Trialling and Advisory Circle
VuB
Schleswig-Holstein

Chamber of Agriculture
Schleswig-Holstein
Horticultural Centre

Annual report
2017

New grafting secateurs by Scionon were trialled in Schleswig-Holstein.

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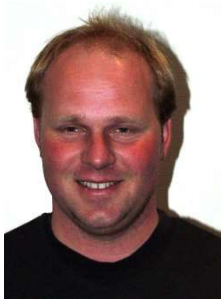

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Annual Report 2017
(Dr Heinrich Lösing, Director)

In 2017, the Trialling and Advisory Circle was able to continue its successful work. A total of 270 nurseries covering 3,070 hectares and 42 supporting members were regularly informed of new findings based on practical experience, science and industry, in particularly fertiliser and plant protection measures which protect the environment, by means of 32 newsletters, via telephone/fax/email and at information events. Advice to individual nurseries continued as it had been previously.

The number of members has been decreasing since the dynamic structural change in the nursery industry in 1995. This trend continued in 2017. The same was true of the contribution areas. These reduced by 94 ha relative to the previous year. This trend is similar across the country. The number of tree nurseries has decreased by 1,685 and the production area by 6907 ha since 2004.

The results of the current statistical survey from 2017 are the subject of controversial debate within the industry. A reduction in the number of companies and production area must, however, be accepted as a fact.

Table 1: Development of the nursery economy in Germany since 2004

	2004	**2008**	**2012**	**2017**
Number of nursery companies	3398	3035	2241	1714
Production areas in ha	25,520	22,597	21,753	18,613

Source: Federal Statistical Office 2017, special series 3, series 3.1.7

There has also been significant interest in machine demonstrations this year.

Presentation of root trimmers for standard trees

In February, a device for root trimming standard trees was presented at the Kleinwort von Holm nursery. In the meantime, the manufacturer Baars (www.baarstechniek.nl) have also developed a device for cutting the roots on smaller plants and presented it in practice.

For decades work has been carried out on simplifying/automating the grafting of woody plants. Almost all of the devices available on the market such as the Omega grafting device do not cut the base and graft, they “punch”. In the case of woody species such as *Malus*, the principle is already being used successfully. For other species such as *Gleditsia and Quercus* it’s virtually impossible to refine with success. A new development by the Scionon company (www.scionon.com) in New Zealand approaches the operation in a different direction. A special blade is mounted on a pair of shears. In addition to a version for right-handed and left-handed people, there is also a version for table grafting that can be fixed to a table.

Propagation cut on a rootstock

Grafting secateurs by Scionon

Two devices were presented as part of the EIP project ‘thermal soil treatment’. These included the fully automatic steaming device for field-scale production by the German company Zeyer (www.zeyer.biz) using tried and tested steam technology by MSD (www.moeschle.de). A steaming device by Hombach (www.hombach.de) for smaller areas was also presented. It is sold by W. Koch from Nauroth.

Presenation of a mobile steaming device for large areas by Zeyer at the Lüdemann Nursery in Hollenstedt

Presentation of a steaming device by Hombach for smaller areas at the Blume Nursery in Vollbüttel

All of the activities were financed using funds from the European Community and the state of Schleswig-Holstein as part of the EIP project on thermal soil treatment over a period of almost three years. The contractor is BTB GmbH. The objective is to develop and optimise alternatives to chemical soil disinfection.

The use of infrared burners on nurseries has expanded, particularly since gas supply is now possible with containers that can be installed on the front of tractors. The companies Drachengas (www.drachengas.de) and Primagas (www.primagas.de) provide TÜV-certified containers on a rental basis.

The devices are primarily used to burn off seedbeds before seed sowing at driving speeds of 100-300 m/h or after seed sowing, at a speed of 3-5 km/h shortly before the tree seedlings emerge. No damage to the seedlings has been observed as a result.

Presentation of the infrared burner by Hoaf (www.hoaf.nl) at M. Ostermann in Ellerbek

Testing the graft growth, here with Rebwachs Pro

The intensive trialling of plant protection products continued in 2017. This included grafting waxes with additives such as the standard product Rebwachs WF (formerly Stähler) which has proven itself over many years but the authorisation for which has expired. New formulations now have to be trialled.

Well over 50 people attended the weed control trials. The focus this year was on potential alternatives to Roundup, Basta and MaisTer fluid. The trials will continue in the coming years.

Inspection of the trial on the plots in Thiensen

As part of the EAFRD (European Agricultural Fund for Rural Development) consultation, a total of 29 nurseries received intensive consulting services on integrated and organic plant protection in 2017. BTB GmbH was commissioned with providing this. The activities were supported by VuB employees. This applied in particular to the subject of organic plant protection. The support was initially limited to two years but has now been extended by a further three years.

Parasitic aphids on a hibiscus plant

Full room at the expert training in February 2018

There was high demand at the expert training sessions organised via the Chamber of Agriculture, Plant Protection Division, together with the VuB. Over 200 participants were trained over two sessions. Participation is required every three years and the session lasts at least four hours.

Since many plant protection products do not have the necessary authorisation for nurseries, the single application in accordance with Section 22 (2), formerly Section 18b, of the Plant Protection Act was processed. A total of 38 plant protection products are currently approved in Schleswig-Holstein for members of the VuB. The order is processed as a single application by VuB employees. The fees per application lasting for three years are currently €560. The joint efforts of BdB Landesverband SH and VuB mean that the funds can now be used for a further 18 months.

Landwirtschafts-kammer Schleswig-Holstein

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Verlängerung der Genehmigung im Einzelfall nach § 22 Pflanzenschutzgesetz (PflSchG)
Ihr Antrag vom **13.11.2014**
Anlage: Gebührenbescheid und Betriebsliste

Sehr geehrte Damen und Herren,

die Anwendung des zugelassenen Pflanzenschutzmittels **Askon**, Zulassungsnummer: **0690-00** wird auf Grundlage des § 22 PflSchG in folgendem Anwendungsgebiet genehmigt:

1. Anwendungsgebiet
Schadorganismus: **Blattfleckenerreger, Echter Mehltau, Rostkrankheiten (Resistenzmanagement)**
Kulturart: **Baumschulgehölze, Stauden**
2. Einsatzgebiet: **Baumschule**
3. Auflagen
Angaben zur sachgerechten Anwendung:
Anwendungsbereich: **Freiland**
Zeitpunkt der Anwendung: **Während der Vegetation**
Maximale Anzahl d. Behandlung
- in dieser Anwendung: **2**
- für die Kultur bzw. je Jahr: **2**
Anwendungstechnik: **spritzen**
Aufwandmenge: **1,0 l/ha**
Wasseraufwandmenge: **200 – 600 l/ha**

4. **Sonstige Auflagen**
Für das genehmigte Anwendungsgebiet sind die für das Mittel in vergleichbaren Anwendungsgebieten sowie die sonstigen in der Gebrauchsanleitung festgesetzten Auflagen und Anwendungsbestimmungen in jedem Falle einzuhalten, soweit es sich nicht bereits um Beschränkungen nach Ziffer 3 handelt.

Approval according to Section 22(2) for the fungicide Askon in outdoor production

The disposal of empty and rinsed plant protection and fertiliser containers continues to be smooth thanks to the Pamira system. The collaboration with HaGe in Uetersen as an on-site location has been established for the past few years. Containers have been collected across the country on a voluntary basis for 20 years. Around 3,000 tonnes in 2017.

Depositing containers at HaGe in Uetersen

Fertiliser advice for nurseries continues to be a focus of our advisory work. Fertiliser recommendations were provided for around 428 samples from container-grown crops, 978 soil samples and 287 N_{min} tests. This number of samples shows the high level of awareness of nurseries of the requirement for needs-based and environmentally sound fertilisation. A further 154 samples were tested to determine nitrogen contents using the rapid nitrate test.

The guideline values in accordance with the Fertiliser Ordinance Section 3 for nitrogen in the soil were also set out. The costs for the sampling and analysing the 40 N_{min} samples were covered by the Horticultural Department of the Chamber of Agriculture. Spring analyses prior to the growing season were also a requirement under the previous Fertiliser Ordinance. This is no longer mandatory under the new Ordinance. The importance of nitrogen as a nutrient and the risk of leaching in the event of excessive applications, mean that guideline values should

continue to be determined for nurseries on a voluntary basis. However, the costs will probably have to be borne by the nurseries themselves. Further information on the new Fertilisation Ordinance can be found under the Fertilisation section of this annual report.

Shoot dieback in privet (photo: S. Heise)

Trials on shoot tip dieback in privet were continued through 2017. Symptoms of shoot dieback still occurred in field production despite a wet summer. The differences between the copper and boron treatments were demonstrated in field-grown crops in response to the soil or leaf fertilisation for the first time. A test of the tolerance was carried out in collaboration with LWK SH.

A trial was carried out on standard trees over a period of two years in collaboration with the engineering company Geries. The objective of the trial was, among other things, to decrease nitrogen leaching by using different fertiliser types (organic/mineral, mineral and partially coated) in various nursery locations. Different products with varying release patterns were also trialled in a range of production systems.

View of the *Tilia* trial field in Holm and the *Abies* trial field in Ellerbek

Commercially available peat-free substrates were trialled in various container-grown crop production systems in several locations. The aim of the trials were to use the peat-free substrates in nursery production without amending processes while maintaining plant quality. *Lonicera nitida* `Maigrün`, *Rosa* `Leonardo da Vinici`® *and Aronia x prunifolia* `Nero` were used as trial plants.


Examples from the container trials: *left Lonicera* in Borstel-Hohenraden and right *Prunus* in Hemdingen

Several prototypes of coated fertilisers were also trialled in comparison to tried and tested standard products in several container operations as part of these trials. *Prunus lusitanica* ‘Angustifolia‘ *and Ligustrum ovalifolium* were used *as* trial plants.

The analysis of heat loss in cold stores used by nurseries was new. In collaboration with the engineering association IGLU (contact: Andreas Baden), there was an opportunity to identify and remedy leaks as part of the EAFRD (European Agricultural Fund for Rural Development) consultation. A total of 8 nurseries took part in the programme in 2017. All of the costs were covered by the EU and the state of Schleswig-Holstein.


View of the cold store door, with two evaporators above it with a normal and a special thermal image camera.

Many of the trials were supported by fertiliser and plant protection product manufacturers, substrate suppliers and nursery suppliers. For 2017, particular thanks go to Arysta, BASF, Bayer CropScience, Belchim, Biofa, Compo Expert, DowAgroSciences, DuPont, Flügel, Haifa North West Europe NV, Hauert Günther Düngerwerke, Heinrich Harden, ICL Specialty Fertilizers, Jost Mikronährstoff- u. Spezialdünger, H. Meyer, Mivena BV, Neudorff, Plantacote

NV, Syngenta, Spiess-Urania Chemicals, Stender AG, Vereinigte Kreidewerke Dammann and Yara.

The intensive trialling work is not possible without practical support. We wish to thank the companies listed below for their support in 2017:

Alves, H., Borstel-Hohen.
Bielenberg, Horst
Bradfisch, Borstel-Hohen.
Bruhn, Barmstedt
Bunk Pflanzen, Elmshorn
Cordes, H., Holm
Cordes, J.-H., Holm
Däneke & Körner, Wedel
Deutschmann, Ellerbek
Ellerbrock, K., Pinneberg
Flessau, H., Halstenbek
Grelck, Halstenbek
Hachmann, Barmstedt
Harder, P., Ellerhoop
Heydorn, P., Bevern
Hoyer, C., Bullenkuhlen
Hoyer, H.-H., Bevern
Huckfeld, A., Hemdingen
Kleinwort, J., Holm
Kleinwort, Wedel
Kröger, S., Horst
Krohn, H., Halstenbek
Kudenholdt,H.-H.,Ellerbek
Langeloh, Tornesch
Lescow, Bokholt-Hanr.
Michelsen, B., Pinneberg
Münster, G., Appen-Etz
Münster, G., Borstel-Hoh.
Oetting, F.,J., Rellingen
Ostermann, F., Ellerbek
Ostermann, Rellingen
Paulsen, St., Rellingen
Pein, G., Appen-Etz
Pein, H., Appen
Ramcke, D., Wedel
Reinke, H., Rellingen
Röttger, H., Heist
Schmidt, J., Lutzhorn
Schrader, Kölln-Reisiek
Schröder, H., Ellerbek
Schuldt, H., Ellerhoop
Schurig, Barmstedt
Seidler, T., Elmshorn
Spilkers, Barmstedt
Stahl, C., Groß-Nordende
Stahl, Tornesch
Steffen, A., Rellingen
Stoffer, Seeth-Ekholt
Timm & Sohn, Tangstedt
Vogt, E., Pinneberg
Zorn, Tangstedt

The 2017 study tour was to England. A total of 8 nurseries were visited. With 17 participants, this trip was less popular than in previous years.

Participants on the study tour to England, in the David Austin Roses Nursery show gardens for old and new plant species

Joint employee training events were carried out with the Schleswig-Holstein Chamber of Agriculture and the DEULA in Rendsburg. There is still a significant degree of demand for the forklift driver training seminar.

Added to the programme six years ago and carried out by the German Red Cross, was training in first aid for the first aiders at work. Retraining is required every two years. The costs of this are covered by the professional horticultural association.

The collaboration with the Horticultural Department of the Chamber of Agriculture and advisers to the plant protection product industry continued taking into account environmental protection in particular with a focus on information collection and dissemination.

In the entire BdB, contributions were made to the committees on ‘production and environment’, ‘IT’, ‘deciduous trees’ and to the ‘working group on horticultural research’. Written questions and questions by telephone from within Germany and abroad continued to be answered as they had previously.

Contact herbicides as a replacement for Basta
(B. Zielke, Dr H. Lösing)

1. Trial objective

On June 30th, 2017, the deadline for using up the herbicide Basta (200 g/l glufosinate as an aluminium salt), which had been used in nurseries for years, passed following the expiry of the authorisation. The VuB carried out trials on the new formulation, Basta 150 SL (150 g/l glufosinate as an aluminium salt) in 2014. The product is currently authorised in Austria and the company Bayer has attempted to obtain authorisation for Germany. The takeover of the company Monsanto is resulting in extensive changes in the plant protection product sector. The marketing rights to the herbicide Basta have been taken on by the company BASF. The timeline for the reauthorisation of the herbicide Basta in Germany is currently unknown.

The product Basta is a non-selective broadleaf herbicide with a contact and partial systemic action. Its use was less risky in deciduous tree production than the use of systemic herbicides that contain glyphosate. It was, for example, commonly used by nurseries to spray the lower leaves of deciduous tree species. The trials described below compare the effect of various contact herbicides.

Fig. 1: Basta replacement trial area on 2 June 2017, a day after treatment

2. Trial design

Both trials were carried out on the Trialling and Advisory Circle's trial areas. Treatments with a turquoise background in the table were examined in both trials; those with a brown or white background were only examined in one trial.

Table 1: Summary of treatments

Treatment	Active ingredient	Application rate	Authorisation	Notes
Untreated				
Basta (old)	200 gl/ glufosinate ammonium	3.75 l/ha	-	
Basta 150 SL	150 gl/ glufosinate ammonium	5 l/ha	-	
Beloukha	680 g/l pelargonic acid	16 l/ha	-	
Beloukha	680 g/l pelargonic acid	32 l/ha	-	
Beloukha + Select 240 EC + Radiamix	680 g/l pelargonic acid 240 g/l clethodim	16 l/ha + 0.75 l/ha + 1.5 l/ha	- B	Xn, B4
Finalsan	186.7 g/l pelargonic acid	80 l/ha	ZG	Xi, B4
Finalsan	186.7 g/l pelargonic acid	166 l/ha	ZG	Xi, B4
Glyfos Supreme	450 g/l glyphosate	4 l/ha	B	B4
Gozai	26.5 g/l pyraflufen-ethyl	2 l/ha	-	
Gozai +Select 240 EC + Radiamix	26.5 g/l pyraflufen-ethyl 240 g/l clethodim	2 l/ha 0.75 l/ha + 1.5 l/ha	- B	
Katoun Gold	500 g/l pelargonic acid	16 l/ha	-	
Katoun Gold	500 g/l pelargonic acid	22.5 l/ha	-	
Lentagran WP	450 g/kg pyridate	2 kg/ha	Section 22 (2) B	Xi, B4
Lentagran WP + Select 240 EC + Radiamix	450 g/kg pyridate 240 g/l clethodim	2 kg/ha 0.75 l/ha + 1.5 l/ha	Section 22 (2) B B	Xi, B4 B4
MaisTer fluid	30 g/l iodosulfuron 0.9 g/l foramsulfuron	1.5 l/ha	Use up by June 2019	Xn, B4
Onyx	600 g/l pyridate	1.5 l/ha	-	
Onyx + Select 240 EC + Radiamix	600 g/l pyridate 240 g/l clethodim	1.5 l/ha 0.75 l/ha + 1.5 l/ha	- B	B4
Quickdown + Select 240 EC + Radiamix	26 g/l pyraflufen-ethyl 240 g/l clethodim	0.8 l/ha 0.75 l/ha + 1.5 l/ha	Section 22 (2) B B	N, Xi, B4 B4
Shark	55.92 g/l carfentrazone	1 l/ha	Wine Potatoes	N, Xi, B4
Shark + Select 240 EC + Radiamix	55.92 g/l carfentrazone 240 g/l clethodim	1 l/ha 0.75 l/ha + 1.5 l/ha	Potatoes B	N, Xi, B4 B4

The first trial with 13 treatments was replicated four times and started on 1 June 2017 beneath *Ligustrum* ‘Atrovirens‘ and *Deutzia gracilis*. The herbicides with a turquoise and brown background in the above table were applied with a backpack sprayer equipped with a

Birchmeyer Flood Jet nozzle using 500 l/ha of water. At the time when the treatments were applied the weather was sunny and the temperature was 17°C. There was little wind in the trial area, which was surrounded by high trees. In trial 1, the coverage of weeds was around 50% at the start of the trial. Common weeds were groundsel, annual meadow-grass, shepherd's purse, fat-hen, chamomile and Japanese knotweed. These are relatively small weeds with a height of around 10 cm.

Fig. 2: Weeds at the start of the trial

The second trial took place three weeks later on 20 June 2017 on an open field area. At the time when the treatment was applied the weather was also sunny and the temperature was 23°C. The treatments were only administered by means of simple replication with a parallel spraying device equipped with 120-03 Lechler ID nozzles. They were applied in a water volume of 512 l/ha. The treatments examined have turquoise and white backgrounds in the table. This trial had a similar range of weeds, but the weeds were 10-15 cm in size and had developed more. The second trial aimed to demonstrate the differences between various application rates of herbicides containing the active ingredient pelargonic acid. The herbicides Beloukha and Finalsan were each compared with one another at a half and full application rate. Another question investigated by the trial was whether the addition of the adjuvant Radiamix to the grass herbicide Select 240 EC improved the effect of the herbicide against dicotyledonous weeds too.

3. Results

Trial 1:

An effect of the herbicides containing the active ingredient pelargonic acid was able to be observed just a few hours after the treatment. The tissues of the plants that were treated discoloured. A day after the treatment the parts of the weeds that were above the ground had died completely in the plots of land treated with Finalsan (166 l/ha). The product Beloukha,

which was only applied at 16 l/ha, had less of an effect. In another trial, it was comparable with an application quantity of 40 l/ha. A week later, the effect of the herbicide Basta was visible. The effect of MaisTer and Glyfos Supreme could still not clearly be seen at this point.

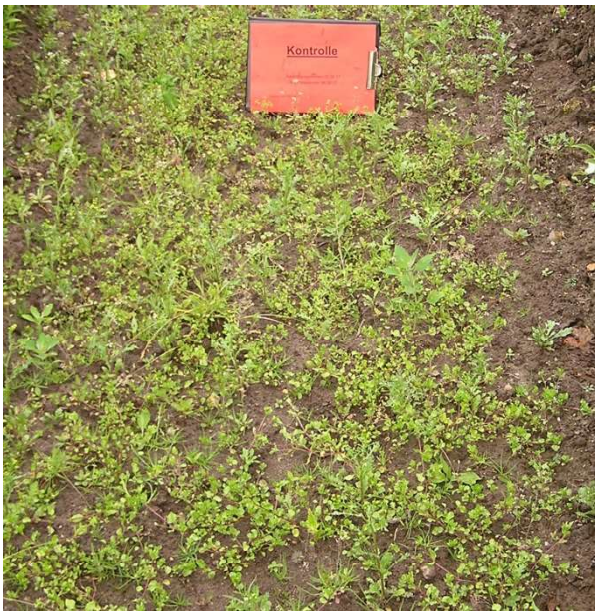

Fig. 3: Control plot seven days after the start of the trial
Fig. 4: Seven days after treatment with 5 l/ha Basta 150 SL

Fig. 5: Seven days after treatment with 16 l/ha Beloukha
Fig. 6: Seven days after treatment with 166 l/ha Finalsan

The herbicide Gozai had a good effect on dicotyledonous weeds seven days after treatment, the annual meadow-grass was not recorded. The herbicide Lentagran WP also had no effect on grass weeds. The effect on dicotyledonous weeds was minimal in this trial.

Fig. 7: Seven days after treatment with 2 l/ha Gozai
Fig. 8: Seven days after treatment with 2 kg/ha Lentagran WP

Three weeks after application there were just four treatments in which the degree of coverage with weeds was significantly lower than in the untreated variant. Most of the weeds had completely died out in the plots treated with the herbicides Glyfos Supreme and MaisTer fluid. The exception to this was the Japanese knotweed. It had a slight red discolouring and grew slower.

The plots treated with the herbicides Basta (3.75 l/ha) and Basta 150 SL (5 l/ha) also had a low level of weed coverage. Both products had a similarly good effect at the quantities applied. The effect against annual meadow-grass and yellow fieldcress was slightly lower on these plots than on the plots treated with MaisTer fluid or Glyfos Supreme.

There was a similar level of weed coverage on the other treated plots compared to the untreated plots. The range of weeds changed in many cases. The percentage of annual meadow-grass and camomile on the plots treated with Beloukha (16 l/ha), Finalsan (166 l/ha) and Katoun Gold (16 l/ha) increased, for example. These two weeds recovered the quickest from the herbicide treatments and covered the space that had become free.

