with different raw material basis, determined connections can between from the test results the source of raw material and the effect of the humate to be derived. Thus peat (well humate) appears a suitable raw material to be, the use of brown coal with small humic acidgehalt (K-humate Schlieben) is also possible, a higher efficiency can however with humate from high-quality coal (Huminsolve r) to be obtained. Other sources of raw material, which were not mentioned so far in the literature, are also applicable, as e.g. K-humate won from Kokosfasern. So knew with this humate a higher effect on growth by tomato plants to be obtained, in the comparison with Huminsolve r.

In the literature for the application of humate, effects of well-humate are described predominantly. The cause is to be looked for surely in the fact that the extraction took place from humic acid in former times particularly by NaOH. In the attempts an effect of well-humate could be proven both with tomatoes, and with water spinach. However those were not always clear and not stable effect both in the comparison as a check, and to treatments with other humate. It can be accepted that the effect was limited by the sodium portion in the humate. In newer literature data to the use of K-humate one refers predominantly. In particular becomes from an increase of branch growth and root growth by an employment of K-humate reports (TAN and NOPAMORNODI, 1979; FORTUN and LOPEZ, 1982; RAO et al., 1987). In the attempts also, frequently a clear effect could be obtained with the employment by K-humate particularly with the Huminsolve r, won from high-quality coal. In the comparison with other humate, like well-humate and NH₄-humate, a better growth was to be usually observed. Favourable surely is the portion of potassium, although this is not very substantial.

An employment of NH₄-humate is not described in the literature. It appeared however to be an interesting question to examine the effect of this humates. The NH₄-humate used in the attempts seemed compared with other less effectively too 153 its. The effect on plant growth was small or even grow-reducing. There that Preparation a small portion of humic acid however high portion of NH₃ contains, was the effect of the humates impaired. Particularly since NH₃ causes a high pH value in the solution, which can be plant-damaging. fulvic acid preparations were characterized in the literature as more reactive preparations (see chapter 2.3) and became frequently the seeds treatment and than sheet application recommended (FIST, 1999 and LEVINSKY, 1996). The results of the attempts could these statements confirm. The fulvic acid preparation used in the attempts „Biomagic“ had usually a clearly promoting effect on germinating as well as on growth particularly with the water spinach. With attempts in the Aeroponic system with water spinach the root application with fulvic acid exhibited predominantly better results as the sheet application.

If humate with other preparations are used at the same time, a synergy can be obtained (BÖHME, 1997, 1999). With a combined use of well humate with the Algenpräparat Goemar special could not be determined a such synergy so clearly. However the admission of some macro elements was better affected such as K, approx. and mg with tomatoes obviously by this combined employment. Application way and - mixes The optimal concentration represents an important factor for the effectiveness of the use of humate. The use of humic acid preparations in high concentrations and/or with high frequency damage can bring the plants (STANTSCHEV, 1977; Christian EH, 1968; TATTINI et al., 1989). From the results of the attempts this statement could be confirmed. The continuous application of the assigned humate (well, Kund NH₄-humate), i.e. either the application of humate with each nutritive solution gift or the constant presence of humate in a tank culture, retarded and/or often reduced the growth of tomato plants. If humate become intermittent, maximally weekly against it, appliziert better results could be achieved.

Likewise high concentrations led (e.g. with the application of Humisolve r) to one geringern development of all examined growth characteristics in the comparison to Control. In the attempts the different humate not all was available at the beginning of the work on this topic. An accurate comparison of the humate applications mengen with consideration of the humic acidgehalte was not possible from there always. 154 The application of humate with different development stages of the tomatoes and the water spinach, worked partly differently. However still no favorable phase of the application could be determined with tomatoes, with water spinach proved a treatment in phases critical for the development as favourable on the basis of the available results. Both the addition of humate and root application, and as sheet application appeared suitable application ways to be. The effect of the sheet application was particularly clear if the treatment with fulvic acid took place. As different authors emphasize, humic acid can be used also for seeds treatment (STANTSCHEV, 1977; BRYAN, 1976: GAWRONSKI, 1984). The results of the attempts confirmed, by a seeds treatment could these statements a

better germinating be obtained. This effect became particularly clear during the seeds treatment of the water spinach seeds with fulvic acid (bio Magic).

Influence of growth factors Starting point of the attempts was that the effect of the humate is different with different substrates. It was to be clarified whether the effect of humic acid preparations stands in a close relationship with the edaphischen growth factors. The comparative investigations with inert and organic substrates showed a rather clear connection between the humate and the different substrates. With that, a such effect could be proven to inert substrate perlite not so clearly. With substrates with small air capacity (e.g. Kokos Mexico), the influence of the humate was clearer. There are numerous statements to the influence of humate regarding an increase of the nutrient admission (DEMIANENKO, 1977; FORTUN and LOPEZ, 1982; ADANI et al., 1998; LOBARTINI et al., 1998). However these statements were usually met only in each case for a humate and only for an element. In the result that available work could influences of different humate for the admission of the macro elements (K, approx., mg, P) and iron by the example by tomatoes and water spinach to be met. Further could be worked out an estimate for the nutrient admission for different cultural procedures. The influence of humate on the nutrient content in the plants depends also on the substrate. With inert substrates, e.g. perlite, is to be registered a smaller nutrient admission than with organic. Further a smaller nutrient admission was determined also with the procedure of the water-culture for tomato.