The herbicide Gozai had a very good effect on annual dicotyledonous weeds, but did not control the annual meadow-grass, which had completely taken over the space that had become available three weeks after treatment.

The herbicides Onyz (1.5 l/ha), Lentagran (2 kg/ha) and Shark (1 l/ha) had the least effect overall. As expected they did not have an effect on monocotyledonous weeds. However, in this test they were only applied by themselves and in small quantities against the dicotyledonous weeds that were already 10 cm at the start of the trial.

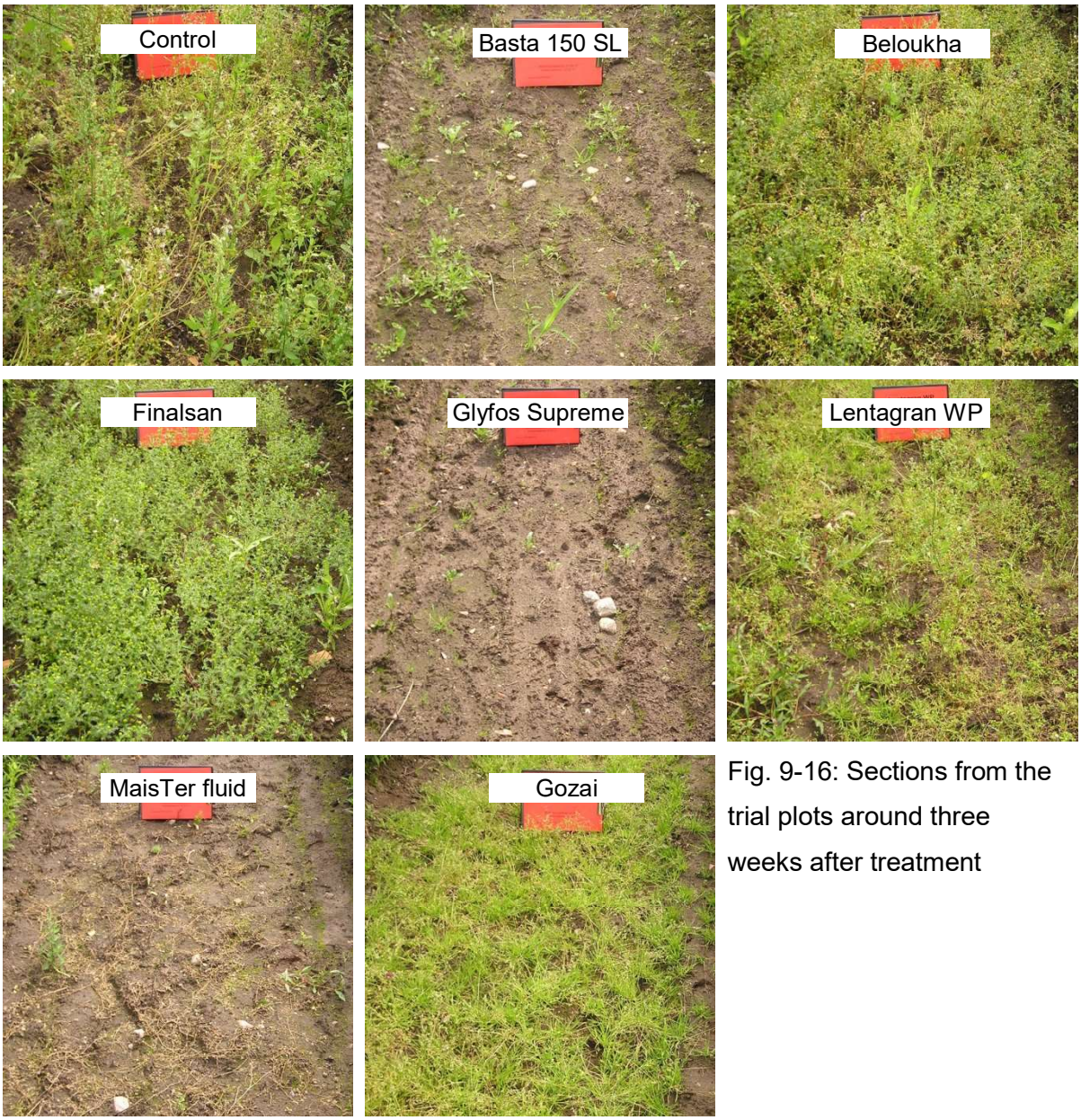

Fig. 9-16: Sections from the trial plots around three weeks after treatment

Trial 2:

This trial was evaluated 17 days after treatment application. The effect of the herbicide containing pelargonic acid could be observed depending on the rate applied.

At the full application rate (166 l/ha), 30.99 kg/ha of pelargonic acid was applied with the product Finalsan. With Beloukha (32 l/ha), just 21.76 kg/ha of pelargonic acid was applied. The effect tended to be less significant.

Fig. 17: 17 days after treatment with 16 l/ha Beloukha
Fig. 18: 17 days after treatment with 32 l/ha Beloukha

Fig. 19: 17 days after treatment with 80 l/ha Finalsan
Fig. 20: 17 days after treatment with 166 l/ha Finalsan

The adjuvant Radiamix, which was tank mixed with the herbicide Select 240 EC, did not improve the effect of the herbicide Lentagran WP on dicotyledonous weeds. The weeds were probably already too large to be controlled by the herbicide in the trial.

Fig. 21: 17 days after treatment with 2 kg/ha Lentagran WP
Fig. 22: 17 days after treatment with 2 kg/ha Lentagran WP + Select 240 EC + Radiamix

Fig. 23: 17 days after treatment with 1 l/ha Shark + Select 240 EC + Radiamix
Fig. 24: 17 days after treatment with 0.8 l/ha Quickdown + Select 240 EC + Radiamix

The products Shark, Gozai and Quickdown, all herbicides for use in potatoes, still had an effect on weeds of this size. In combination with the grass herbicide Select 240 EC, they reduced the level of weed coverage significantly. The product Shark had the least effect. When it was combined with Select 240 EC and Radiamix, Quickdown had an effect that was comparable with the product Gonzai with Select 240 EC and Radiamix, even without the adjuvant Toil.

When the weeds were inspected more closely, however, it transpired that these had not been killed down to the roots and only the parts above the soil level had been damaged. Weeds

such as yellow fieldcress, shepherd's purse and groundsel started to grow from below again 17 days after treatment.

4. Summary

In a trial to determine the efficacy of leaf-active herbicides, products containing pelargonic acid were compared with the new and old formulations of the herbicide Basta, a product containing glyphosate, the herbicide MaisTer fluid and Lentagran in the solid and liquid formulations and herbicides to kill weeds in potato crops.

The superior effect of the systemic and partial systemic products Glyfos Supreme and MaisTer fluid and Basta in the old and new formulations was clear.

The herbicides based on pelargonic acid and the two products that contain pyridate or the active ingredients for weed control in potatoes did not have a good effect on grass as predicted. If both grass and broad-leaved weeds are present they need to be combined with a grass herbicide.

The products containing pelargonic acid had a very quick but only brief effect. This makes them interesting for use on tree seed beds before tree seedling emergence. The effect of Shark, Gozai and Quickdown was somewhat slower to start but was considerably stronger. From trials carried out in 2010 we know that these herbicides can have a gemination-inhibiting effect on weeds but also on tree seeds.

The weeds in this trial were already too large for the product Lentagran WP or its liquid counterpart Onyz to be used. Lentagran WP is however in practice significant in terms of its use on deciduous tree seed beds with small weeds.

Of the herbicides tested, Glyfos Supreme, MaisTer fluid (use by June 2019), Finalsan, Lentagran WP (Section 22.2) and Quickdown (§ 22.2) can currently be used. The grass herbicide Select 240 EC is also authorised.

A nursery owner currently still has a choice depending on the area of use and the weeds that are growing. The trial shows the difficulties that threaten nurseries if the range of leaf-active herbicides is further reduced. Larger weeds or weeds with tap roots cannot be sufficiently controlled with non-systemic products.

Tolerance and efficacy of herbicides in summer transplants
(B. Zielke, Dr H. Lösing)

1. Introduction and trial objective

Conifer seedlings are transplanted in summer after the main growth period. Soil herbicides are used to keep the transplant beds free of weeds. When selecting the soil herbicide, the condition of the needles (hard and mature or still soft and immature) is decisive in terms of tolerance.

The objective of the trial was to investigate various soil herbicides to determine their efficacy and tolerance. The tolerance of related herbicides was also investigated in light of the damage that the herbicide Terano previously caused to spruces. In order to do this, the herbicides were applied at higher rates.

2. Trial design

The herbicides were applied on 6 June 2016 in sunny weather and at a temperature of 18°C. They were applied twice. The trial plants were *Picea abies* and *Picea sitchensis* which were transplanted on 25 August. The herbicides listed in Table 1 were applied using a parallel spraying device with 120-025 Lechler nozzle ID purple at a pressure of 5.5 bar and a speed of 3 km/h. This resulted in a spray volume of 512 l/ha.

Fig. 1-2: Trial area on the day of treatment

The plots of land were broadly free from weeds at the point at which the treatments were applied. However some weeds had started to emerge and were in the cotyledon or first true leaf stage. Common weeds were fat hen, annual meadow-grass, lady's thumb and chickweed. There were a small number of red dead nettles, curly docks and wild pansies.

Table 1: The treatments were applied at twice, and in the case of Spectrum, three times the application rates to check the tolerance

Herbicide	Application rate	Active ingredient	Authorisation	Notes
Control				
Artist	2.5 kg/ha	175 g/kg metribuzin 240 g/kg flufenacet	Section 22 (2) B	N, Xn, B4
Butisan Kombi	2.5 l/ha	200 g/l dimethenamid-P 200 g/l metazachlor	Item 51 ZP	N, Xn, B4 NG 346
Spectrum	1.2 l/ha	720 g/l dimethenamid-P	Item 51 ZP	N, Xn, B4
Wing P* (Spectrum Plus)	4 l/ha	212.5 g/l dimethenamid-P Pendimethalin (250 g/l)	-	
Fresco	3.75 l/ha	Metobromuron (400 g/l)	-	

NG346: Within 3 years, the maximum application rate of 1000 g metazachlor per hectare on the same area must not be exceeded, even when the active ingredient is combined in other plant protection products.

*Wing P is authorised at 4 l/ha in the Netherlands. It has been authorised in Germany since December 2017 under the name Spectrum Plus for sweetcorn and vegetable production, but will probably only be sold from 2019.

3. Results

3.1 Efficacy

On 10 October 2016, around one month after the start of the trial, the level of weed coverage was just under 70% on the untreated plots. All of the treatments significantly reduced the number of weeds.

The herbicide Spectrum did not control seedlings of fat hen that had already emerged when it was applied at 1.2 l/ha. The weed coverage was an average of 35% over these plots in mid-October. Doubling the application rate considerably improved the effect against fat hen seedlings that had already emerged. In mid-October, the level of weed coverage in the plots treated with 2.4 l/ha Spectrum was just under 12%.

The lowest level of weed coverage occurred after treatment with the products Artist and Fresco at the full and double application rates. On average, less than 5% of the plot was covered with weeds by mid-October.

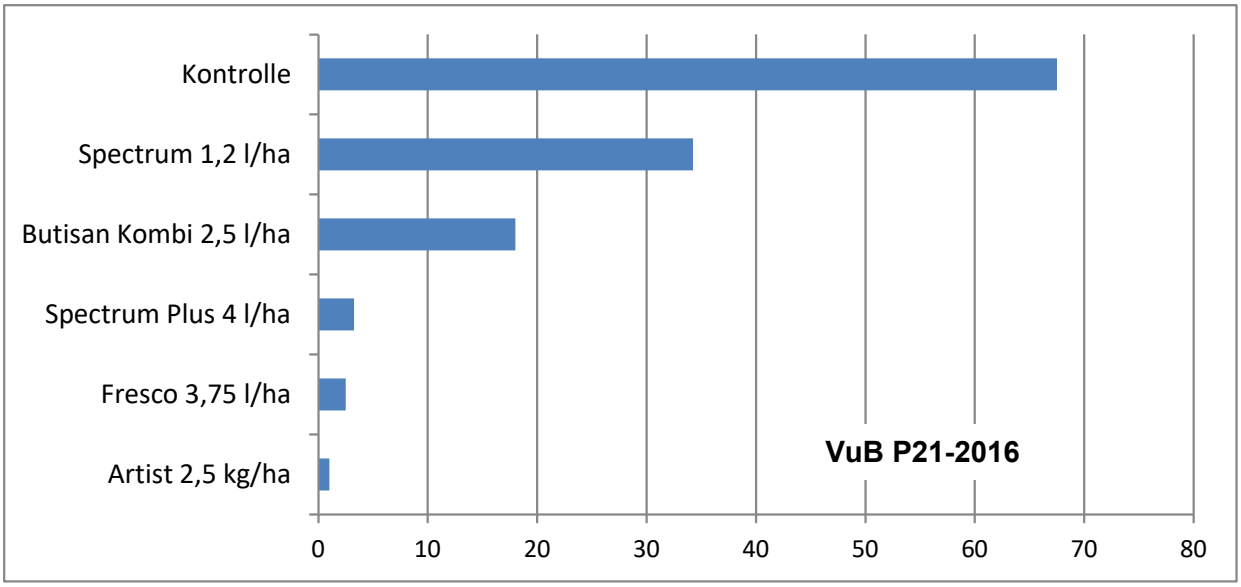

Fig. 3: Level of weed coverage a month after the start of the trial

Fig. 4-7: Sections of the trial plots on 10 October 2016, one month after treatment

In addition to knowledge about the level of weed coverage, the trial also provided information on the strengths and weaknesses of the herbicides against less common weeds. At the rates applied, the herbicides Butisan Kombi and Spectrum had a good effect against red dead nettle

but were not effective against wild pansies. Spectrum was also not effective against curly dock seedlings. The herbicide Fresco had an excellent effect against curly dock seedlings and wild pansies, but did not prevent the germination of red dead nettle sufficiently.

3.2 Tolerance

Just a few weeks after treatment there was some considerable damage to the plants. The Sitka spruce was more sensitive than the red spruce.

Damage was caused by the herbicides Artist and Fresco in particular. Even at an application rate of 2.5 kg/ha, Artist led to chlorosis on the tips of the Sitka and red spruces. Twice the application rate caused necrosis. The use of Fresco at 3.75 l/ha and at twice the application rate caused similar effects in both spruce species.

Fig. 8-9: Damage caused by the herbicides Artist and Fresco (with the same active ingredient as Proman) was visible around a month after treatment

The other herbicides that were trialled all contained the active ingredient dimethenamid-P. In this trial, they did not cause any damage to red or Sitka spruces at any of the application rates trialled.

The chlorosis and necrosis on the plants treated with Artist or Fresco were still visible the following spring before bud emergence. Table 2 provides an overview of the results of the tolerance test.

Bud emergence occurred as normal at the start of May provided the terminal bud had not been damaged. By August 2017 the plants had recovered from the damage astonishingly well. Even Sitka spruces which had been treated with twice the application rate of the products Artist or Fresco had recovered and had normal needle colours. The plots did, however, have gaps and a smaller plant size was noted. Distortions typical of the use of Terano were not able to be identified on any of the plants.

Table 2: Tolerance trial results

Herbicide	Application rate	Tree species trialled	
		Picea sitchensis	*Picea abies*
Artist	2.5 kg/ha	-	-
Butisan Kombi	2.5 l/ha	+	+
Spectrum	1.2 l/ha	+	+
Wing P	4 l/ha	+	+
Fresco	3.75 l/ha	-	-

Discussion:

The herbicide that used to be authorised for nurseries is now much used and Terano, sometimes caused damage to spruces in the past. The official recommendation was therefore not to use it in such production. It was not clear whether the active ingredient flufenacet (resistance group K3) or the active ingredient metosulam (resistance group B) also caused the striking distortion. New residual herbicides were trialled when the authorisation for the herbicide Terano expired. The herbicide Artist contains the active ingredient flufenacet, while the herbicides Spectrum, Spectrum Plus (Wing P) and Butisan Kombi contain the active substance dimethenamid-P (resistance group K3), which is related to flufenacet.

In the trial, Artist was applied at 2.5 kg/ha and at twice this application rate and therefore at rates of up to 1200 g/ha flufenacet. This would correspond to a rate of 2 kg/ha of Terano. Damage occurred, but it was not the same as the damage typical of Terano. The active ingredient dimethenamid-P, which is related to flufenacet and found in the products Spectrum, Butisan Kombi and Wing P, did not cause any damage even when the application rates were doubled or even trebled. The use of these products at normal application rates therefore appears to be safe for spruces.

The herbicide Artist, which is interesting in terms of its effect, and the product Proman, which contains the same active ingredient as Fresco, have been approved for VuB members with areas in Schleswig-Holstein according to Section 22 (2). The authorised application quantities of 2 kg/ha of Artist or 3 l/ha of Proman can be used in red spruces in spring before bud emergence. (VuB Annual Report 2013, page 24 et seqq. and 2014, page 49 et seqq.). The use of these herbicides at reduced application quantities is also possible in spruces transplanted in summer with hard needles.

Blue algae on container beds areas and paths
(B. Zielke)

During the summer months, a slimy algae-like mass expands over container beds and gravel paths on nurseries. These masses sometimes almost form carpets, which not only look bad but also mean a real problem in terms of occupational safety because of the risk of slipping. To date, little was known about what this actually was and what could be done about the problem. An investigation in a laboratory and a literature research now provide clarity.

Fig. 1: Algae sample from a nursery in the district of Pinneberg during the test by KLS Gewässerschutz [water protection] in Hamburg

The company KLS Gewässerschutz from Hamburg identified a sample sent by VuB as blue algae from the species *Nostoc commune.* Blue algae are cyanobacteria. These bacteria can carry out photosynthesis and join together to form vegetative cell chains (hormogonia) that enable forward motion. The gelatinous deposits consist of long cell filaments (trichomes) entwined around one another and embedded in a common jelly. Within these deposits, some cells differentiate into heterocytes, special cells that can bind to nitrogen in the air. Since *Nostoc* can take both carbon and nitrogen from the air, it is able to survive on any subsoil that is moist enough. If the moisture levels are not high enough resistant forms (akinetes) are formed. The deposits then dry to form a paper-like dark substance that can swell up again when more moisture is available. This makes this blue algae extremely resistant.

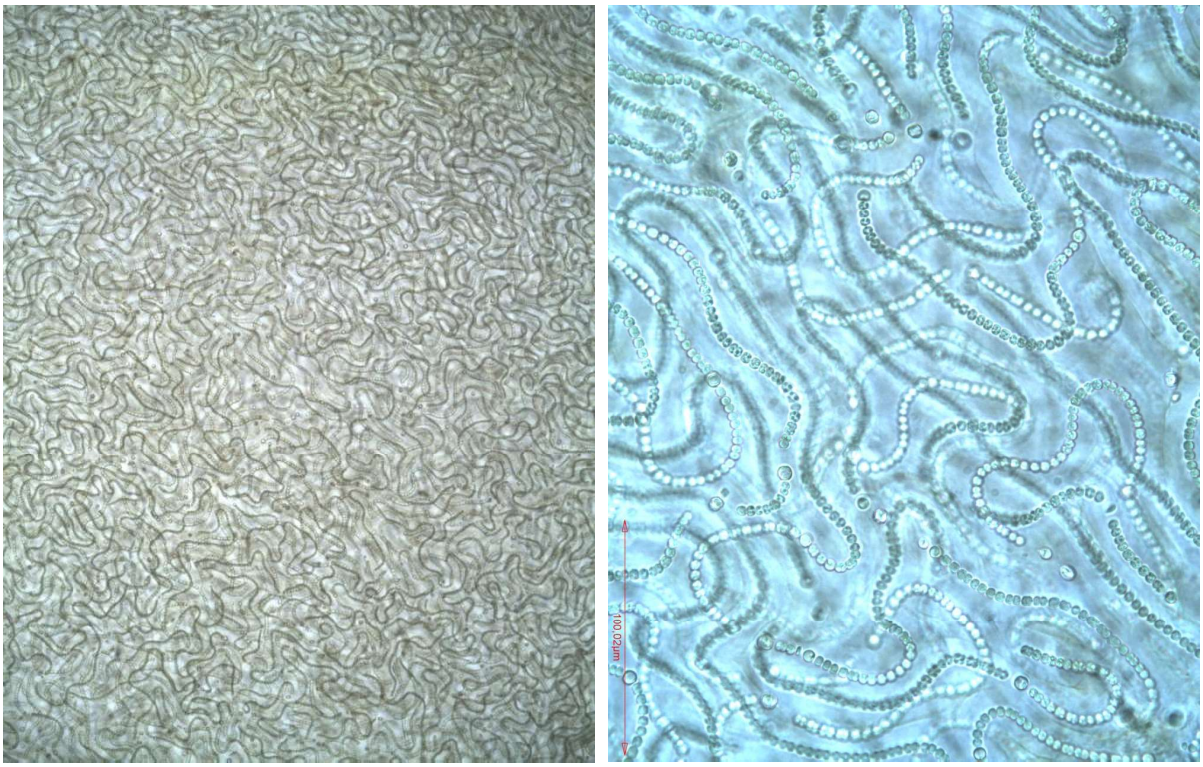

Fig. 2-3: Deposit and fibres of the blue algae *Nostoc commune*; light microscopic photos enlarged 40 and 400 times, photos: KLS Gewässerschutz Hamburg

Blue algae have been on this earth for several million years. They produced the first oxygen in our atmosphere, making life on this planet even a possibility. In the North American nurseries investigated, *Nostoc* was not only able to be found in the beds but also in the entire irrigation system. This omnipresence and resistance make *Nostoc* very difficult to remove. The *Nostoc* carpets can be mechanically removed. Irrigation should be reduced to the necessary minimum and areas should be managed in such a manner that they dry quickly. A lack of phosphorous also limits the growth of the blue algae. Herbicides such as glyphosate do not have an effect and can even have the opposite effect as it is a source of phosphorous. Substances designed to kill algae do not necessarily work as the structure of the cell walls in blue algae is different. Only the active ingredient pelargonic acid from the herbicide Finalsan damages the shell of the cyanobacteria. However, since each cell is in principle an independent organism, the ‘carpet’ can even regenerate quickly if this is used. The production measures mentioned are more effective.

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Controlling the winter eggs of the woolly beech aphid
(B. Zielke, Dr H. Lösing)

1. Trial objective

The woolly beech aphid (*Phyllaphis fagi*) continues to be one of the most significant pests in red and copper beech cultivation. Several trials have been carried out to control these aphids in the past few years (see annual report 2002, page 19, annual report 2003, page 26 et seqq., annual report 2005, page 32 et seqq., annual report 2006, page 24 et seqq., annual report 2008, page 24 et seqq.).

The range of products used to control the aphids is very much limited. Effective products come from the neonicotinoid group of active ingredients (Confidor WG, Mospilan SG), and the products Teppeki and Movento OD can also be used.

The treatment of beeches pre-bud emergence with Para Sommer Oil is now standard treatment against the winter eggs of the woolly beech aphid (*Phyllaphis fagi*) (see VuB annual report 2010; page 7). Nothing achieves a 100% effect, but the degree of infestation with aphids at the start of the growing season is decreased by these measures. Treatment with products containing mineral oils means some of the aphids die and suffocate within the winter eggs.

In practice, there is still uncertainty about the rate to be applied. The issue of whether insecticide should be added to improve the effect also continues to arise. The trial described below aimed to clarify these issues.

Fig. 1: The woolly beech aphid overwinters as blue eggs on the bark of the plants

2. Trial design

The trial was repeated three times. The plot length was 5 m. Trial plants were biennial beech seedlings which were in rows of three in beds. The treatments were applied at two different times. The first treatments were applied on 19 April 2017, well before the plants started to grow, in sunny weather and at 9°C. The wind speed was 0-2 m/sec. The second treatment was applied on 3 May 2017, immediately before growth commenced on

the plants. At this point, the temperature was 11°C and it was a cloudy day. The wind speed was 2-3 m/sec. By the second treatment date the buds had already swollen and the first leaves were visible. Some treatments were applied at both application dates

.

A further difference between the treatments in addition to the application time was the water volume used. Some products were applied in 1000 l/ha of water while others were applied in double the quantity, so 2000 l/ha. In these treatments, the plots were driven through twice with the parallel spraying device. The plots were approached from two different directions and the nozzles placed at an angle to simulate double flat fan nozzles. The water coverage achieved on the plants treated was monitored using water-sensitive paper that had been fixed to the upper and lower level of the plants.

Fig. 2-3: Water-sensitive paper to show coverage left before and right after treatment with 1000 l/ha of water. The paper was hung up in the upper and lower area of the plants.

The test treatments are shown in the following table.

Table 1: Treatments, water volumes and application dates

Treatment	Application rate	Active ingredient	Water volume l/ha	Date	ZL*	Notes
Control						
Para Sommer	20 l/ha	654 g/l paraffin oil	2000	03/05/17	Article 51 ZP	N, B4
Promanal Neu	20 l/ha	546 g/l paraffin oil	2000	03/05/17	Article 51 ZG	N, B4
Mospilan SG+ Para Sommer	0.3 kg/ha + 20 l/ha	200 g/kg acetamiprid 654 g/l paraffin oil	1000	03/05/17	Article 51 ZP	N, Xn, B4 N, B4
NeemAzal + Promanal Neu	3 l/ha + 20 l/ha	10.6 g/l azadirachtin 546 g/l paraffin oil	1000	03/05/17	Article 51 ZP Article 51 ZG	
Spruzit Neu	20 l/ha	4.59 g/l pyrethrins 825.3 g/l rapeseed oil	2000	03/05/17	ZP	N, B4
a) Finalsan b) Para Sommer	166 l/ha 20 l/ha	168.7 g/l pelargonic acid 654 g/l paraffin oil	1000 2000	a) 19/04/17 b) 03/03/05/17	ZG Article 51 ZP	Xi, B4 N, B4
a) Para Sommer b) Para Sommer	20 l/ha 20 l/ha	654 g/l paraffin oil	1000 1000	a) 19/04/17 b) 03/03/05/17	Article 51 ZP	N, B4
a) Para Sommer b) Para Sommer	20 l/ha 20 l/ha	654 g/l paraffin oil	2000 2000	a) 19/04/17 b) 03/03/05/17	Article 51 ZP	N, B4

*Note on the authorisation (ZL) situation: Para Sommer and Promanal Neu are authorised against spider mites and species of scale insect. Finalsan is only authorised to treat weeds in ornamental trees.

Ten randomly selected leaves per plot on the upper part of the plants were turned over for assessment on 18/05/18. The number of aphids that had grown on each leaf was determined for the location and the position. Mean values were calculated.

3. Results

The use of the water-sensitive paper showed how well the vertical target areas were wetted with the different quantities of water and at the different nozzle settings. With the nozzles set straight and a water quantity of 1000 l/ha, the vertical target areas in the upper region of the plants were sufficiently well wetted while those in the lower region of the plants were insufficiently wetted.

With two trips and nozzles set at an angle (the transfer of this to practice means the use of double flat fan nozzles), the wetting of the vertical target areas in the upper and lower regions of the plants which as yet had no aphids on them was very good.

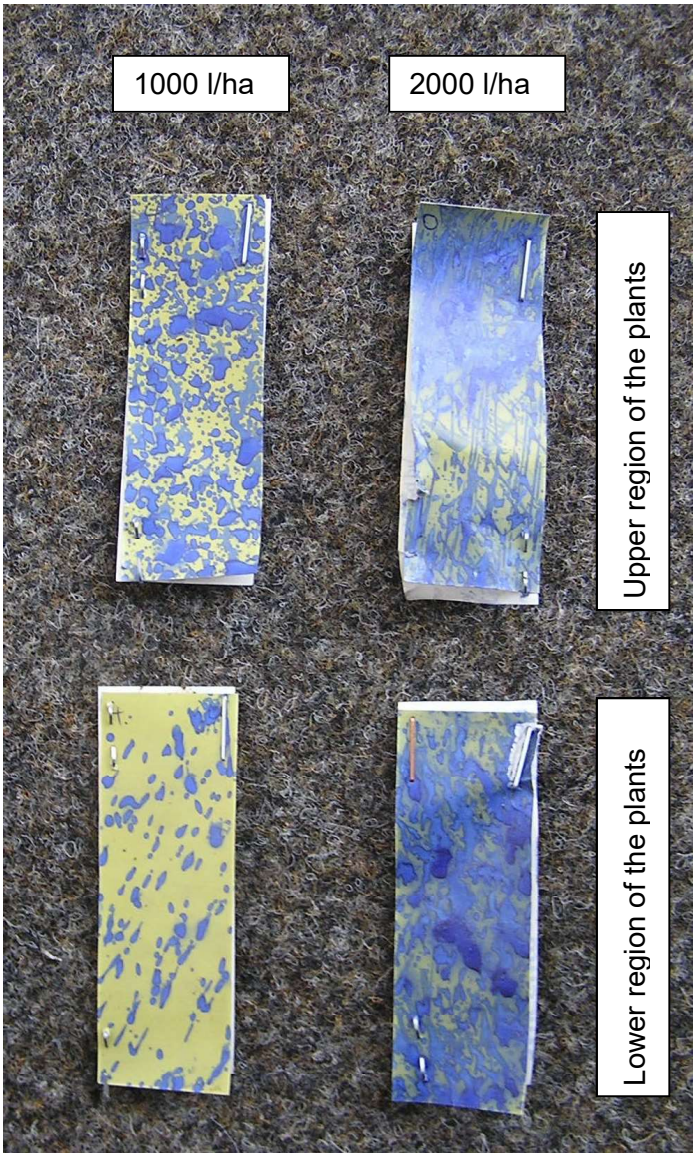


Fig. 4: Wetting of the vertical target areas with various water volumes and different nozzle settings.

The number of aphids per leaf showed differences between the treatments. On 18/05/17 there were an average of just under 9 adult aphids on the bottom of the leaves on the untreated plots. The lowest number of aphids was identified on the plots treated twice with Para Sommer Oil, at just less than one aphid per leaf. The oil treatments with higher quantities of water per hectare and the simulated use of the double flat fan nozzle tended to do better than treatments carried out with a smaller quantity of water. The addition of an insecticide such as Mospilan or NeemAzal was not able to overcome the disadvantage of the smaller quantity of water applied.

The following graphic shows the mean values from the trial.

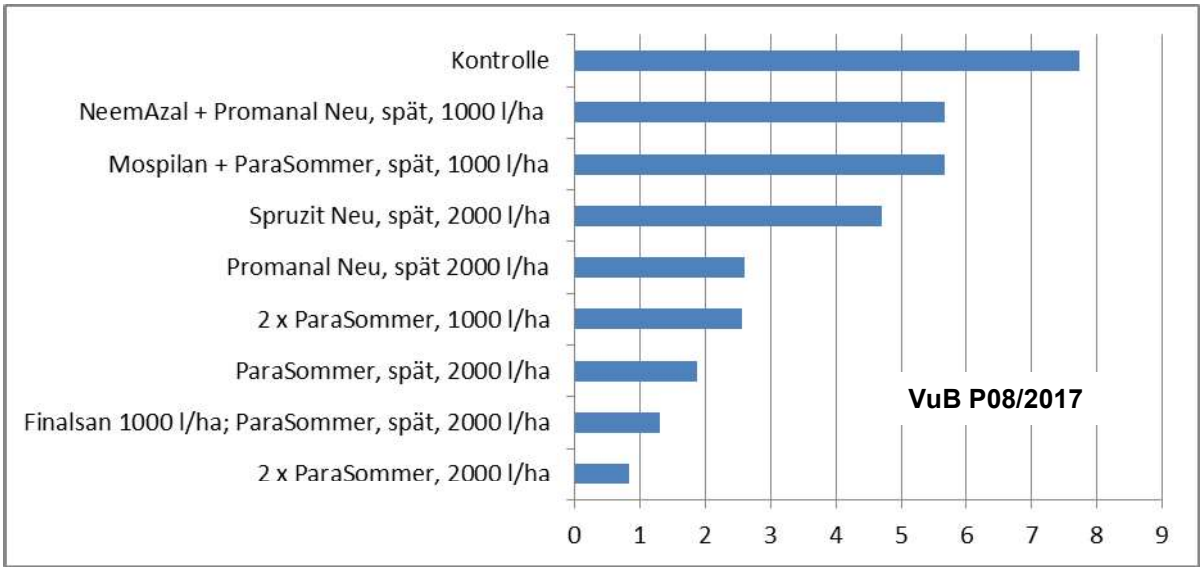


Fig. 5: Average number of woolly beech aphids per leaf in the upper region of the plants (mean values from three replicates). In addition to the products used, the graphic also shows the time at which the product was applied and the quantity of water used

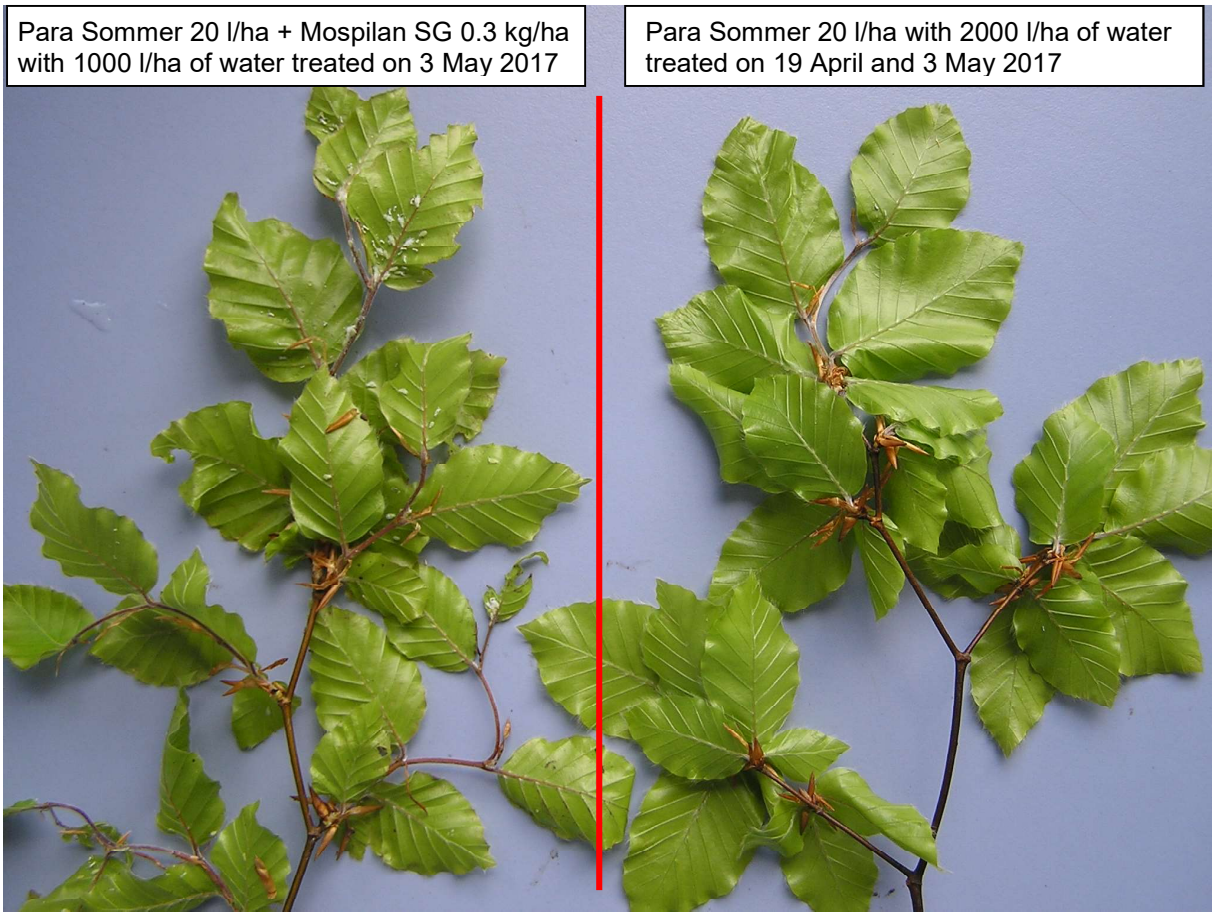


Fig. 6: Trial plants from various plots recorded on 18 May 2017

4. Summary

The objective of the trial presented was to test the efficacy of various pre-emergence spray treatments to control the winter eggs of the woolly beech aphid.

From an earlier trial (see VuB annual report 2010; page 7), it is known that the time at which the treatments are applied should correspond with mild temperatures, where possible shortly before the plants come into leaf and therefore shortly before the aphids hatch.

The assumption that good wetting is critical to the success of these treatments was able to be confirmed by the trial. Water-sensitive paper was used to show the wetting with various water quantities and nozzle types. Since the bark of the beech tree seedlings predominantly consists of vertical target surfaces, the simulation of the use of double flat fan nozzles was successful. Very good wetting was also achieved in the lower region of the plants at 2000 l/ha of water. The quantities of water applied may even be able to be reduced with nozzles of this type while obtaining sufficient coverage.

Tank mixing insecticides at this stage is not effective when there is still no leaf canopy and can even be counterproductive in terms of beneficial insects.

Fig. 7: A lady bird in a beech area shortly before leaf emergence

Tolerance and efficacy of insecticides against *Aphis gossypii*
(B. Zielke, Dr H. Lösing)

1. Trial objective:

Hibiscus syriacus are commonly infested with aphids in nursery production. The aphids are mostly the aphid species *Aphis gossypii,* which is the most common species in the world and occurs primarily on cucumbers and cotton. On hibiscus, this aphid has a dark appearance in spring whereas during the heat of summer lighter-looking smaller forms develop. It is difficult to control *Aphis gossypii,* and sometimes crops are unmarketable because of severe infestations or the associated contamination with sooty mould. In a trial carried out on a nursery, the efficacy of various insecticides against these aphids was compared.

Fig. 1-3: (from left to right) severe infestation with aphids on the young shoots, shortened internode length and decreased growth, sooty mould on the leaves as a result of a severe aphid infestation

2. Trial design

A trial with eight treatments and three replicates was carried out in a greenhouse containing *Hibiscus syriacus* (varieties ‘Maike‘, ‘Mathilda‘, ‘Lavender Chiffon‘, ‘White Chiffon‘, ‘Red Heart‘, ‘China Chiffon‘, ‘Marina‘) in 5 litre containers. Each plot consisted of 20 plants.

On 17/05/17 the trial plants were treated in sunny weather and at 25°C. The products listed in Table 1 were applied until run-off using a backpack sprayer. Careful wetting of the plants was ensured (around 1000 l of water per ha). A second treatment was carried out under similar weather conditions on 26 May 2017. The numbers of insects were counted immediately before the second treatment and four days after the second treatment. In order to do this, the number of aphids on ten shoot tips from the centre of each plot was counted. After the second count

the trial was ended as the infestation in the untreated control and the poorer performing treatments could no longer be tolerated by the company.

Table 1: Overview of the treatments

Treatment	Application rate	Active ingredient	Authorisation	Note
Control	-	-		-
Confidor WG 70	0.35 kg/ha	700 g/kg imidacloprid	ZP (UG)	N, Xn, B1, NB 504
Isoclast	0.4 l/ha	120 g/l Sulfoxaflor	-	-
Movento 150 OD	0.3 l/ha	150 g/l spirotetramat	B and B (UG)	N, Xn, B1
Neudosan Neu	20 l/ha	515 g/l green soap	ZP (UG)	N, Xn, B4
NeemAzal-T/S	3 l/ha	10.6 g/l azadirachtin		N, B4
Sivanto Prime	1.125 l/ha	200 g/l flupyradifurone	-	-
Teppeki	0.16 kg/ha	500 g/kg flonicamid	Item 51 ZP (UG)	B2

NB 504: Treatment before flowering is only permitted if no use of the plants outdoors is planned for the year of treatment.

Fig. 4: Trial plants on 26 May 2017 when the second treatment was applied

3. Results

3.1 Tolerance

None of the insecticide treatments caused any damage to the hibiscus plants. At the end of the trial, there was a reduction in internode length due to aphid feeding and colonisation.

3.2 Efficacy

At the start of the trial, there was an aphid infestation on the plants. There were more than 30 aphids on some of the shoot tips. There were no plants without any aphids on them. An extensive count was not carried out at the start of the trial for reasons of time.

On the date of the first count, nine days after the first treatment, the effect of a number of insecticides could be seen even without a precise count. The aphid colonies had increased significantly in all three replicates of the untreated plots relative to start of the trial. This could be seen with the naked eye for the plants treated with Neudosan Neu or NeemAzal-T/S, no differences compared to the untreated plots were identified.

Significantly lower numbers of aphids per shoot tip occurred, however, on plants that had been treated with the products Confidor WG 70, Sivanto Prime, Isoclast or Teppeki. This observation was made across all three replicates and was confirmed in the count.

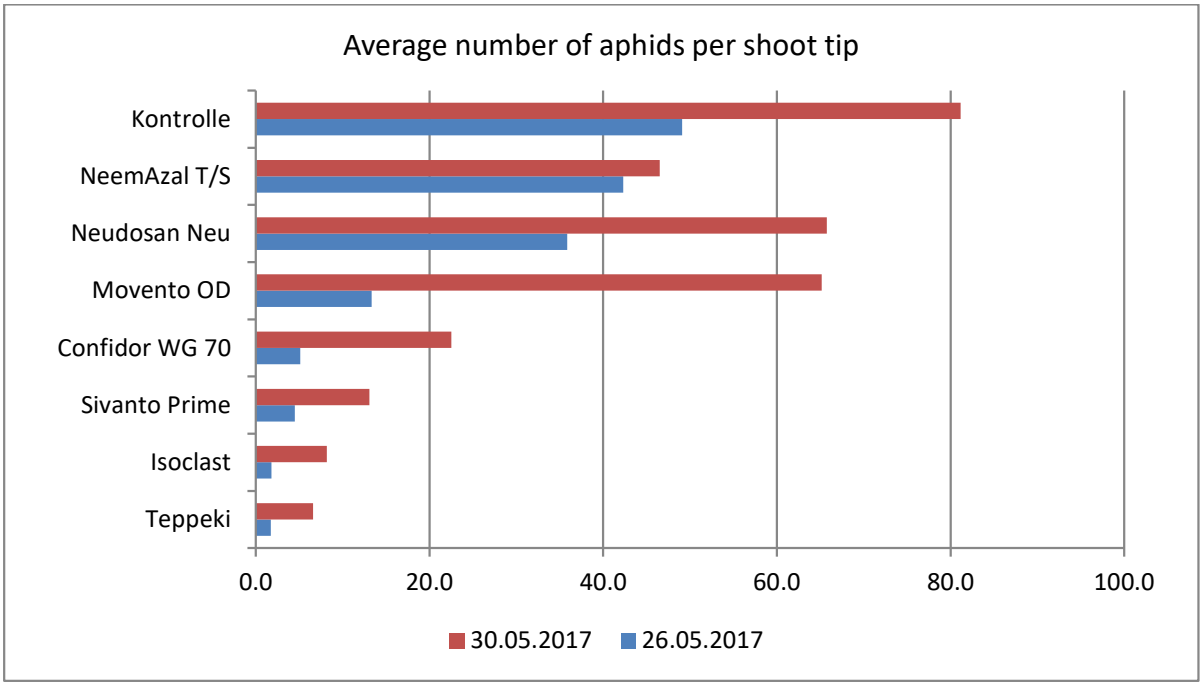


Fig. 5: Results of the counts on 26 May 2017 and 30 May 2017 (mean values from three replicats each with ten shoot tips)