With most substrates a small effect of the humate exists regarding the admission of potassium. The admission of calcium and magnesium becomes both from the humate, and of the kind of the substrate affects. A similar result could also concerning the Fe-admission with water spinach to be determined, similar observations are present also from KREIJ and HEARING (1997). It confirmed the investigation the acceptance that it is important to humate with a high solubility also in a pH value under 6,5 to begin. Effect of humate with stress conditions The effect of humate as plant stabilization means at extreme temperatures is out admits of the literature and own attempts (STANTSCHEV, 1977, LEMAIRE, 1972, HOANG, 1996, FREIBERG, 1999). So far however humate did not become yet under controlled Conditions temperature stress tested. Attempts in a climatic chamber also a heat stress, different results for the freshness and dry weight of tomatoes resulted in. With fulvic acid treated tomatoes exhibited a significantly higher dry weight. Clear results could be obtained with water spinach, which was treated with a cooling stress. Well and K-humate (low and high-per cent) as well as Huminko and fulvic acidn worked stress-decreasing, i.e. had a higher increase than control.

Influence of the humate on plant growth humate affect differently different plant types and their organs (MARTIN et al., 1962; YOUNG and CHEN, 1997). So complex investigations for the effect of humate and fulvic acid on growth and the development of a fruit vegetable (tomatoes) and a sheet vegetable (water spinach) did not take place so far. Generally it can be estimated that the effect of humate was clearer with water spinach under the different conditions. If with the tomato the growth conditions are optimal, the effect of humate is less visible and provable. The application of humate affected with the tomato differentiated the examined plant characteristics. The influence on the yield was non-uniform under the given attempt circumstances. Concerning the employment of different humate no clear statements can be met regarding the effect the yield. With the water spinach humate and fulvic acid worked clearly yield-increasing. Treatments after each cut improved the increase importantly.

Conclusions From the results of the attempts the following conclusions result: Relationship between cultural procedures and humate humate can be used with the examined cultural procedures, substrate culture, tank culture and Aeroponic as plant stabilization means. However the effectiveness of the humate hangs with the individual procedures of the conditions such as humatetyp, frequency and Quantity of the application as well as the plant type off. Tomatoes react to a humate Application in the water culture more sensitively, than with a substrate culture. The use of humate and fulvic acid with water spinach both in the Tankkultur and with the Aeroponic cultivated, a high effectiveness shows. If humate should be used with a Aeroponic procedure, at least an application within the closer root range is recommended in the first weeks of cultivation. Afterwards an addition is enough to the nutritive solution basin. Estimate of different humate Under appropriate conditions good results can as with different humate Plant stabilization means to be reached. The following criteria should be considered with the choice of the humate:

- high concentration at humic acid won from coal with high order
- High portion of fulvic acid
- Good solubility and stability also at pH values under 6,5
- Connection at potassium is to be preferred sodium or ammonium
- Technological advantages have firm humate opposite liquid
- humate won from other raw materials, e.g. peat or Kokosfasern can be also used, if coal is not available.

Application ways and - mix The correct dosage of the humate or fulvic acid is of great importance. Sheet applications can be used for plant stabilization equally as applications into the root area. It is to be attached possible humate to the assigned nutritive solutions, in order to achieve thereby a continuous supply, a higher effectiveness becomes 158 but reaches usually with intermittent application. The concentration of the humate in the nutritive solution should not exceed orientierungsweise 0.05% with humate with a high portion of humic acid (e.g. Humisolve r) and with humate (e.g. humate from brown coal) with a smaller portion of humic acid 0.1%. During the preparation of humate lösungen the content of humic acid should be considered. Further is also the content of other substances, like amino acids and vitamins, as well as ballast materials of importance. The effectiveness of the humate depends also on the time of the application with consideration of the development stages of the plants.

humate as plant stabilization means:

- It could be confirmed that humate are able germinating from seeds to promote, were particularly clear the results with the water spinach. Further investigations should clarify, as well as which humate or fulvic acid is particularly suitable their concentration and the duration of treatment.
- humate have a derivative action on the plant organs, every now and then are a smaller plant height, particularly in the young plant stage to observe and higher freshness and dry weights. Thus a higher stability of the plants can obtained become. The growth of the root system correlates positively with the application of humate, in particular K-humate. Thus a higher nutrient admission is possible.
- The treatment with humate has an influence on the nutrient admission of the plants. However no clear statements could be met to all macro elements. Most substrates exists a small effect of the humate regarding the admission of potassium. The admission of calcium, magnesium and iron becomes against it more frequently both of the humate, and of the kind of the cultural procedure affects. It suggested itself an interrelation between humate application, substrate and nutrient admission, these should in future attempts deepening be examined.
- Generally it can be estimated that humate positively affect growth of plants on certain stress conditions. In particular at extreme temperatures, know humate the negative effect of heat stress with tomatoes and cooling stress decrease with water spinach. From the investigations also a positive effect of humate can be derived with stress of lack of light. Future attempts to the humate problematic should this question take up.