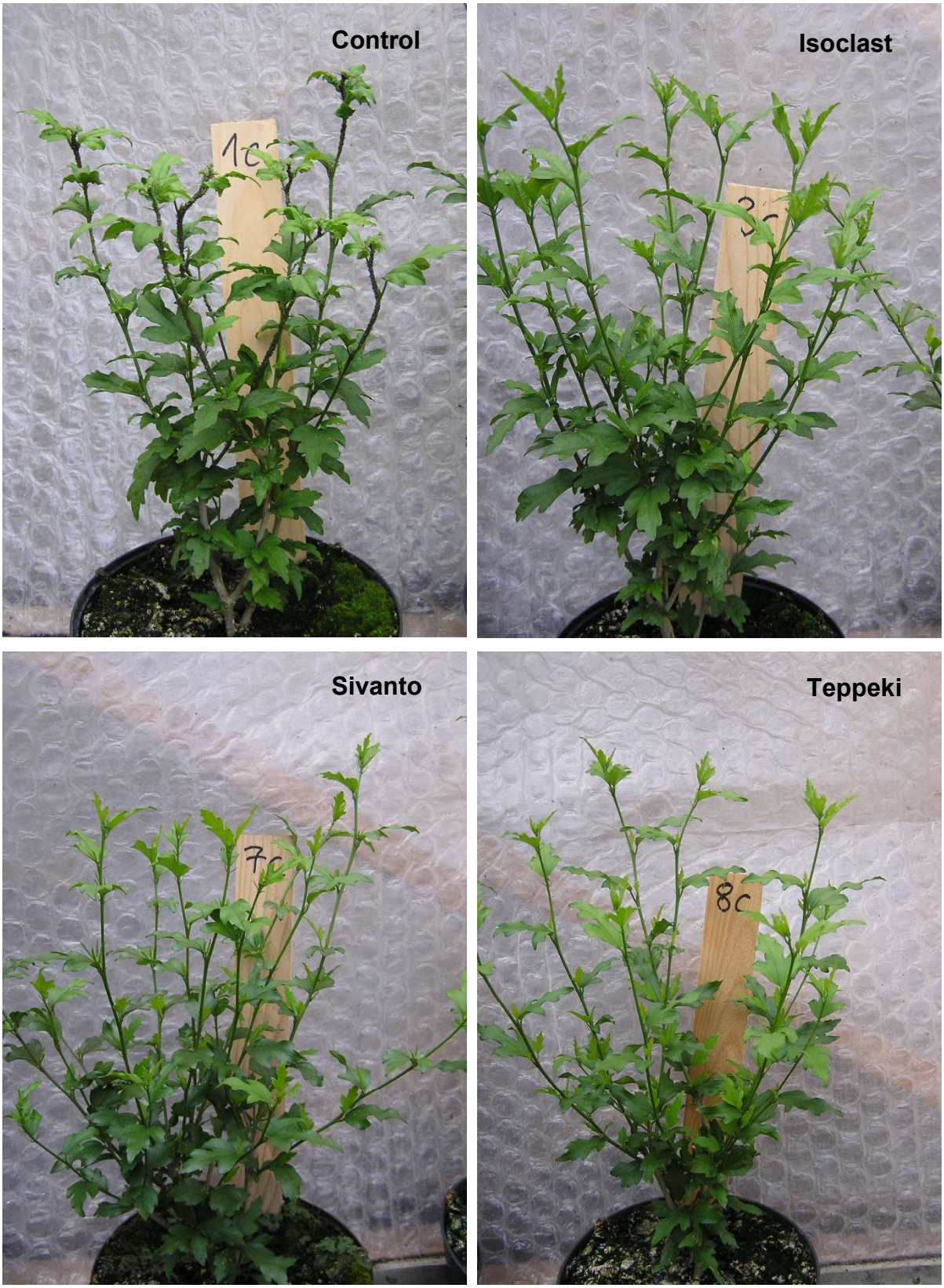


Fig. 6-9: Typical plants from various treatments on 26 May 2017

A similar result occurred at the second count just a few days later. Plants in the untreated control and other severely infested treatments already had growth deformations. The same

treatments as for the first count produced positive results. The average number of aphids on the plots treated with Confidor WG 70 and Movento OD, however, had increased slightly.

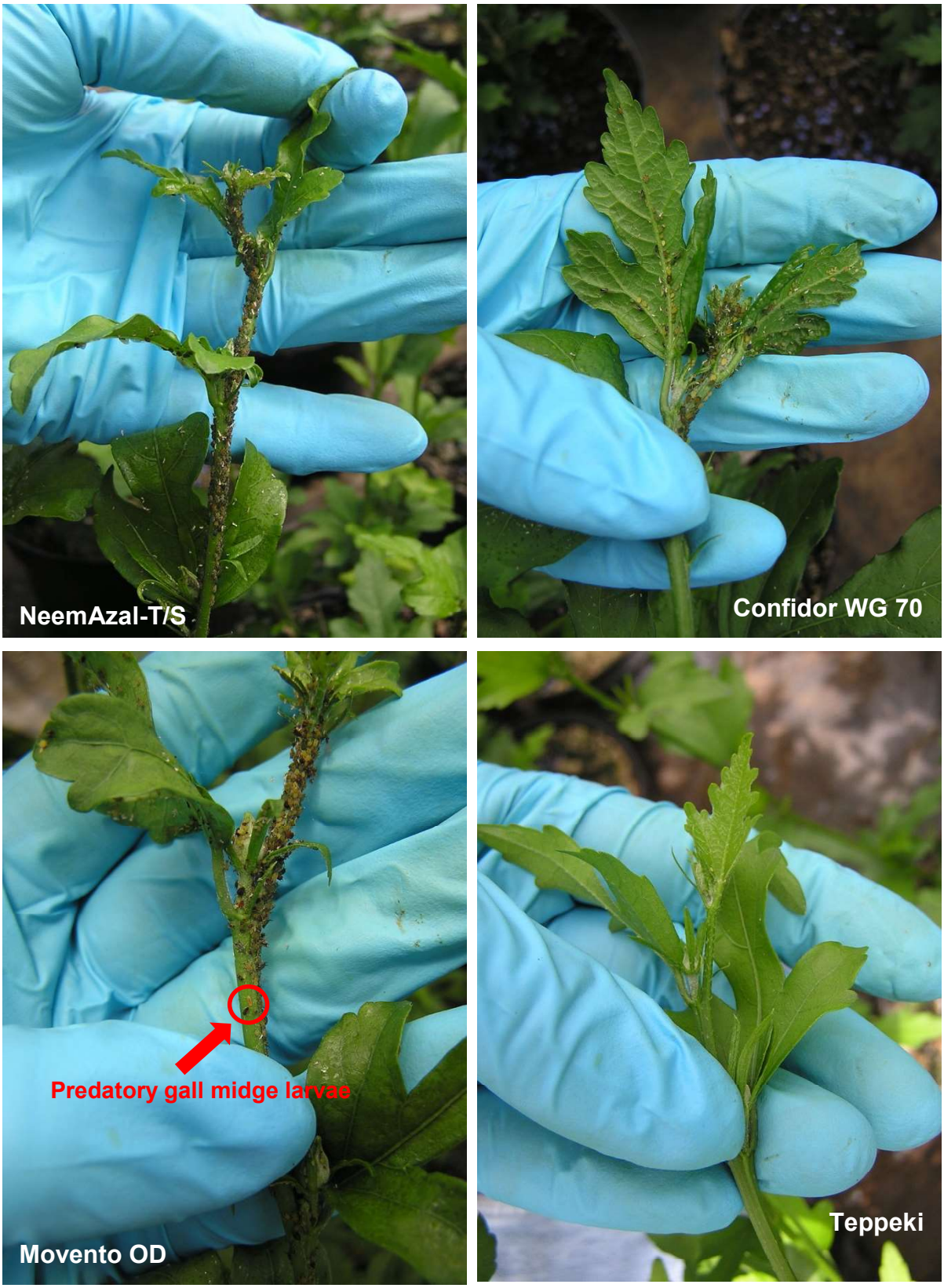


Fig. 10-13: Shoot tips of typical plants from various plots on 30 May 2017.

In the trial, beneficial insects that had arrived naturally were able to be observed at both counts. These were predatory gall midge larvae (probably of the genus *Aphidoletes),* hoverfly larvae and lady bird larvae. Adult beneficial insects lay their eggs where their offspring will have food. This meant that the larvae of the beneficial insects were primarily able to be found on plots with large numbers of aphids. Larvae of the predatory gall midge and hoverfly were observed on untreated plots and those treated with Movento OD, Neudoson Neu and NeemAzal-T/S.

The products Sivanto Prime and Isoclast are advertised as compatible with beneficial insects in the United States, where they are authorised. The insecticides Movento OD and Teppeki act selectively on sucking insects and are also compatible with some beneficial insects. The products Neudoson Neu and Confidor WG 79 cause severe damage to beneficial insects. While plants treated with Neudosan Neu were quickly populated with beneficial insects again after use, the effect of the active ingredient in Confidor WG 70 persisted for several weeks.

Fig. 14: Pupa of a lady bird

Fig. 15: Orange-coloured gall midge larvae in the aphid colony

4. Summary:

A trial was carried out on *Hibiscus syriacus* on a nursery with a natural aphid infestation in order to determine the effect of insecticides on *Aphis gossypii.* The insecticide Teppeki, which is authorised in ornamental plant production, had a very good effect on this pest. The systemic, authorised products Confidor WG 70 and Movento OD had a less positive effect in this trial. The products Isoclast and Sivanto Prime, which are authorised in the United States, had a very positive effect. An application has been made for authorisation of these products in Germany.

Beneficial insects to control *Aphis gossypii*
(B. Zielke, Dr H. Lösing)

1. Trial objective

The previous report described the problems of *Aphis gossypii* when producing *Hibiscus syriacus.* In addition to the fact that some insecticides do not have a good effect against these aphids, there is also another challenge.

Many *Hibiscus syriacus* plants are sold through garden centres or DIY chains. Nurseries that produce plants for this group of customers are increasingly being confronted with specifications detailing which plant protection products can actually be used in production. These specifications are based on the lists published by environmental protection organisations on the danger to bees as a result of plant protection products. The classification of the danger to bees caused by plant protection products (e.g. B4 = not dangerous to bees) used by the authorities in the legal authorisation does not play a role. Against this background, the use of beneficial insects against aphids on hibiscus plants was supported for the first time in practical operation.

Fig. 1: Colony of *Aphis gossypii* on a young shoot.
Fig. 2: Closer view of the aphids

2. Trial design

In a 600 m² greenhouse, nursery grown *Hibiscus syriacus* were transferred from 9 cm pots into 3 l pots. The young plants were treated with 2% Para Sommer Oil a week before potting to eradicate the small number of winter eggs laid by the aphids.

In the rear part of the greenhouse, a small number of young plants that had been bought in were transplanted into larger containers. A severe infestation of *Aphis gossypii* occurred on these plants. Against the background of the planned use of beneficial insects, the plants were treated with the product Teppeki.

The beneficial insects were applied according to a delivery and use plan put together by the company Katz BioTech. The predatory gall midge *Aphidoletes aphidimyza* was delivered as pupae in vermiculite. The carrier substance was dispersed in heaps on the surface of the containers which were then covered with clay pots to protect the pupae against irrigation. Once the adult gall midges hatched, they flew through the hole in the top of the pot. Adult midges live on honeydew, mate and lay eggs in a targeted manner near to aphid colonies. The larvae of the predatory gall midge paralyse their victims and then consume their contents.

Fig. 4: Predatory gall midges in vermiculite underneath clay pots
Fig. 5: Ten days later larvae can already be observed eating the aphids

The parasitic wasp *Lysiphlebus testaceipes* was also distributed in application bags in the greenhouse. Each of the 15 bags, which were hung up with the opening facing downwards, contained 100 parasitised aphids. The adult wasps that hatched display pronounced searching behaviour. They can even find single, hidden aphids. They use their ovipositor to lay their eggs in the aphids. The larvae of the wasps then develop inside the aphids. The aphids inflate, discolour and die. The wasps then complete their development in what are known as aphid mummies. The wasps then leave the aphid mummies through a round hole cut in the abdomen of the aphid.

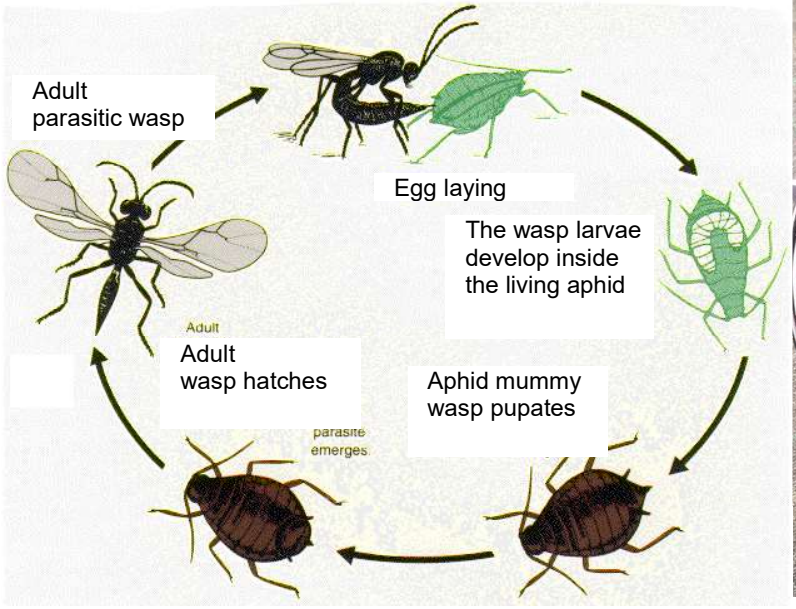


Fig. 6: Life cycle of the parasitic wasp *Lysiphlebus testaceipes* (www.entomology.wisc.edu)
Fig. 7: Application bag, hung up with the opening facing downwards

A total of 2000 predatory mites (*Phytoseiolus persimilis*) were also dispersed in the greenhouse every 14 days as a preventative measure. The following table lists the times of use.

Date	**Parasitic wasp** *Lysiphlebus testaceipes*	**Predatory gall midge** *Aphidoletes aphidimyza*	**Predatory mite** *Phytoseiolus persimilis*
11/05/17	1500 insects in the application bag	1500 insects in vermiculite	2000 insects dispersed
24/05/17	1500 insects in the application bag	1500 insects in vermiculite	2000 insects dispersed
08/06/17	1500 insects in the application bag	1500 insects in vermiculite	2000 insects dispersed

A fourth date for the introduction of beneficial insects was set as 22 June 2018. Since dispatch of plants had already started by this point and final treatment with insecticide was planned, the final application of beneficial insects was not carried out.

3. Results

3.1 Plant production and progression of the infestation:

Once the aphids had been eradicated the hibiscus plants grew quickly. The infestation of the bought in hibiscus with *Aphis gossypii* that was housed in the rear part of the greenhouse was able to be limited considerably by means of treatment with the product Teppeki but not completely eliminated. This minor infestation with aphids was tolerated to provide the beneficial insects with sustenance.

On 19 May 2017, a good week after the first application of the beneficial insects, numerous larvae of the predatory gall midge *Aphidoletes aphidimyza* were able to be observed on the plants in the rear part of the greenhouse. The first aphids parasitised by the parasitic wasps were also able to be identified. On 30 May 2017, six days after the second application of the beneficial insects, the number of the aphids that were infested with *Lysiphlebus* had increased significantly and numerous gall midge larvae were able to be observed on the shoots of infested plants. The infestation appeared to be spreading slowly starting from the initial infestation at the back of the greenhouse. The infestation was, however, limited to individual plants. Shoot deformation, a reduction in growth and sooty mould fungi were not able to be observed. Regular monitoring showed that the front and central parts of the greenhouse were free of aphids.

In early June, three plants were discovered in which the beneficial insects no longer appeared to have the infestation under control. One shoot on each showed deformations. The three plants were subjected to corrective treatment with Teppeki.

From mid-June, the first plants were prepared for delivery. The entire greenhouse was treated with Teppeki to prevent complaints about individual aphids and to ensure that the plants could be delivered to garden centres with absolutely no aphids.

Fig. 8: Greenhouse with hibiscus plants on 24 April 2017, around one week after transfer
Fig. 9: The same greenhouse on 8 June 2017, the plants were over 40 cm in height

4. Discussion

For a first trial, the use of beneficial insects against *Aphis gossypii* was very successful. Good preliminary treatment of the young plants with a mineral oil preparation to kill the winter eggs, regular and thorough monitoring of the plants and individual corrective treatments using the insecticide Teppeki, which is compatible with beneficial insects, helped make the method a success. While infestations with *Aphis gossypii* led to significant declines in plant quality in

other companies in 2017, the company carrying out the trial was able to produce high quality hibiscus plants.

In addition to the beneficial insects applied, other naturally occurring beneficial insects were also able to be observed on the plants, probably because they came in through the side wall ventilation.

The use of beneficial insects brought numerous challenges with it. There were numerous aphid mummies on a number of plants. It could be problematic if these (dead) insects are perceived by the customer to be pests, thereby making the plants unsaleable. Other arguments against the use of beneficial insects are the costs associated with this. In this trial, around EUR 0.50 per square metre + VAT and labour costs were spent on the beneficial insects. The product costs for Teppeki treatment are less than one cent per square metre.

The company manager or an employee must be interested in this issue for the use of the beneficial insects to be successful. Advice should be sought at the start. A good method for all companies is integrated plant protection. The young plants should be pre-treated with a mineral oil preparation to decimate the winter eggs. As the crop grows, insecticides that are compatible with beneficial insects can be used.

Fig. 10: Larvae of an hover fly that moved into the crop

Fig. 11: Numerous aphid mummies may put consumers off

Insect pathogenic nematodes for use against vine weevil larvae
(B. Zielke, Dr H. Lösing)

1. Introduction

In 2015, BASF invested millions in its nematode production facilities in Littlehampton in England. The production capacities were doubled, and according to their own estimation BASF is now the largest producer of nematodes in the world. The use of new technology and special formulations means the nematodes are now allegedly of a very high quality.

In a trial, the efficacy of Nemasys H (*Heterorhabditis bacteriophora)* and Nemasys L *(Steinernema kraussei*) produced by BASF was compared with the efficacy of a product from a competitor to control vine weevil larvae (*Otiorhynchus sulcatus).* A 1:1 mixture of the products Nemasys H and L was also examined.

Each of these treatments was applied to two different plant species. To one of these the entire quantity of nematodes was applied on the application date. To the other, a third of the total quantity was applied on three different application dates at intervals of two weeks (see Table 1). The trial was carried out at two locations, one of which was evaluated in detail. In November, samples were used to determine which of the two nurseries had the highest natural infection by vine weevil this year. The detailed evaluation was then carried out there.

Fig. 1: Vine weevil larvae killed by insect pathogenic nematodes. The *Heterorhabditis bacteriophora* nematodes discolour the larvae turning them red/brown and the *Steinernema kraussei* nematodes turn the larvae light brown.

2. Trial design

In both of the nurseries, the trial plants were *Taxus*, second year plants in 9 x 9 cm pots. *Taxus cuspidata* was located on an outdoor bed while *Taxus* x *media* 'Hilli' was located in a greenhouse. Plots consisted of at least 80 plants in each case. The trial was replicated four times. The first application of the reduced quantity treatment was applied at both locations on 24 August 2017 (treatments 3, 5, 7 and 9). Two weeks later, on 7 September 2017, the second treatment was carried out with a further third of the quantity. The application of treatments 2, 4, 6 and 8 was also carried out on this date. Two weeks later, on 20 September 2017, treatments 3, 5, 7 and 9 were applied for the final time with the last third of the application quantity. Freshly delivered nematodes were used for all of the treatments, the suspensions were created on site and the corresponding treatments applied using a watering can. Applications were washed in using a handheld irrigation lance. The control plots were treated with a corresponding quantity of water.

Table 1: Summary of treatments

	Preparation	**Type of nematodes**	**Application**	**Total nematodes Quantity of water**
1	untreated	-	-	-
2	Nemasys H (BASF)	*H. bacteriophora*	Week 36 full quantity	1 million / m² 4 l / m²
3	Nemasys H (BASF)	*H. bacteriophora*	One third each on weeks 34, 36 and 38	1 million / m² 4 l / m² in each case
4	Nemasys L (BASF)	*S. kraussei*	Week 36 full quantity	1 million / m² 4 l / m²
5	Nemasys L (BASF)	*S. kraussei*	One third each on weeks 34, 36 and 38	1 million / m² 4 l / m² in each case
6	Nemasys H + Nemasys L	*H. bacteriophora* + *S. kraussei*	Week 36 full quantity	1 million / m² 4 l / m²
7	Nemasys H + Nemasys L	*H. bacteriophora* + *S. kraussei*	One third each on weeks 34, 36 and 38	1 million / m² 4 l / m² in each case
8	Comparison product	*H. bacteriophora*	Week 36 full quantity	1 million / m² 4 l / m²
9	Comparison product	*H. bacteriophora*	One third each on weeks 34, 36 and 38	1 million / m² 4 l / m² in each case

Table 2: Application dates and weather

Date	Weather
Week 34: 24/08/17	23°C, cloudy
Week 36: 07/09/17	19°C, cloudy
Week 38: 20/09/17	24°C, sunny

Fig. 2-3: The quantity of water to be applied per unit of area was evaluated using yellow trays

Fig. 4-5: Application of the nematode suspension to damp substrate using a watering can. The suspension was freshly prepared and used immediately in both locations. There were overlaps of treatment at the edges of the plots. Only plants from the middle of the plots were therefore used for the evaluation. Once the nematode mixture had been applied the plants were generously watered using a hand held irrigation lance

In week 45, seven weeks after the final application of treatments 3, 5, 7 and 9, samples were taken at both locations to determine which trial should be evaluated. Significantly more vine weevil larvae were able to be identified in the untreated plots at the nursery where the trial was carried out inside a greenhouse.

The trial was therefore evaluated in detail for this location. In order to do this, 20 plants were taken from the middle of each plot and their rootballs were destructively inspected for larvae. The number of larvae per pot was determined. It was noted that the larvae were of different sizes. During the count, the decision was taken to count the ‘large’ larvae and the ‘small’ larvae separately. For the first two replicates of the untreated control, these figures are available as a total. Figure 9 shows a comparison of the different larvae sizes.

3. Results

In the evaluation of the plants, almost every rootball showed damage as a result of vine weevil larvae. This was expressed in the form of evidence of feeding on the rootballs, weak roots or even damage to the surface of the main roots or the root crown. At least one vine weevil larvae was found in 92% of the pots in the untreated control. There were often several larvae. On average, three vine weevil larvae were found in each 9 x 9 cm pot in this treatment.

There were significantly fewer vine weevil larvae in the pots that had been treated with the insect pathogenic nematodes. Dead larvae were rarely able to be identified and had probably already decomposed. It was possible to observe that many plants with damaged roots started to regenerate.