Recommendations for the further scientific work On the basis of the accomplished attempts and the obtained results the following resuming investigations should take place to clarifying open questions: • Development from methods to the clear classification of humate and humic acid, among other things by use of the UV-Vis Spectroscopy. • Effect of the humate treatments on morphologic and physiological changes generative on and vegetative plant organs, with consideration that plant-anatomical characteristics, particularly with the sheets. • Effect of humate on stress conditions in the root area, like extreme pH values and under or over supply of individual nutrients, e.g. iron, as well as under extreme climatic conditions, in particular small light offer. • Effect of humate in connection with a chemical or a biological Plant protection with protected cultivation of useful plants. • Influence of the application form, as sheet application or as root application on the effectiveness of humate and clarifying of damage mechanisms of the humate through Use of isotopes.

8. Summary The starting point of the cultivation of gardening plants, is not only a constantly better utilization of their potential of yield, but also a better stabilization of biomass production. The use of pollution free and biological plant stabilization means appears in particular for integrated cultivation procedures to be suitable. Such one Means, with which the nutrient utilization ability and the vitality will not only improve in relation to stress influence of the plants to be able, are in particular meaning for hydroponic cultivation methods. Numerous references in the literature prove that humic acid preparations a broad Action spectrum on plant growth exercise. However are the statements over their effect often not clearly. Positive effects on the plant development, improvement of the vitality and quality of the products become frequent as well as the growth conditions in the root area described. They are cause for a deep-going investigation for the application and effect of preparations on the basis of humic acid. Beside experimental Investigations for the effect of humic acid preparations, it was necessary an extensive literature search of the classification of the humate up to the broad description their effect conditions and - form to make. This analysis of the level of knowledge covered the following Scherpunkte:

- Situation of the use of humic acid in the world
- Classification of the humic acid and organization of their parliamentary groups, as well as their molecular characteristic
- Raw materials for the extraction of humic acid and the extraction methods as well as their characteristics
- Effect on the ground fertility and nutrient availability, as well as the nutrient admission of the plants
- Effect both on growth and the development of the plants, and on their vitality and their stress resistance
- Effect on the internal and outside quality of useful plants

- Combinations of humate with other preparations and their practical application From this the problem definition for the research work and the experiments was derived, which concerned themselves with the following questions
- Investigation to the influence of humic acid preparations on the germinating process and the development of tomato as well as water spinach seedlings
- Effect of different humate, like well, k, NH₄, and fulvic acid on the development and vitality of the plants with different application way as well as - frequency
- Influence of humate on the development of tomatoes and water spinach with the cultural procedures - substrate culture, tank culture and Aeroponic
- Influence of different humate on the growth and the development of tomatoes and water spinach under different stress situations The results of the investigations can be summarized as follows:
 - humate can be used with the examined cultural procedures, substrate culture, tank culture and Aeroponic as plant stabilization means. However the effectiveness of the humate hangs with the individual procedures of the conditions such as humatetyp, frequency and quantity of the application as well as the plant type off.
 - Tomatoes react to an humate application in the water culture more sensitively, than with a substrate culture.
 - The employment cultivated by humate and fulvic acid with water spinach both in the tank culture and with the Aeroponic, shows a high effectiveness
 - The correct dosage of the humate or fulvic acid is of great importance. Sheet applications can be used to the plant stabilization equally as applications into the root area. It is possible humate the assigned nutritive solutions to attach, in order to achieve thereby a continuous supply, a higher effectiveness however usually with intermittent application one reaches.
 - humate have a derivative action on the plant organs, every now and then are a smaller plant height, particularly in the young plant stage to observe and higher freshness and dry weights.
 - The treatment with humate has an influence on the nutrient admission of the plants. However no clear statements could be met to all macro elements
 - Generally it can be estimated that humate positively affect growth of plants on certain stress conditions. In particular at extreme temperatures, know humate the negative effect of heat stress with tomatoes and cooling stress decrease with water spinach.

Behandlungs- variante	Frischmasse	Trockenmasse	Phoehe
Kontrolle	26,18	2,03	49,90
0,1 % H _s -R	23,63	1,85	48,20
0,05 % H _s -R	25,16	2,06	47,60
Fulvosäure	25,71	2,90 *	48,70
Gesamtmittelwert	25,17	2,21	48,60
S _{Rest%}	11,37	20,53	5,58
LSD ($\alpha=0,05$) ⁽¹⁾	2,60	0,41	2,46
GD Dunnett ($\alpha=0,05$) ⁽²⁾	3,14	0,50	2,98

Tab. 5.1.9.1 - 2: Statistic analysis table of the investigation to the effectiveness of humate on the vitality and the nutrient utilization ability of tomato plants on stress conditions Dunnett test and/or T-test (LSD) to the comparison of the test members against control (bilateral), significances by star with average values characterized