Fig. 6: Evaluation of the trial on 7 November 2017

Fig. 7: Vine weevil larvae and evidence of root feeding

Fig. 8: Roots of a severely infested plant and larvae from a pot

Fig. 9:Above 'small' and below 'large' larvae

The fewest number of vine weevil larvae tended to be found in the two Nemasys L treatments. If you calculate the degree of efficacy of this treatment, it is 98%. Small numbers of larvae were also counted in the treatments consisting of a mixture of Nemasys H and Nemasys L. There was an outlier in the fourth replicate in the mixed treatment, single application. There may have been an error in the application.

Table 2: Total number of living vine weevil larvae per 20 pots evaluated (four replicates)

Treatments	A	B	C	D
1. Control	45	64	58	72
2. Nemasys H, 1 million / 1 m²	6	15	22	15
3. Nemasys H, 3 x 0.33 million / 1 m²	11	5	22	19
4. Nemasys L, 1 million / 1 m²	2	1	1	3
5. Nemasys L, 3 x 0.33 million / 1 m²	0	0	1	1
6. Mix of H + L, 1 million / 1 m²	0	2	4	45
7. Mix of H + L,3 x 0.33 million / 1 m²	1	7	0	0
8. Comparison product, 1 million / 1 m²	16	28	38	35
9. Comparison product, 3 x 0.33 million / 1 m²	39	27	15	20

The following figure shows the average number of larvae per pot by size. In the untreated control, this distinction was applied only to two replicates and the ratio transferred to the overall average of four.

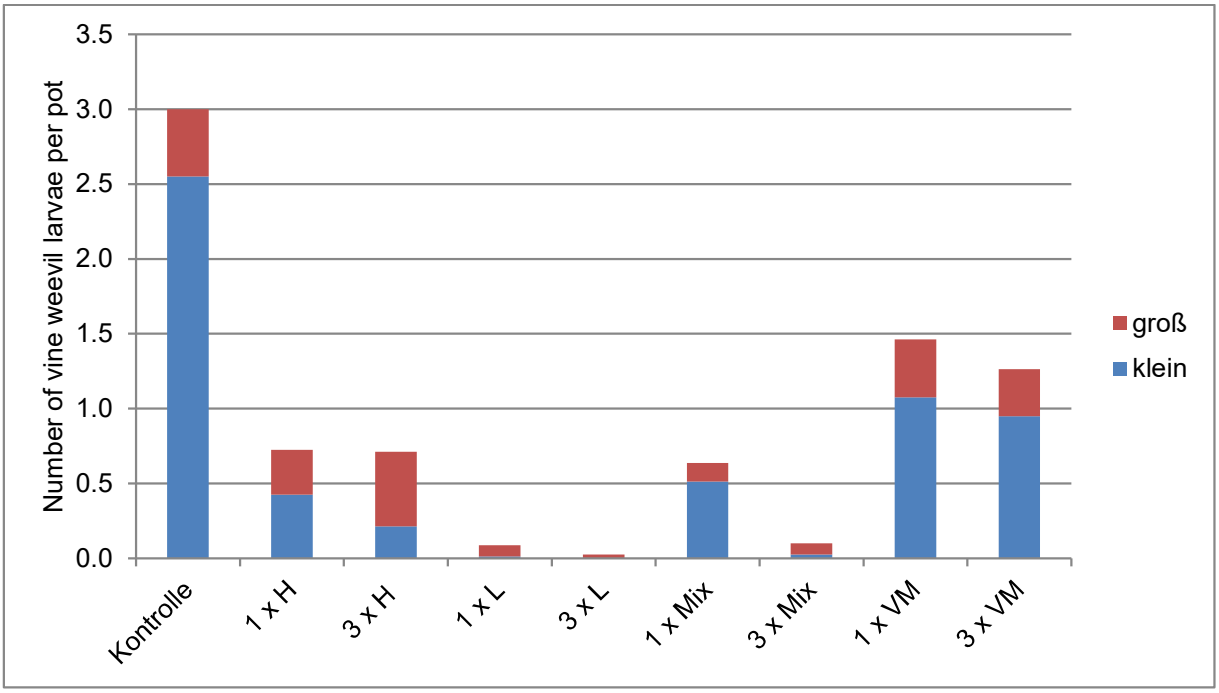


Fig. 10: Average number of 'small' (blue) and 'large' (red) vine weevil larvae per pot in week 45 (mean values from four repetitions)

A data logger was installed in the greenhouse to monitor the air and substrate temperatures. Over the course of the trialthe substrate temperatures fell from an initial average of over 15°C to single digits in November.

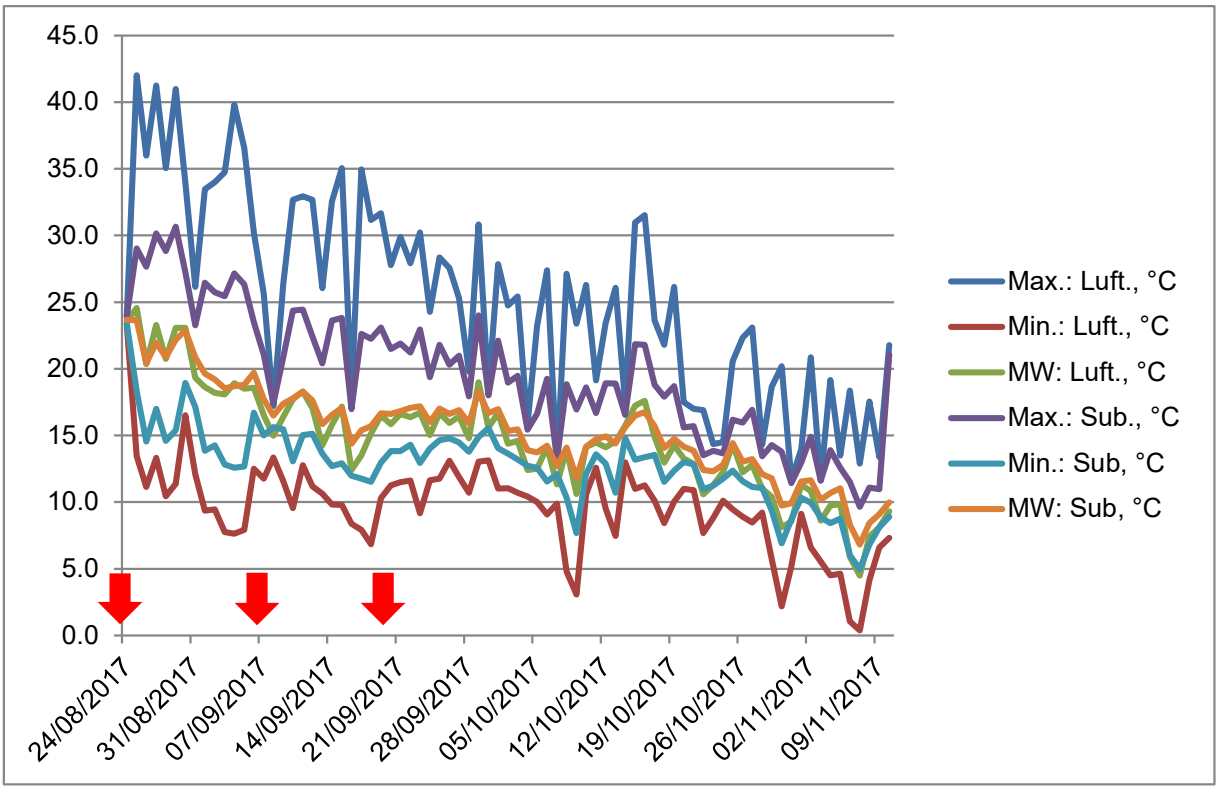


Fig. 11: Air and substrate temperatures over time The red arrows show the dates on which the treatments were applied

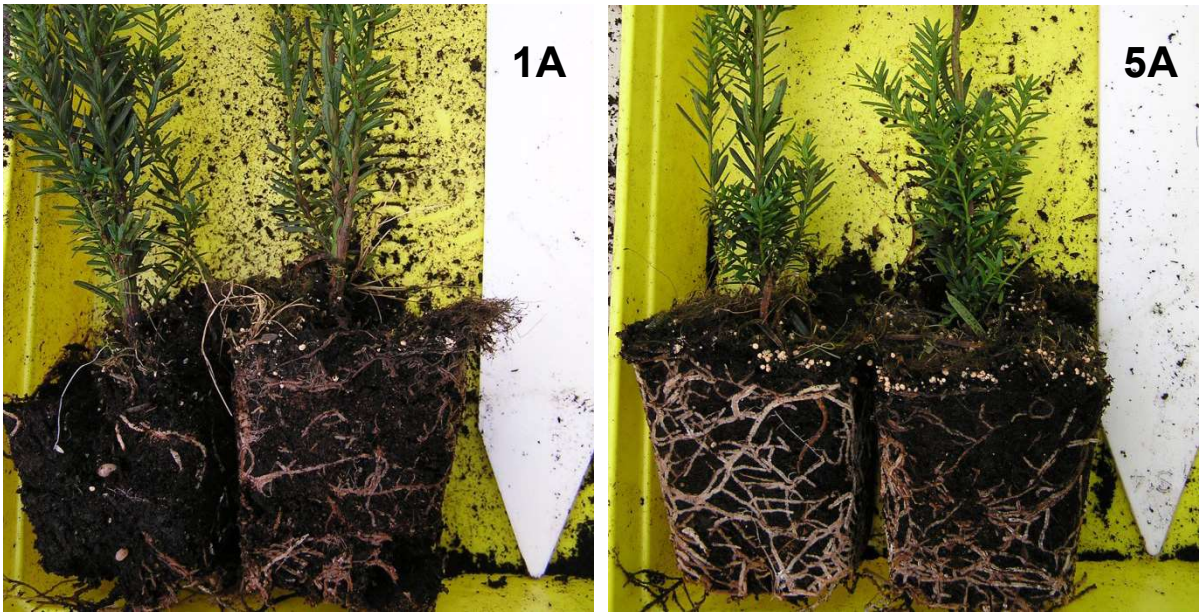


Fig. 12-13: Left untreated, right plants treated *with Steinernema kraussei* on three occasions. Both treatments showed evidence of root damage by vine weevil larvae. Only single larvae was found in treatment 5. The roots of these plants have already regenerated

4. Discussion

In this trial, the nematode *Steinernema kraussei* (Nemasys L) showed a very good effect against vine weevil larvae. It was superior to the nematodes of the genus *Heterorhabditis* in the products Nemasys H and the comparison product. A mixture of equal parts Nemasys L and Nemasys H which also had 1 million nematodes per square metre also had a very good effect with the exception of one replicate.

In 2005, VuB carried out a similar trial at somewhat lower temperatures. At that time, the *Heterorhabdites bacteriophora* nematodes had an efficacy of 55% and the *Steinernema kraussei* nematodes had an efficacy of less than 20%. In a trial carried out in 2016 in which the substrate temperatures at the start of the trial were on average around 10°C lower, minimal efficacy was achieved with either genus of nematode.

Practitioners who use nematodes late in the autumn are often not satisfied with the effect. The results of this trial show that the application of the nematodes is sensible from the end of August when the substrate temperatures are warm. Three separate treatments of nematodes, each at a third rate, tends to have a better effect than a single treatment of the full rate. According to the results of this trial, however, the use of the more effective species, *Steinernema kraussei,* is more important. The nematodes Nemasys H and L from the company BASF can be obtained from Öre Bio-Protect GmbH (www.oere-bio-protect.de) or Sautter & Stepper (www.nuetzlinge.de).

Country guidelines on the determination of "simple ancillary activities in plant protection".

Source: State plant protection services, version of: 11/2016

For which no evidence of expertise is needed if they are carried out under the responsibility and supervision of a person with evidence of expertise (according to Section 9 paragraph 5 No. 2 of the Plant Protection Act).
Plant protection products may in principle only be used if the user has evidence of expertise in plant protection (Section 9 of the Plant Protection Act). The Plant Protection Act only provides for a few exceptions.

No evidence of expertise is necessary for the:

1. use of plant protection products that are authorised for non-professional users in the home and garden sector,
2. practice of simple ancillary activities under the responsibility and supervision of a person with evidence of expertise,
3. use of plant protection products as part of a training scheme under the instruction of a person with evidence of expertise,
4. use of plant protection products to prevent damage caused by game.

This guideline serves to clarify which activities are deemed to be simple ancillary activities in the sense of the Plant Protection Act and includes an overview of the examples agreed between the federal states.

There are further plant protection activities for which neither evidence of expertise nor supervision by a person with evidence of expertise are required. These include in particular the spreading of beneficial insects such as the distribution or hanging up of *Trichogramma* (a type of wasp) capsules or cards to fight European corn borers, apple and plum fruit moths, *Encarsia* (parasitic wasps) hangers or stickers to fight whitefly, *Amblyseius* (mites), bags to prevent thrips, *Chrysoperla* (European lacewings), agents to prevent aphids and the like.

Evidence of expertise is, however, generally required for plant protection products applied via backpack sprayer or spraying devices. The user must meet high requirements in terms of user protection, dose accuracy, environmental and consumer protection. Applications on non-agricultural land also generally require expertise or may only be carried out by experts. The wording "responsibility and supervision of a person with evidence of expertise" also includes expert instructions on and control of the application of the plant protection product

and the avoidance of risks to human, animal and ecosystem health. The expert may be held liable for any damage that occurs.

The list of activities that are to be classified as simple ancillary activities includes:

1. The covered application of rodenticides using application devices; the laying of bait in bait areas; the insertion of bait into vole nests.
2. The application of molluscicides (slug pellets) using application devices.
3. The use of manual brushing tools for weed control in grassland.
4. The laying of glue barriers and insect capture belts to fruit and ornamental trees (area of use: glues, waxes, tree resins).
5. The hanging up of pheromone dispensers (confusion method) and capture systems with pheromones as bait.
6. The painting of interfaces and grafting points on fruit and ornamental trees, vines and forest plants with wound sealing products, wound treatment products and tree waxes (area of use: glues, waxes, tree resins).
7. The application of plant protection products using spray guns in steep slope viticulture only under the **direct** supervision of an expert user with control of the application as part of the plant protection control programme.
8. The application of herbicides using spray guards in combination with spray devices with rose reels in nursery and orchards under the direct supervision of an expert user.
9. Single stick or single plant treatment with a spray nozzle or using a spraying process in hop cultivation. Use is exclusively with a tractor and spray team (= close connection) with two spray nozzles or two handheld spray nozzles; one person must be an expert.
10. The immersion of grafted trees/grafts in a pre-prepared plant protection product. The liquid containing the plant protection product must be prepared by an expert.

Nitrogen contents in nursery soils – guideline values according to the Fertiliser Ordinance §3 for 2017

(BSc. Sebastian Heise)

Following the amendment to the Fertiliser Ordinance of June 2017, among other things the obligation to determine the fertiliser requirement in nursery areas no longer applies. The specifications of the 'old' Fertiliser Ordinance applied until mid-2017. According to this, before applying fertiliser at levels of more than 50 kg/ha nitrogen (total-N) and more than 30 kg/ha phosphate (P_2O_5) per year, the quantity of nutrients available to plants in the soil had to be determined.

For nitrogen, the quantity of nitrogen available in the soil should be determined once a year; for phosphate one soil analysis per area is required at least once every six years. However, the determination of the available quantity of nitrogen does not necessarily have to be in the form of a number of N_{min} tests on the area, but rather values from representative locations determined by the advisory circle can be used for the company's own areas.

In 2017, a further 40 nursery areas divided into the main crop groups were examined to determine their N_{min} content in mid-February. The results were provided to companies via newsletters and publications. The costs of these tests were borne equally by the Schleswig-Holstein Chamber of Agriculture and the Testing and Advisory Circle.

The results of the N_{min} tests listed in the table can be used as guideline values in accordance with the Fertiliser Ordinance §3. If the companies have not carried out their own nitrogen tests of the areas, the values mentioned should be deducted from the intended nitrogen fertiliser quantity depending on the crop and soil type. This procedure is used to ensure that the crop is provided with the nitrogen quantity necessary for its needs and excessive quantities of nitrogen are not applied.

Furthermore, nursery companies in Schleswig-Holstein carried out N_{min} tests on a further 287 areas over the course of 2017.

N_{min} – guideline values 2017		
Crop	**Soil type**	NO_3-N +NH_4-N [kg/ha] (0 - 60 cm soil depth)
Field areas for cuttings, rose rootstocks and fruit tree rootstocks	Clayey sands and sandy clays	**39**
Deciduous woody seedlings and transplant beds	Clayey sands and sandy clays	**15**
Coniferous woody seedlings and transplant beds	Clayey sands and sandy clays	**7**
Rose stocks	Clayey sands and sandy clays	**22**
Shrubs, light feathers and hedge plants	Clayey sands and sandy clays	**16**
Fruit-bearing trees	Clayey sands and sandy clays	**23**
Conifers	Clayey sands and sandy clays	**20**
Evergreen deciduous trees	Clayey sands and sandy clays	**22**
Standard trees	Clayey sands and sandy clays	**34**
Christmas trees	Clayey sands and sandy clays	**16**

This table is evidence of the knowledge of nitrogen contents in the soils for your crops. In the case of an inspection, it must be able to be presented in line with the individual company recording obligation if you have not carried out your own N_{min} tests on the areas.

The new Fertiliser Ordinance
(BSc. Sebastian Heise)

The new Fertiliser Ordinance entered into force from 2 June 2017, replacing the 'old' Fertiliser Ordinance of 2007. The revision aimed to increase the efficiency of fertiliser application and decrease the damage to ground and surface waters and ammonia gas emissions from agricultural sources.

The most important regulations for nurseries are summarised below:

Scope of the Fertiliser Ordinance:
Under the Ordinance, in addition to areas used for agriculture, nurseries and horticultural areas also count. The exceptions are closed and soil-independent systems where these have a controlled water supply and therefore the leaching of nutrients can be prevented (this includes container crops, greenhouse areas and static polythene tunnels).

In principle, the following should be taken into account when using fertilisers:
There should be a balance between the likely nutrient requirement of the plants, the nutrient supply from the soil (e.g. preculture, green manure, farmyard manure) and the fertiliser. The quantities and times of application are to be selected such that the available nutrients are available to the plants in good time and in sufficient quantity. Penetration into bodies of water and the groundwater should be avoided.

The determination of the fertiliser requirement for nitrogen (annually) and phosphate (every six years) (Section 4) is no longer required in nurseries and areas where ornamental plants and Christmas tree crops are grown. In order to ensure good professional practice, 40 nursery areas are tested for nitrogen in March of each year. The results (N_{min} guideline values) are shown by main crop groups for nurseries and are published by VuB in collaboration with LK SH.

In order to avoid nutrient losses and harm to bodies of water as a result of runoff, fertilisers containing nitrogen (> 1.5% N_{total}) and fertilisers containing phosphate (> 0.5% phosphate) can only be applied if the soils are capable of taking in these fertilisers.

Application is prohibited in

- **flooded** or **saturated** soils (the soil is deemed to be saturated if puddles have formed or the frost-free soil cannot be walked on due to the moisture) or

- **snow-covered** soils (applies if the surface of the soil can no longer be seen because of the layer of snow) or
- **frozen** soils (soils which will not thaw over the course of the day according to the weather forecast for example from the German Meteorological Office).

Exception: application to frozen ground is possible

- In the case of lime fertilisers which contain less than 2% phosphate where there is no risk of runoff.
- Up to 60 kg N_{total}/ha if the ground:
    - thaws on the day on which it is applied (German Meteorological Office forecast),
    - there is no risk of runoff to adjacent areas or bodies of water,
    - there is plant cover (areas that have grown naturally and frozen main and catch crop stocks do not count)
    - and the frost is preventing structural damage and soil compaction.
- In the event of the application of solid manure (farmyard and cloven-hoofed animals) and compost, more than 60 kg total N/ha can be applied to frozen ground if the last three points are complied with.

Restricted periods:

The application of fertilisers > 1.5% N is prohibited in the period from the harvesting of the last main crop until 31 January. There is a ban on the application of solid manure and compost from 15 December to 15 January in any given year.

There are other application bans in water protection areas:

- organic fertilisers containing nitrogen from 1 August to 28 February.
- mineral fertilisers containing nitrogen from 15 September to 31 January.
- solid manure (except chicken manure) from 1 August to 30 November and 15 December to 15 January.

Restricted periods according to the Fertiliser Ordinance for arable land		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Fertilisers > 1.5% N	* until 30 January									
Solid manure and compost	15 December to 15 January									
Water protection areas										
Org. fertilisers > 1.5% N	* until 28 February									
Solid manure (except chicken manure)	1 August to 30 November 15 December to 15 January									
Mineral fertilisers	15 September to 30 January									
* after harvesting of the last main crop until										

In order to protect bodies of water, when applying fertilisers containing nitrogen or phosphorous it is necessary to ensure that no nutrients get into the surface water directly. The distance regulations set out a minimum distance of 4 m between the edge of the application area determined by the application width and the upper edge of the embankment of the body of water. If the application width corresponds to the working width, the distance can be reduced to 1 m. The minimum distance is 5 m for areas with a 10% gradient within 20 m of the embankment.

The total nitrogen and phosphate content must be known before the application of organic, organic and mineral or mineral fertilisers in the form of a manufacturer's declaration, laboratory test or the use of official guideline values.

Maintaining fertiliser records, the recording obligation (as set out in Section 10) of the substances applied and the requirement to store this for seven years no longer applies to companies with nursery areas which have less than 15 ha of land used for agricultural purposes other than the nursery and grow a maximum of up to two ha of vegetables or strawberries, provided these are not in water protection areas. Companies whose land is in water protection zones are obliged to submit the fertiliser results to the competent water authority by 30 November of each year. VuB recommends continuing to keep records showing the type of fertiliser and the quantity for each area.

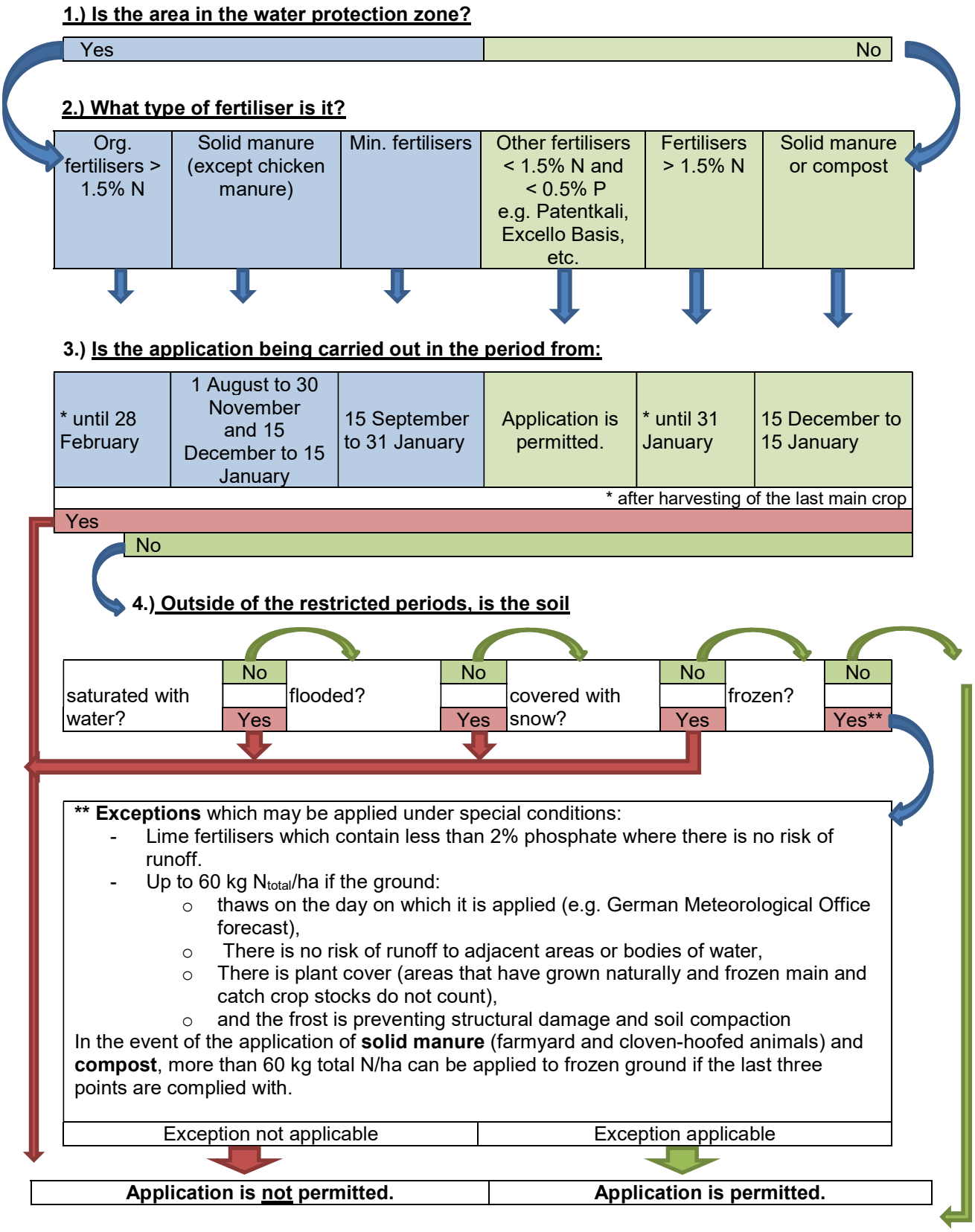
On average, the company can apply a maximum of 170 kg N_{total} per hectare and year in the form of farm manure, organic and organic-mineral fertilisers. In the case of composts, a maximum of 510 kg N_{total} per hectare may not be exceeded in a period of three years.

The devices for the application of fertiliser must ensure precise dosing and sufficient application accuracy and be able to adjust the quantity applied. Farmyard manure applicators with a mechanically or hydraulically adjustable scraper or floor feeding distributors meet the requirements as well as all other devices with adjustable application rates. The use of solid manure spreaders without controlled manure supply is prohibited.

Generating a nutrient comparison:
Companies with nursery areas are exempt from the obligation to generate a nutrient comparison and to evaluate this nutrient comparison.

When is the application of fertilisers permitted in nurseries?
In general, the following applies: the total nitrogen and phosphate contents of the fertilisers being applied must be known before application.

On average, the company can apply a maximum of 170 kg N_{total} per hectare per year in the form of farm manure, organic and organic-mineral fertilisers. In the case of composts, a maximum of 510 kg N_{total} per hectare may not be exceeded in a period of three years.



Two-year comparison of long-term fertilisers in standard trees
(BSc. Sebastian Heise, Dr Götz Reimer)

1 Introduction and trial objective

In 2016, a long-term trial was carried out in a standard tree production in collaboration with the Geries engineering company (who work in water protection consultancy, among other things). In this trial, different types of fertiliser (mineral, organic and mineral and partially coated) were investigated for their effect in terms of growth promotion and nitrogen dynamics. The trial covered two growing seasons from spring 2016 to autumn 2017. The standard trees of the genus *Tilia x intermedia* 'Pallida' were already planted in spring 2015 with a trunk size of 8-10. The fact that the trees were already in their second year of growth meant that they had established themselves in their location and were able to take in the nutrients provided directly. The type of soil is a humus-rich, clayey, slightly sandy soil.

In the trial, two partially coated long-term fertilisers Multigro (18-6-18-4) and Agromaster 2-3M (19-5-20-4), the organic and mineral Terra Plus N (12-4-6-3) and NovaTec premium (15-3-20-3) were examined (Fig. 1-4).

In the Multigro, 80% of the nitrogen and 60% of the potassium are coated. The duration of release at an average soil temperature of 21°C is given as four months. In the Agromaster 2-3M, 34% of the nitrogen and 20% of the potassium are coated. At an average soil temperature of 21°C, the duration of release is given as two to three months. The percentage organic material in the organic and mineral fertiliser Terra Plus N is 68%. The duration of release of the nitrogen is several weeks according to the manufacturer's specifications depending on the heat, moisture and soil activity. The NovaTec premium fertilisers have a duration of release of up to 10 weeks. This is achieved by the use of a nitrification inhibition substance and the associated ammonium stabilisation.


Figure 1: Multigro 18-6-18-4


Figure 2: Agromaster 2-3M 19-5-20-4


Figure 3: Terra Plus N 12-4-6-3


Figure 4: NovaTec premium 15-3-20-3

The trial was replicated three times. Each replicate consisted of 15 young trees, so 45 trees per treatment. An overview of the fertiliser application quantities and dates can be found summarised in Table 1. The first application of the fertiliser was on 3 May 2016. The

subsequent fertiliser application for treatments 2-4 was carried out on 15 July 2016. In 2017, the first application was on 20 April and the subsequent applications on 21 June 2017. Figures 5-8 show the respective spread patterns for the individual fertilisers.

Table 1: Summary of the fertiliser treatments

Treatments	Fertiliser type	N quantity (kg/ha)		Total N quantity (kg/ha)	Application date
		Spring	Summer		
1	Multigro	130	---	130	03/05/16, 20/04/17
2	Agromaster	65	65	130	3 May + 15 July 2016, 20 April + 21 June 2017
3	Terra Plus N	65	65	130	
4	NovaTec premium	65	65	130	

Figure 5: Spread pattern for Multigro (130 kg N/ha)

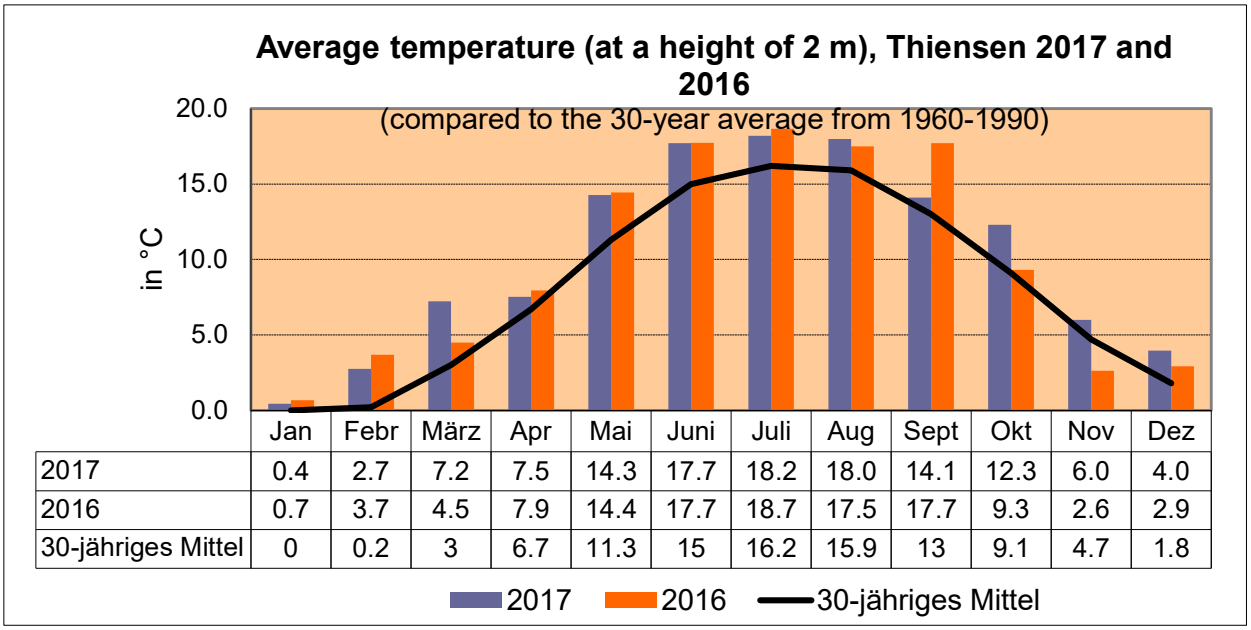
Figure 6: Spread pattern for Agromaster 2-3M (65 kg N/ha)

Figure 7: Spread pattern for Terra Plus N (65 kg N/ha)

Figure 8: Spread pattern for NovaTec premium (65 kg N/ha)

1.1 Weather conditions in 2016 and 2017

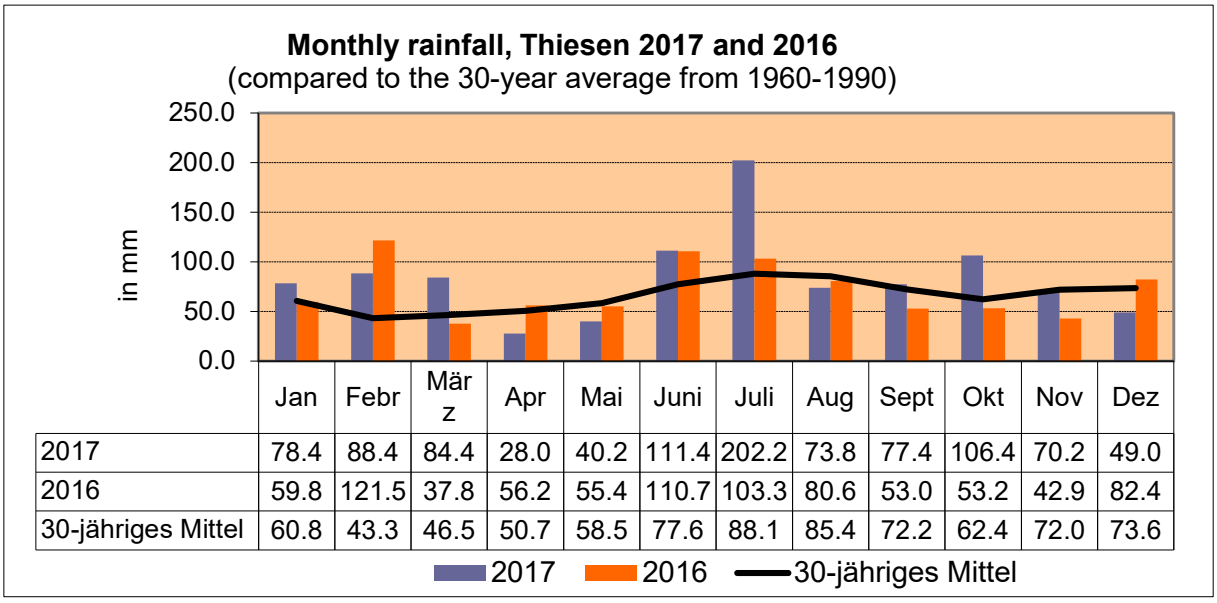
In the trialest year, 2016, the average monthly temperatures were around 2°C higher than the 30-year average. The monthly temperatures in 2017 roughly corresponded to the temperatures from the previous year. The temperature profiles can be seen in Figure 9.



	Jan	Febr	März	Apr	Mai	Juni	Juli	Aug	Sept	Okt	Nov	Dez
2017	0.4	2.7	7.2	7.5	14.3	17.7	18.2	18.0	14.1	12.3	6.0	4.0
2016	0.7	3.7	4.5	7.9	14.4	17.7	18.7	17.5	17.7	9.3	2.6	2.9
30-jähriges Mittel	0	0.2	3	6.7	11.3	15	16.2	15.9	13	9.1	4.7	1.8

Figure 9: Temperature profile for 2017 and 2016 and 30-year average

In terms of precipitation levels, 2016 had a number of wet months. In February, almost three times the precipitation of the 30-year average fell, 120 mm of rain. The months of June and July were also somewhat wet, with up to 40 mm of precipitation in a day. The months of August, September, October and November were warm and dry. The year 2017 was a high precipitation year, with the exception of the months of April, May and August. Only small quantities of rain fell in these months. Precipitation levels corresponding to the 30-year average were only achieved in September and November. The wettest months were January to March, June, July and October. The quantities of precipitation were doubled in these months and in July they were three times the average. The exact values are shown in Figure 10.



	Jan	Febr	März	Apr	Mai	Juni	Juli	Aug	Sept	Okt	Nov	Dez
2017	78.4	88.4	84.4	28.0	40.2	111.4	202.2	73.8	77.4	106.4	70.2	49.0
2016	59.8	121.5	37.8	56.2	55.4	110.7	103.3	80.6	53.0	53.2	42.9	82.4
30-jähriges Mittel	60.8	43.3	46.5	50.7	58.5	77.6	88.1	85.4	72.2	62.4	72.0	73.6

Figure 10: Rainfall for 2017 and 2016 and 30-year average

2 Growth results

Figure 11: View of the rows of trial plants on 17 May 2017 (1 and 2 from the right). Image by N Schütte

2.1 Plant growth in 2016

Figure 12: Rows of trial trees on 6 June 2016

In May (Fig. 11) there was uniform new growth in the crown and trunks of the lime trees (Fig. 12). All of the lower shoots were removed in late June. The trees continued to develop evenly regardless of treatment. Monthly measurements were taken of the trunk for the entire duration of production (Fig. 15) (May-November). Significant growth was measured in the months from May to August. In May, the average increase was 1.3 cm, in June it was 0.9 cm, in July it was 0.8 cm and in August it was just 0.1 cm. From September no further increase in the trunk circumference was identified. The growth was the same in all treatments.

2.2 Plant growth in 2017

The lime trees started to bud in late April and by mid-May they were fully in leaf (Fig. 13). The plants developed in a very homogeneous manner over the course of the months. By the end

of September the growth had ended and the trees were showing initial indications of autumnal colouring. 14). No differences were able to be observed depending on the fertilisers.

Figure 13: Development of the lime trees on 16 May 2017

Figure 14: Initial autumnal colouring on 25 September 2017

The increase in the trunk circumference was also measured every month in the period from March to November 2017. Figure 15 shows the months (April-September) in which measurable growth took place.

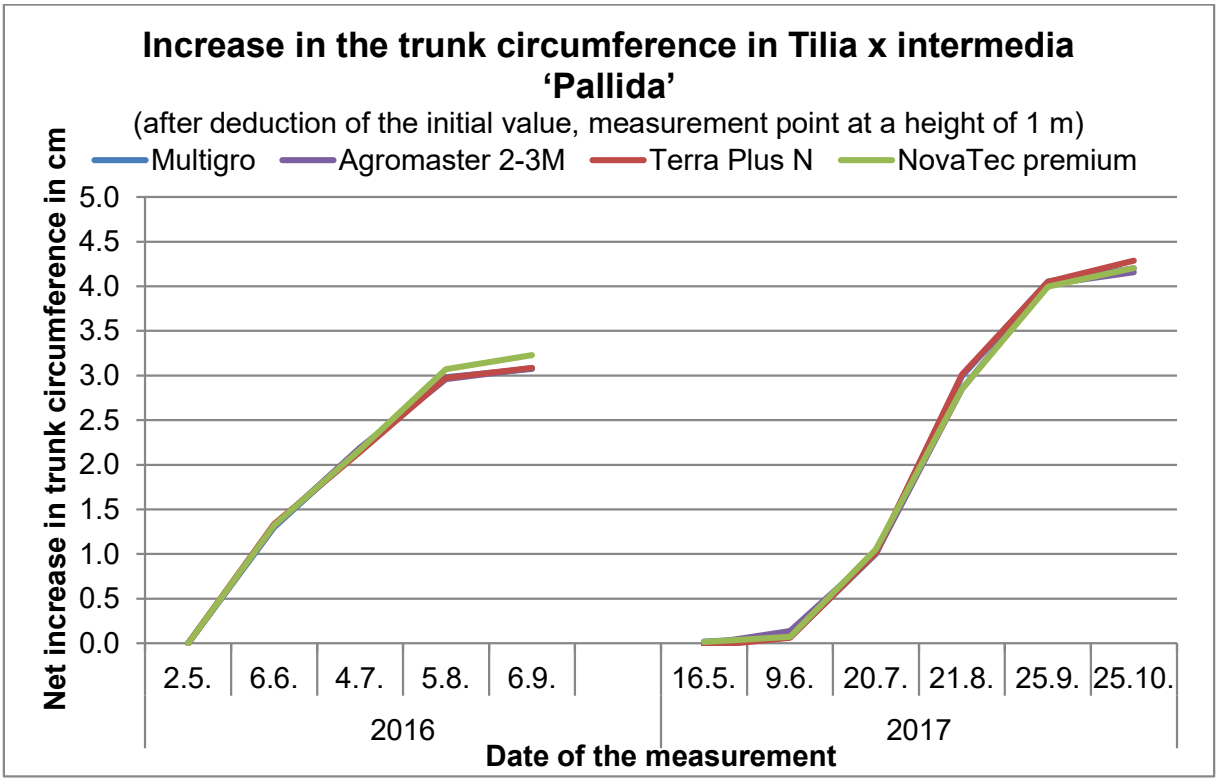


Figure 15: Net increase in trunk circumference by individual fertiliser treatment.

The main growth in circumference occurred from the middle of May. The net increase was 1 cm from 16 May to 9 June 2017, from June to 20 July 2017 the growth was 2 cm and by 21

August the trees had grown a further centimetre. The different fertiliser types had no impact on the growth of the trees.

3 N_{min} test results

Over the entire duration of the trial the company Geries Ingenieure regularly measured the nitrogen contents (NO_3- + NH_4+) together with VuB in the soil layers from 0-60 cm. One mixed sample was created for each treatment from the three replicates. The sampling was carried out in parallel to the measurement of the trunk circumference.

Cow manure was applied to the area in the year in which the young trees were planted (2015). The subsequent supply of nutrients including nitrogen from the organic mass of the manure can be seen in the analyses in the second year. In the treatment plots that were fertilised using purely mineral products, the breakdown of the organic mass into nitrogen that is available to the plants is higher than in the case of the treatment with the organic and mineral product. The subsequent mineralisation from the soil pool in 2016 did not result in any visible differences between the fertiliser types.

The Nmin tests from 2017 show the differences between the fertiliser types (Fig. 16). The full quantity of Multigro was applied on the first fertiliser application date. There was only a small increase in the nitrogen content that was visible in the first two months. The release of the coated nitrogen (80%) started strongly in July and released nitrogen continuously from this point, including in the months that had high levels of precipitation. The Terra Plus N that was applied on two different occasions demonstrably started to release nitrogen after the first fertiliser application date. A total of 2/3 of the total nitrogen measured was in the upper layer of the soil (0-30 cm) by the second fertiliser application date. After the second application of fertiliser the Nmin values did not increase any further but instead decreased. The breakdown of the organic component in the Terra Plus N was probably delayed as a result of the high frequency and volume of rain over this period. The nitrogen contents in the plots treated with NovaTec premium continuously increased after the first application of fertiliser, including after the second fertiliser application. A decrease in the nitrogen values was observed when the precipitation started. A displacement of the nitrogen from the upper soil layer (0-30 cm) to the lower soil layer (30-60 cm) was also observed. The Agromaster 2-3M increased the nitrogen level in the soil after the first application of fertiliser and retained this level for the entire growing season. The nitrogen values in the soil also dropped at the end of the growing season. In the first half of the year, the majority of the nitrogen was in the 0-30 cm soil layer. In the second half of the year, the level of nitrogen at 0-30 cm and at 30-60 cm balanced out.

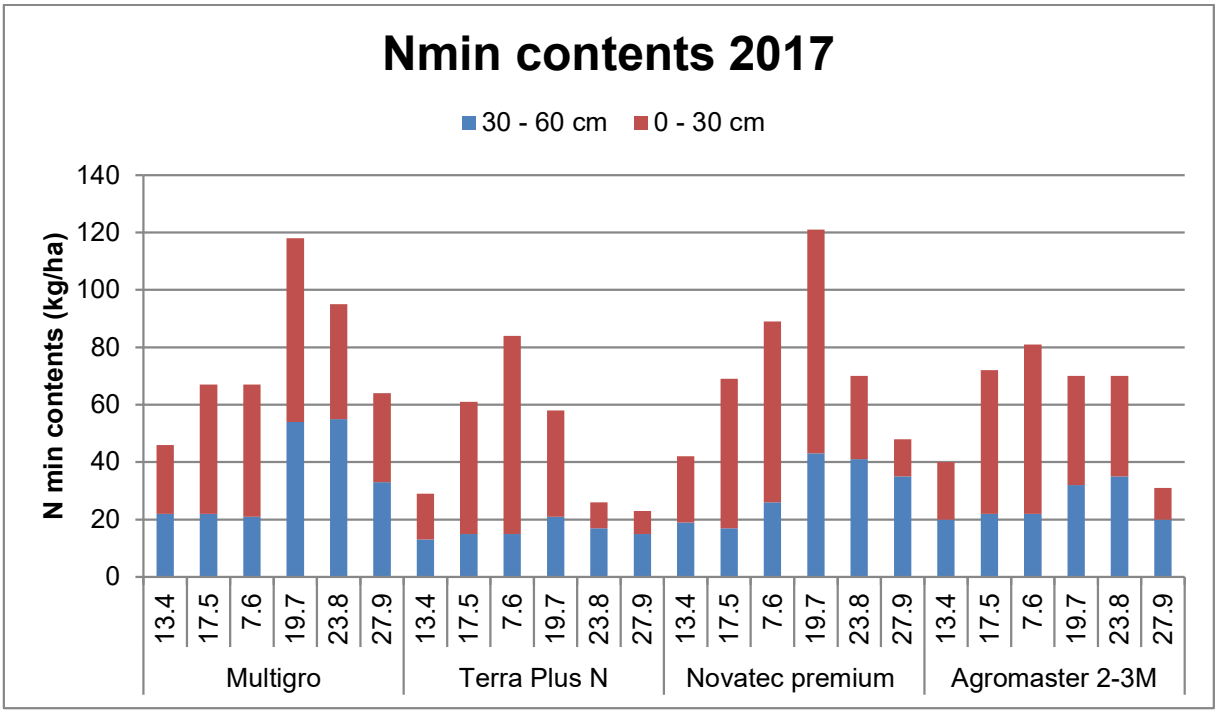


Figure 16: N_{min} contents at 0-60 cm in 2017

In both trial years, a chloride window was created during the trial when the first application of fertiliser was carried out. The chloride window shows the maximum possible leaching depth of nitrate from the same year. Like nitrate, (NO_3^-),chloride (Cl^-) is negatively charged, resulting in similar leaching behaviour in the soil. If a sample only identifies chloride in the soil layers from 0-30 cm and 30-60 cm but nitrate is found in lower layers, the nitrate must be from the previous years. No statement was made on nitrate leaching in this trial as the chloride analyses did not provide clear and significant results. The assumption can therefore be made that the distribution of the fertiliser applications was advantageous in 2017. In connection with the higher precipitation in July and the resulting leaching into deeper layers of the soil, the Nmin values in the 30-60 cm layer were higher in the 130 kg N treatment at the start.

4 Summary

A long-term trial on standard trees of the genus *Tilia x intermedia* ‘Pallida’ was carried out in collaboration with Geries Ingenieur GmbH in Ellerhoop in 2016. In the trial, different fertiliser types (organic and mineral (Terra Plus N), mineral (NovaTec premium), partially coated (Multigro and Agromaster 2-3M)) were compared with one another. The duration of the trial spanned two growing seasons. During this time, the trunk circumferences and the nitrogen contents in the soil layers at 0-30 cm and 30-60 cm were measured. A good result in terms of a reduction in leaching losses and growth was achieved by the fertilisers Terra Plus N and Agromaster 2-3M. Both fertilisers achieved an equivalent growth result with low nitrogen contents. The fertilisers Multigro and NovaTec premium achieved the same growth result but with higher nitrogen contents in the layers of the soil sampled. Multigro showed an agricultural advantage in the trial as it was only applied in spring and provided sufficient nitrogen for the entire duration of the trees’ growing period. The trial showed that the application of organic matter had a positive impact on the nutrient level over at least two growing seasons regardless of whether this was in the form of green manure and/or farmyard manure.

Significance of aluminium availability in the soil to the growth and quality of Nordmann firs (Fendrik Meints, Osnabrück University, Dr Diemo Daum, Osnabrück University, Dr Heinrich Lösing, VuB)

1. Introduction

Aluminium can impair plant growth when it is found in the soil. This problem is normally only encountered in strongly acidic soils. Analyses of the nutrient levels in nursery soils using a CAT method, however, found relatively high aluminium contents at numerous locations as an ancillary finding. This trial on Nordmann firs (*Abies nordmanniana*) aimed to determine whether the aluminium identified is relevant to nurseries. Dissolved aluminium ions interact with other cations in the soil. Magnesium and calcium ions can be adsorbed from the soil particles and replaced by the higher value aluminium ion, and these substances are then more susceptible to leaching. This can result in corresponding symptoms of deficiency in the plants. When examining issues of excess aluminium it is therefore sensible to include the nutrients magnesium and calcium.

2. Trial design

Ten nursery areas in the Pinneberg area with Nordmann firs that were planted five years ago were included in the survey. The conifers were primarily growing in slightly clayey and sandy soils with pH values of between 3.8 and 5.8. The soil and plant tests carried out are summarised in Table 1. Since there are recurring problems with needle browning in Nordmann fir cultivation, this as yet unexplained symptom of damage was taken into account when counting the trees.

Table. 1: Overview of the soil and plant tests carried out (recording period: May 2017)

Test	**Parameters recorded**
Soil analyses	Aluminium and magnesium content following extraction with $CaCl_2$, CAT, KCl, NH_4NO_3 and following aqua regia digestion; calcium content following extraction with KCl and NH_4NO_3 or following aqua regia digestion; pH value (in the $CaCl_2$ extract)
Needle analyses	Aluminium, magnesium and calcium contents in one-year-old needles
Needle counts	Needle browning and needle chlorosis on the trees
Shoot growth	Length of the one-year-old terminal bud

3. Results

The aluminum content in the soil increased exponentially with decreasing pH. This relationship was particularly close if the soil samples were extracted with potassium chloride and calcium

chloride (Fig. 1). The other extraction or digestion methods tested, however, showed a weaker link or no link between the pH value and the aluminium content of the soil (Table 2).

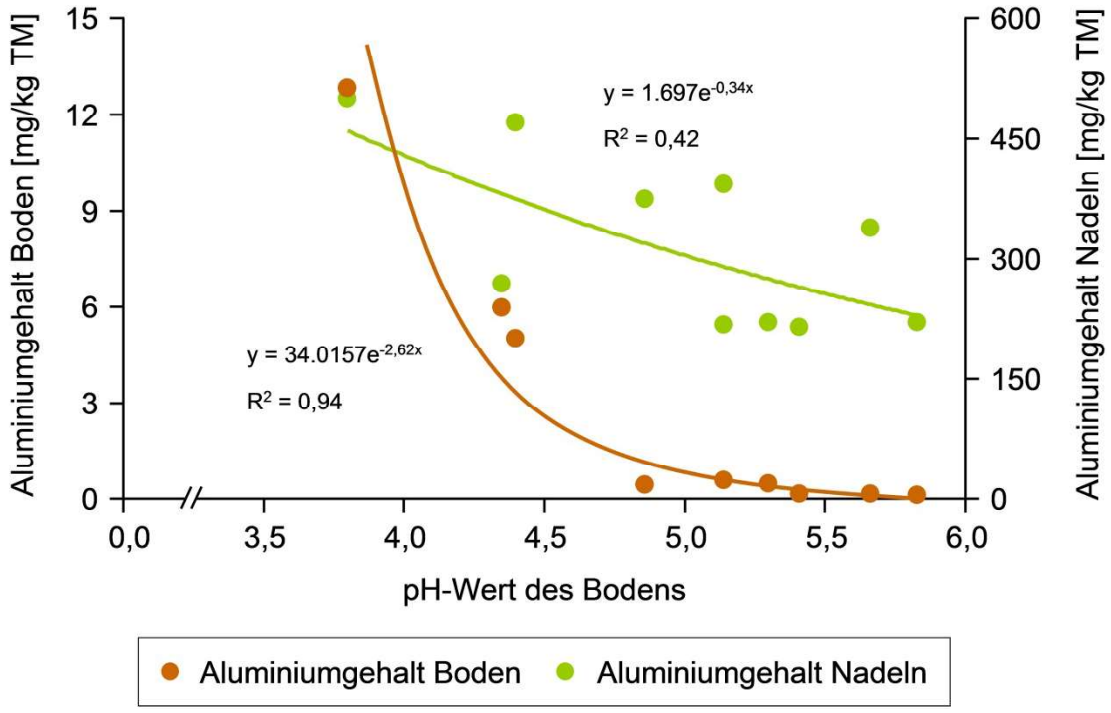


Fig. 1: Impact of the pH value of the soil on the aluminium content of the soil ($CaCl_2$ extraction) and in the needles (n=10)

Table 2: Impact of the extraction or digestion methods on the aluminium and magnesium contents in the soil and the link between this and the pH value of the soil (the closer the numerical value for R^2 is to 1 the better the link can be described with an exponential function); n=10

Extraction or digestion method	Aluminium content in the soil		Magnesium content in the soil	
	Fluctuation range [mg/kg]	Connection to the pH value (R^2)	Fluctuation range [mg/kg]	Connection to the pH value (R^2)
$CaCl_2$	0.1-13	0.94	26–79	0.47
CAT	117-343	0.39	27–81	0.42
KCl	0.4-80	0.98	29–68	0.46
NH_4NO_3	0.9-2.3	0.10	23–68	0.47
Aqua regia	7.350-16.136	0.00	750-1,651	0.01

It was also noticeable that the level of the aluminium content measured was very much impacted by the extraction method. The aluminium contents determined using the CAT method were significantly above the values for the other extraction methods (Table 2). These differences had to be taken into account when evaluating the aluminium content in the soil.

The pH value of the soil only had a relatively minimal impact on the aluminium content of the needles (Fig. 1). Only a weak link between the aluminium contents in the soil and needles was able to be identified ($R^2 \leq 0.42$). Obviously, Nordmann firs have mechanisms that ensure that even with high availability in the soil, aluminum is only absorbed to a limited extent or fixed in the roots. Equivalent adaptation strategies are known for other species of plant that prefer to populate acidic locations. The needles of the Nordmann fir remained healthy even in the soils with the lowest pH value and the highest aluminium contents (Fig. 2). Needle browning was not observed in any of the tree stocks. There was also no link between the aluminium contents of the soil and the needles in terms of shoot growth on the trees.

Fig. 2: Healthy Nordmann firs that had been growing for five years in clayey, sandy soil with a pH value of 3.8

The magnesium and calcium contents in the soil decreased as the pH value dropped. In the case of magnesium, this link was relatively weak and very much depended on the extraction methods used (Table 2). Other factors such as previous application of magnesium fertiliser may have affected the result. The magnesium contents measured in the soil were in a similar range regardless of the extraction method used (Table 2) and could primarily be allocated to content class C (40-70 mg/kg soil for clayey, sandy soils).

The pH value of the soil had no impact on the magnesium content of the needles. However, there was a link between the magnesium content of the needles and the shoot growth in Nordmann firs. If the magnesium content fell below around 0.7 g/kg in the dry needle mass, the length of the terminal bud was reduced (Fig. 3). Magnesium is an essential component of the chlorophyll molecule. Insufficient supply of this nutrient therefore impairs photosynthesis in the green parts of the plant. Visually identifiable needle chlorosis did not, however, occur in any of the tree stocks examined.

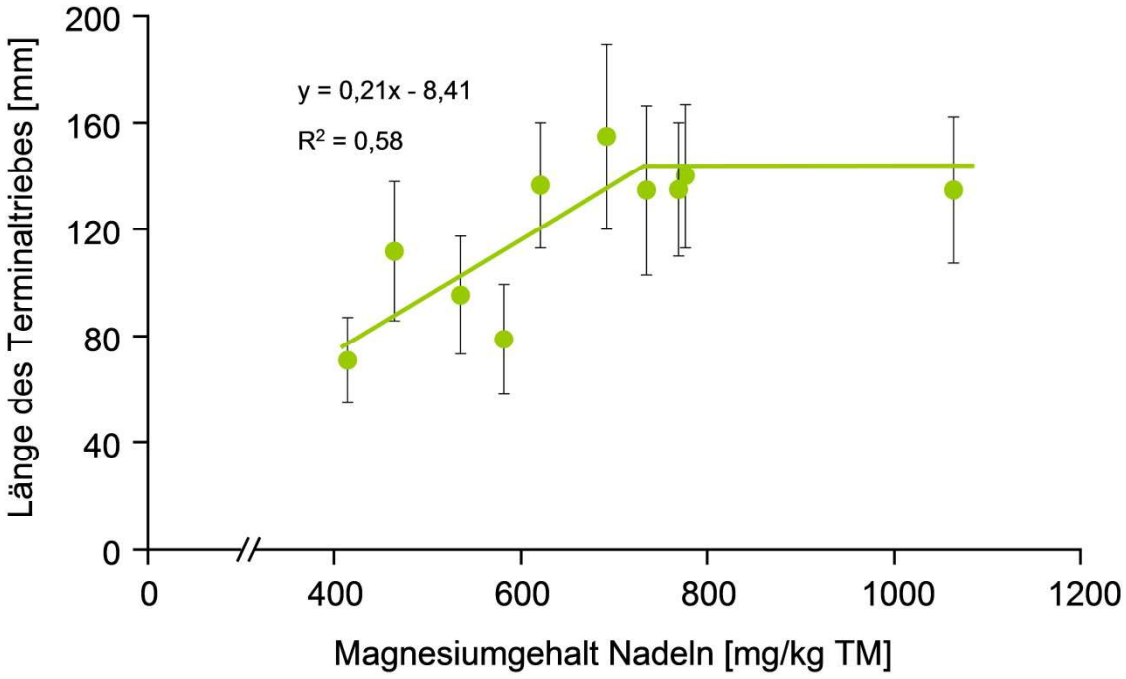


Fig. 3: Impact of the magnesium content in the needles on shoot growth in Nordmann firs (mean ± SD, n = 100 for each location)

The calcium content in the needles was at a similar level in most of the locations although the calcium contents in the soils varied significantly depending on the pH value (KCl extraction: 161 mg/kg at pH 3.8 and 1568 mg/kg at pH 5.8). No impact of the calcium content in the needles on shoot growth in the trees was therefore able to be identified.

4. Summary

Our tests carried out to date did not show any indication that high aluminium contents in the soil cause direct harm to Nordmann firs. It is advisable, however, to ensure that the pH value in the soil does not fall below 5.0 in order to prevent an impairment of the shoot growth as a result of magnesium deficiency. This nutrient is subject to leaching to a greater extent in highly acidic soils. Magnesium uptake by the roots can also be impaired by a high aluminium concentration in the soil solution.

The aluminium content in the needles of conifers can only be estimated to a moderate extent using the soil analyses tested. Extraction with potassium chloride and calcium chloride was most effective (R^2 = 0.42 or 0.41). The pH value of the soil had a comparable ability to predict the aluminium content of the needles (R^2 = 0.42). The CAT method did not enable any conclusions to be drawn about the aluminium contents in the needles (R^2 = 0.14). With this method, which was established to test for nutrients, significantly more aluminium is evidently extracted from the soil than is actually available to plants. This could be due to the chelator DTPA which is found in the CAT extraction agent and can convert aluminium into water-soluble complexes. The CAT method therefore cannot be used to evaluate the aluminium content in the soil on the basis of existing guideline values.

Further tests are necessary to clarify whether excess aluminium, magnesium deficiency or other nutritional disorders may contribute to the occurrence of needle browning on Nordmann firs. Comparing the mineral composition of damaged and healthy trees in several of the locations affected would be informative. If this identifies any abnormalities, these links should then be investigated in greater detail in fertiliser trials.

Comparison of peat-free substrates that are available on the market for the cultivation of nursery trees (B. Sc. Sebastian Heise)

1 Introduction and trial design

The consumer, and therefore also retailers, are increasingly demanding alternatives to the use of peat in substrates. The suggestion is that not using peat will protect the local nature and environment. Some peat-free substrates are already being used in the field of horticulture, for example the production of organic herbs or indoor ornamental plant cultivation as a result of the proximity to the consumer. The use of peat-free substrates is not particularly widespread in nurseries because there is as yet minimal demand for this. The nursery substrates currently used as a standard are, however, generally substrates with reduced levels of peat anyway. Their main component is white peat (slightly decomposed moor peat) with many additional ingredients such as wood fibres, coco peat and compost mixed in. The additional substance content varies between 10 and 30%.

For several years, trials have been carried out to further reduce or entirely replace peat. Whether or not it will be possible to replace peat entirely in nursery tree production without causing problems remains to be seen. Against this background, two peat-free substrates on the market were trialled in the cultivation of nursery trees by the Trialling and Advisory Circle in 2017. The main focus was on determining whether the substrates could be used with the same commercial cultural methods and without any major changes.

The two peat-free substrates (Table 1) essentially consist of coco peat and wood fibres. Coco peat has similar properties to slightly decomposed moor peat, such as a high water storage capacity and air capacity, and enables a precise adjustment to the pH and therefore a good alternative.

Table 1: Substrate compositions

Ingredients	**Manufacturer: H. Harden**	**Stender AG**
Coco peat:	70% by volume	50% by volume
Wood fibres:	30% by volume	30% by volume
PG mix:	0.8 kg/m^3	---
Perlite:	---	20% (2-6 mm)
Clay:	5.0 kg/m^3	5.0 kg/m^3
Radigen:	100 g	100 g
N balance:	200 g/m^3	N-stabilised wood fibres
pH value:	5.0-6.0 without lime or wetting agents	5.8

The fertilisers and quantities applied were adapted to commercial standards and did not play a significant role in the trialling of the substrates. The H. Harden substrate had a coarse

structure, primarily as a result of the wood fibres (Fig. 1). The substrate by Stender, however, was fine (Fig. 2).

Figure 1: H. Harden substrate structure

Figure 2: Stender AG substrate structure

2 Growth and results in the ‘Leonardo da Vinci’® rose

The roses (200 plants) were potted into 3 l rose pots on 18 March and placed on the container production area. The peat-free substrate used came from H. Harden. Fertiliser was applied to the roses in the peat-free substrate using Nutricote T100 while Osmocote Pro 5-6M was used for the peat-based substrate, both were used at 4 g/l. Figure 3 shows the trial bed after potting on 24 March 2017. The bed with the peat-free substrate (left) is the end bed and is therefore subject to greater levels of dehydration, the control plants containing the peat based substrate is on the right.

Figure 3: The trial beds (left peat-free substrate, right substrate containing peat) on 24 March 2017

Figure 4: Peat-free substrate

Figure 5: Substrate containing peat

Figures 4 and 5 show the substrate around one week after potting. The H. Harden peat-free substrate has settled slightly. This can barely be seen in the substrate containing peat, however. The different materials (wood fibres, coarse pieces of peat) can clearly be seen. The initial root tips were able to be identified on the edges of the pot after a growing period of around four weeks. A first visible difference was seen after a period of around ten weeks. Significantly more roots were visible in the peat-free substrate (Fig. 6). This could be linked to the different levels of nutrient release from the two different types of fertiliser.

Figure 6: Root development on 31 May 2017, left peat-free substrate, right substrate containing peat

However, the root growth had no impact on the growth above the ground. The plants developed in a very uniform and homogeneous manner. By mid-June, the roses were ready for sale so a final visual inspection was carried out. The height and number of shoots on the plants was relatively standard as a result of pruning measures (Fig. 7). The roses were able to be sold with no limitations or losses.

Figure 7: Trial bed on 12 June 2017

Figures 8 and 9 show the typical plants from the two substrates.

Figure 8: Typical plants from the peat-free substrate on 12 June 2017

Figure 9: The plants from the peat substrate on 12 June 2017

2.1 Summary for the ‘Leonardo da Vinci’® rose

The ‘Leonardo da Vinci’® roses were transferred into peat-free substrate and peat-based substrate in 3 l rose containers on 18 March 2017. A total of 4 g/l of fertiliser was applied. Nutricote T100 was used in the peat-free substrate and Osmocote Pro 5-6M in the peat substrate. There were no limitations or problems when processing the peat-free substrate. No negative characteristics were identified over the entire growing period using the peat-free substrate. Differences were able to be identified in root growth. The peat-free substrate contained greater numbers of roots. This did not, however, have an impact on the growth above the ground. All of the plants were ready and saleable within the relevant period. Additional measures such as extra watering were not necessary at any time due to the high level of rainfall that year.

3 Growth and results for the *Aronia x prunifolia* ‘Nero’

In a further trial, 2000 aronias were potted in 3 l containers on 1 May 2017 and placed on production beds (Fig. 10). A total of 1000 plants were potted in the H. Harden peat-free

substrate and 1000 in a mixture of Baltic and Quickborn peat. The peat substrate was also covered with pine bark to prevent weeds (2 cm), as is standard on the nursery. Both substrates were processed using a stationary potting machine. There were no difficulties or limitations with this. The fertilisers (Osmocote Pro 8-9M) were added at 3 g/l during the potting process. In the peat-free substrate, 1 g/l of Nutricote T100 was mixed in so only 2 g/l of Osmocote Pro 8-9M was added.

The containers containing peat-free substrate covered five beds that were placed at the start of the container area. Watering was via overhead circle sprinkler.

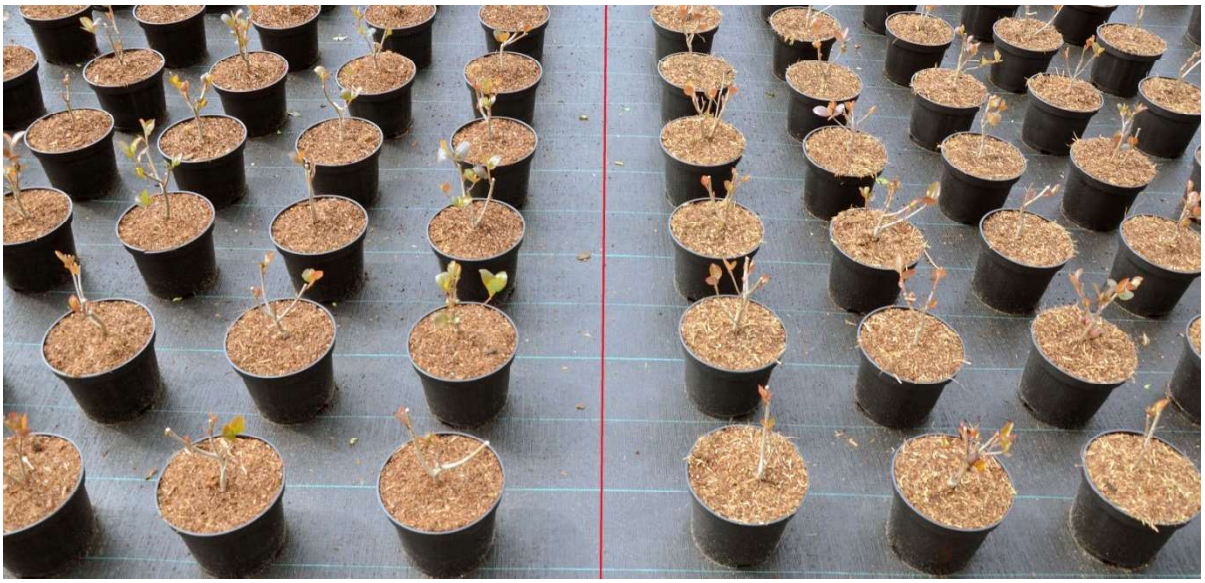


Figure 10: Trial area on 2 May 2017, left peat-free substrate and right substrate containing peat

The growth of the plants did not vary in the first six weeks but there were slight colour differences in the leaves after six weeks. The aronias in the peat-free substrate were slightly lighter, but this colour difference disappeared over the next few weeks. There was a clear difference in terms of the amount of weeds. The substrate covered with pine bark had no weeds (Fig. 11) while the peat-free substrate had clearly developed weeds (Fig. 12).

Figure 11: Peat substrate covered with pine bark with no weeds

Figure 12: Weed growth on the peat-free substrate (without mulch)

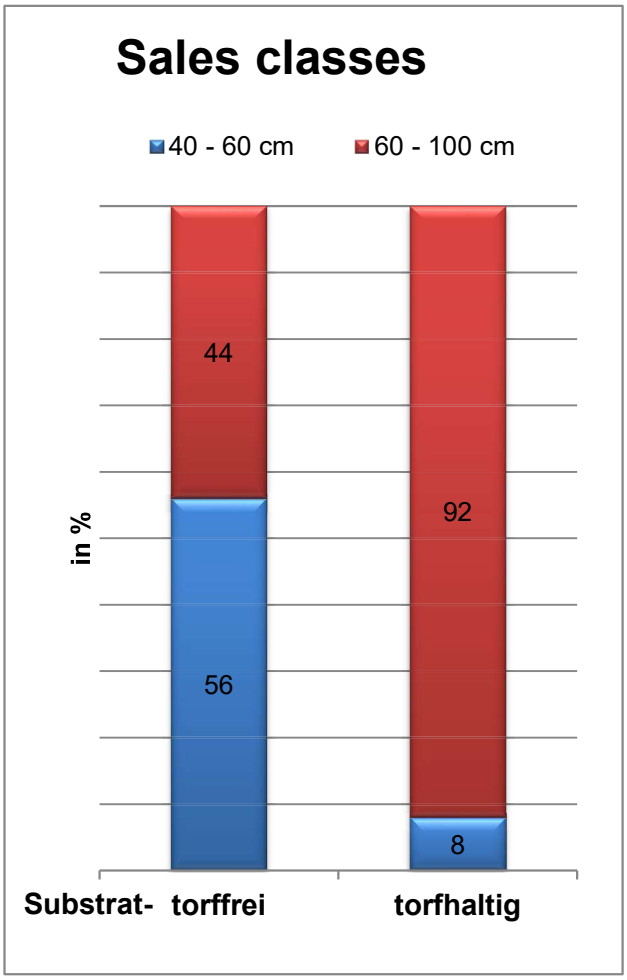


Figure 13: Classification into sales classes

Further fertiliser was added to both treatments in July at 2 g/l, as is standard in the company. At this point, all of the plants had developed evenly. Slight differences in height were able to be identified in September, around 12 weeks after potting, and these differences increased over the next four weeks until the final inspection on 10 October. The height of 50 plants from each category was measured. The mean value for the peat-free substrate was 60 cm ± 3.9 cm while for the substrate containing peat it was 69 cm ± 5.2 cm. The differences were even more obvious when the plants were divided into sale classes (Fig. 13). A total of 56% of the plants produced in the peat-free substrate were in the sales class 40-60 cm. Just 44% reached the company's target sale size of 60-100 cm. A total of 92% of the plants produced conventionally in peat reached the sales class of 60-100 cm, with just 8% being smaller. The financial loss of failing to reach 60-100 cm is calculated as being between EUR 0.50 and EUR 1.00 per plant. The following Figures 16-19 show typical plants from each substrate and the root development.

Figure 14: Typical plants for the peat-free substrate on 10 October 2017

Figure 15: Root development in the peat-free substrate on 10 October 2017

Figure 14 clearly shows weed growth on the surface of the substrate. The plants have a typical habit and branching. The roots (Fig. 15) have developed down to the bottom of the container.

Figure 16: Typical plants for the substrate containing peat on 10 October 2017

Figure 17: Typical plants for the substrate containing peat on 10 October 2017

The plants in the substrate containing peat (Fig. 16) branched out from the base well and showed growth appropriate to their culture. The container does not have roots down to the very bottom (Fig. 17). A possible explanation for this is that the substrate containing peat was less well drained than the peat-free substrate, which may have had a negative impact this year as there was frequent heavy rain. In contrast to this, the high draining properties of the peat-free substrate meant dissolved nutrients were more quickly washed away so the plants' nutrient requirements were not sufficiently well covered up to the end of the growing season.

3.1 Summary for *Aronia x prunifolia* ‘Nero’

On 1 May 2017, a total of 2000 aronias were potted, 1000 in H. Harden peat-free substrate and 1000 in the nursery’s usual substrate containing peat. They were then placed on the container production areas. Overhead circle sprinklers were used for watering where necessary. The peat-free substrate got around 50% more water, but this is standard within the company as the beds were at the edge. Around half of the plants produced in the peat-free substrate did not achieve the target sale size. The cultivation was equivalent to that used in the substrate containing peat and was not adapted to any potential special requirements of peat-free substrate such as the application of more fertiliser as a result of potential nitrogen immobilisation. If the substrate were to be adapted carefully to the culture, production should be unproblematic as shown in this example for *Aronia x prunifolia* ‘Nero’. This trial clearly showed the positive effect of covering plants with mulch to avoid weeds on the surface of the substrate.

4 Growth and results for *Lonicera nitida* ‘Maigrün’

Rooted *Lonicera* seedlings were transferred into 11 x 11 cm pots by hand on 21 April. Two different peat-free substrates were used, one by the company H. Harden and another by Stender AG (Table 1). Each treatment consisted of around 360 plants when the potting was carried out. The fertiliser was applied using standard spot dosing at 4 g/l. The H. Harden substrate already contained 1 g/l of Nutricote T100, so 3 g/l of Nutricote T100 was added. The Stender substrate did not contain fertiliser, so 4 g/l of Osmocote Pro 8-9M was applied. Plants potted into substrate containing peat by the company were used as a control. The potted plants were placed in rows of two. They were placed at the start of the container field with both treatments placed in an alternating manner to minimise the possible edge effects. The control containing peat starts after four rows of plants (Fig. 18).

Figure 18: *Lonicera* trial bed on 21 April 2017

Figure 19: Stender (left) and Harden substrate, direct comparison, 21 April 2017

Figure 19 shows both substrates in a direct comparison. In addition to the different colour tones, the different structures are also visible.

The first roots were seen in the peat-free substrate by Stender. Differences in growth were visible by mid-July. The plants in the peat-free substrate (Harden) were smaller and had not developed quite so extensively. The control treatment containing peat and the peat-free substrate by Stender, however, showed hardly any differences (Fig. 20). The differences in growth may be due to the fertilisers used.

In June, it was demonstrated that the peat-free substrates had significantly fewer weeds growing on them than the control. On closer inspection, it was observed that the surfaces on the peat-free substrates were dry in the upper area. The assumption can therefore be made that the surfaces of the peat-free substrates dry more quickly (better drainage), so weed seeds find it more difficult to establish themselves. The economic aspect comes into its own here, as this reduces working hours needed to achieve weed control.

Figure 20: Differences in growth in the various substrates on 19 July 2017

Figure 21: A typical plant from each treatment on 27 September 2017

Figure 21 shows a typical plant from each substrate type. The plants produced in the peat-free substrate (Stender) and the substrate containing peat had a similar habits and similar shoot development. The development of the plants in the peat-free substrate (Harden) was less. The growth evened out over the course of the growing season.

At the end of the trial differences in leaf colour were able to be identified in the Harden peat-free substrate. The leaves were identifiably lighter, while the two other treatments had a strong green leaf colour. The colours were determined using an R.H.S. colour chart. The leaf colour on the plants from the peat-free substrate by Stender was around 137 (moderate olive green), for the peat-free substrate by Harden it was around 143-144 (strong yellow green) and for the control containing peat the colour of the leaves was around 141 (deep yellowish green). *Lonicera nitida* is an indicator plant for nitrogen deprivation. The lightening indicates insufficient nitrogen supply at the end of the growing season. This is probably due to the different types of fertiliser in combination with the substrates used.

The plants all reached the company's sales size target of 30-40 cm.

4.1 Summary for *Lonicera nitida* 'Maigrün'

At potting on 21 April 2017, two peat-free substrates were compared with a substrate containing peat in the production of *Lonicera nitida* 'Maigrün'. One of the peat-free substrates came from the company H. Harden and the other from Stender AG. The substrates differed in

structure (Harden = coarse; Stender = fine), colour and to some extent contents. Osmocote Pro 8-9M was used as fertiliser for the Stender substrate and the one containing peat. Nutricote T100 is used in the Harden substrate. All three variants were provided with a spot application of fertiliser (4 g/l for the treatment containing peat and the Stender substrate and 3 g/l for the Harden substrate as 1 g/l was already mixed into the substrate).

Differences in growth were identifiable from the start, decreased over the course of the summer, but occurred again in a different form at the end of the summer. The plants in the peat-free substrate by Harden had delayed growth. They recovered from this delay, but the leaves became lighted at the end. The plants in the Stender peat-free substrate did not differ significantly from the treatment containing peat. The differences are probably more to do with the impact of the different types of fertiliser and less to do with the substrate.

The production of groundcover, shown here using the example of *Lonicer nitida* ‘Maigrün’, is possible in the standard peat-free substances on the market with adaptations to the fertilisers applied, but no major changes to production.

5 Discussion and outlook

Three trials with peat-free substrates in the production of nursery trees were carried out in 2017. The trials were carried out in rose, shrub and groundcover production. The trials were carried out as comparisons with conventional substrates containing peat. Substrates were processed as standard with fertiliser added in all of the trials.

The year 2017 was characterised by heavy and high-frequency rainfall so nurseries did not have to carry out additional watering of the peat-free substrates. This may be different in warm and dry years.

The growth was barely different to the nursery’s standard levels in all of the trials. On closer inspection, differences in height and leaf colour did occur in individual cases, but these were not exclusively due to the substrate and rather a result of the combination of fertiliser and substrate. This can be optimised with the manufacturer’s help.

The trials showed that the production of nursery trees in peat-free substrate is possible, but questions remain such as:

- How does the peat-free substrate behave for retailers in terms of water holding capacity and watering intervals?

- Is greater use of fertiliser necessary as a result of possible nitrogen fixation and does this result in higher production costs?
- Can the need for peat-free substrates be met if peat is no longer used?
- Peat-free substrates remain more expensive than those which contain peat. Whether or not the end customer will pay the additional costs remains to be seen.

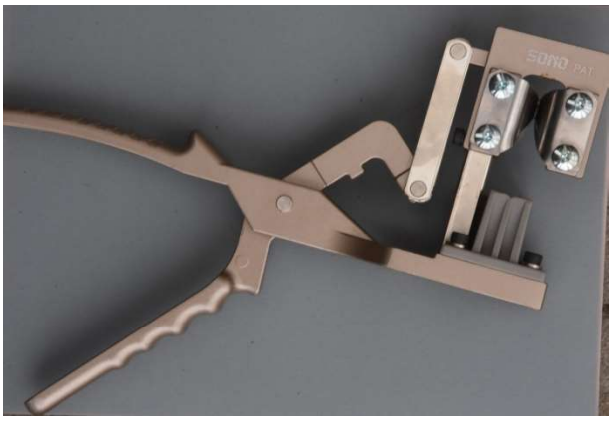
Grafting devices – new developments
(D. Heinrich. Lösing, Helmut Schwarz, Appen)

The grafting of trees remains an important aspect of nursery production. It requires a thorough specialist knowledge, experience and a lot of practice. This is the case in particular for the range of different specialist grafts used in nursery stock production. Grafting is generally carried out by experienced older specialists.

For decades, attempts have been made to support or automate grafting activities using devices. The first development was Omega grafting in viticulture. This is used successfully in this field to this day. The growth results were particularly problematic in other trees, however. To date, no device has proven successful in specialist grafting. Nowadays there are also fewer trained and experienced staff, a situation which seems unlikely to fundamentally change.

A clean, 3-4 cm long cut from the base and corresponding graft material are needed for a graft to be successful, and both parts of the plant should match one another in diameter as far as possible. Most of the devices available for grafting do not make a cut, instead they “punch” corresponding parts in or out of the graft and the base. The V tongue (Sono J68) and the Omega tongue (Duratool J 100) are shown below and the corresponding grafts can be seen immediately after the procedure was carried out, and a number of months later.


Omega grafting device Duratool J 100


V-shaped grafting device Sono J 68

In practice, these devices have little importance. The grafting of vines is an exception, as mentioned above. The ‘fusion’ of the base and the graft appears to be relatively simple in this genus. *Malus* species are also relatively unproblematic in the range produced. *Prunus* species and in particular the classes *Fagus*, *Gleditsia* and *Quercus* are significantly more difficult. In *Fagus* and *Quercus*, the cutting of the grafts is a problem as in general the species are characterised by particularly hard wood.

Fresh graft, left in the Omega shape and right in the V shape

V-shaped graft a few months later

Omega-shaped graft a few months later

A development by the company Scionon (www.scionon.com) from New Zealand has been available for a number of years. In this, the cut of the graft and base is made with a blade mounted on a pair of secateurs. Using this method, a cut is made in the base and the graft, unlike the devices which create the Omega-shaped and V-shaped tongues which punch. A mobile version is available for working in the field and in crops, a fixed version which can be mounted on tables, is available for grafting stations. The contact in Germany/Europe is Mr Manuell Alisch from Verl.

Grafting secateurs by Scionon

Scionon grafting secateurs cutting

There are two designs of the secateurs for graft material of 5-15 mm and 5-20 mm in diameter. These can be easily disassembled and grinded to sharpen the blades after around 10,000 cuts. Both pairs of secateurs are also available in a version for left-handed people. Other devices for smaller root-balled or container plants are currently in development.

Presentation of the table device at Spiker's Nursery in Barmstedt

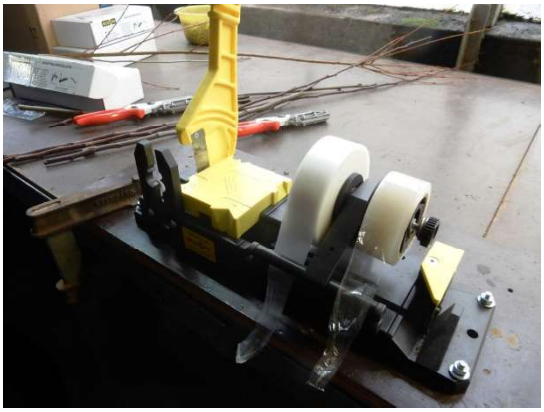


Table device for grafting including a roller for the film tape

According to Mr Alisch, staff can learn the skills of grafting in just a few days. The device is therefore not to be used to support experienced grafters who have developed speed and dexterity over several decades that cannot be achieved with secateurs, but rather the target group is those who have not learned the skill.

When working with the fixed table device, people broadly no longer work with Fleicoband and then wax, but instead the graft is wrapped with a self-adhesive film strip (Buddy Tape) that is wound around a fixed holding role that is preloaded. Initial trials on this method carried out by VuB in 2018, however, did not show particularly positive results for manual winter grafting.

The costs of the grafting secateurs are around EUR 200 and the table device is around EUR 600. The devices are sold by Hermann Meyer in Rellingen.

Intensive work is currently ongoing into the further development of grafting devices. One of the main objectives is to move from punching to cutting and therefore to match the cuts made by professionals with knives as far as possible. Good grafts can only be achieved with sharp knives or blades. The option to sharpen the blade is therefore an important element of the use of grafting devices.

Study trip to Great Britain
(Dr Heinrich Lösing)

From 29 August to 1 September 2017, 17 nursery owners from the Pinneberg area visited eight nurseries in Great Britain. First, however, here are a few figures from the country and its nursery production, in each case in comparison to the Federal Republic of Germany. The information on nursery areas and the number of companies for Great Britain are estimates as precise figures have not been kept for years.

	Great Britain	**Germany**
Number of inhabitants, total	60.46 million	80.621 million
Area, total	219,331 square km	348,540 square km
Population density/square km	276	231
Number of nurseries	917	1714
Nursery production areas	around 5,000 ha	18,613 ha

Sources Federal Statistical Office 2017, special series 3, series 3.1.7, Agriculture & Horticulture Development Board 2017

1 Companies visited

Abbots Moss Nursery, Northwich, www.forestry.gov.uk

The state tree nursery belongs to the Forestry Commission and farms around 200 ha over three locations, one of which is in Scotland. The current total requirement for state forest is given as around 29 million plants a year. Around 80% of the production is on open land and the remainder in plugs. The percentage of coniferous wood is high at around 80% and is dominated by *Picea sitchensis* at around 65%. Some of this is obtained through propagation by cuttings. Seven clones are available. Other coniferous trees include *Pinus contorta, P. sylvestris, Picea abies* and *Pseudotsuga*. In the deciduous wood species, the oak dominates following a decline in ash as a result of ash shoot dieback.


Excellent picture of roots in *P. sitchensis*


High visibility jackets are compulsory for visitors

Before sowing, all of the seed beds are disinfected using Basamid granules, and if the seeds are of a good quality they are sown with a precision seed drill at final clearance. However, the majority are traditionally sown in summer.

Austin Roses, Wolverhampton, www.davidaustinroses.co.uk

The rose nursery was founded in 1961. Today, David Austin is the name in English roses. This name is even well known in Germany among rose fans. According to our tour guide, Robert Corbett, species of D. Austin are even cultivated by 6 licence holders in the district of Pinneberg.

Roses are cultivated on a rootstock of *Rosa laxa* over an area of 60 ha. Production and sales equate to 60% as containerised plants and 40% as bare-rooted plants. There is also a garden centre with a cafe attached, as well as an impressive rose garden. The company has 150 employees in total.

Breeding work has started again in the past few years. There are around 50,000 crosses a year. As well as health, the aims of the breeding plan are also improved scent and flower number.

Attached garden centre with cafe

Container plant production with operational buildings in the background

J & A Growers, Wasperton, www.jagrowers.com

The nursery was founded in 2002 by Jamie Dewhurst and now cultivates an area of around 45 ha. Around 12 million seedlings are produced each year, 90% of which are sold as annual plants. Thus far the focus has always been on hedge plants and deciduous seedings. Due to the high demand for sitka spruces, conifers have also been produced for a number of years. All sowing areas for fine seeds (*Alnus, Betula* etc.) are disinfected with Basamid granules. The sowing of coarse seeds (*Crataegus, Quercus* etc.) then occurs the next year. These species can more easily be treated with herbicides on the seed bed. All of the seeds are also bought stratified and ready to be sown.

A total of five full-time staff work there and there are Romanian seasonal workers. The topic of labour is causing increasing problems. New accommodation is currently being completed to ensure availability. Seasonal workers will only want to keep working on nurseries if the employment and accommodation situation is as good as it can be, claims owner Jamie Dewhurst. The Brexit negotiations mean all horticultural companies in Great Britain are particular unsure because of this issue.

Betula seed beds in the first year

Sitka spruces (no-till farming) in the second year

Coles Nurseries, Leiceister, www.colesnurseries.co.uk

The nursery was founded 103 years ago and is now being run by the fourth generation of the same family. A total of 100 people are employed over a total area of 200 ha. The company has seven operating parts which are physically separate from one another. The range includes young plants, container plants from C3 to C10 (40 ha), standard trees on open land and containers. A number of years ago, another area was added to cultivate using a pot-in-pot system. The greenhouse area consists of 8 ha. No insecticides are used here any more; beneficial insects are used instead.

Sales primarily focus on landscape, wholesale and other production companies for growing on. The transport costs for shipping are around 10-11% of the value of the goods. Delivery is free of charge from £750.

Standard trees in folding containers

View of the container plant production

Howard Nurseries, Wortham, www.howardnurseries.co.uk

The perennial nursery produces a range of 1600 types and species on around 50 ha. The main focuses are *Geranium, Hemerocallis* and *Iris* genuses. The company has 50 employees. Propagation is almost exclusively in the form of sowing, splitting and cuttings. Production can be broken down into open land and container plants. The low level of precipitation (around 600 mm/year) means large natural ponds were created as water stores. The water taken from these is treated with chlorine to disinfect it. This means the use of plant protection agents has been able to be reduced considerably, particularly those to treat bacterial diseases.

Planting is carried out in beds (with five rows) on open land. All of the areas are regularly changed. The species are combined depending on their tolerance to herbicides.

View of the production fields

Preparation of irises for sale (potting)

Barcham Trees, Ely, www.barchamtrees.co.uk

Standard trees and specimen plants of all kinds are produced on an area of 80 ha for container-grown plants and 40 ha for field-grown plants. *Betula utilis* is the plant species with the greatest representation. The company has 59 employees.

The container sizes vary from 35 to 3000 L. White containers are the company's patented trademark. According to Mike Glover, the roots tend to grow in a downwards direction as a lot of light hits the substrate from the sides. Almost all of the irrigation and fertilisation is in the form of drip irrigation. The maximum time spent in containers is two years, and the plants are not re-potted because of the high cost of this. Water is also scarce in this region, so a storage tank was built which can hold 70,000 m^3 of water. All of the return water including drainage water is collected in this tank. The potting is done with a special machine in which trees of widths of 6-8-10-12 are hung up and taken for potting. This results in a daily output of 600-1000 trees from a team of 10-12 people.

One special feature is the sales structure in the company. Over 65% of the plants are supplied directly to end customers, and some of the planting is carried out in collaboration with local gardening and agricultural companies.

White folding containers are Barcham Trees's patented trademark.

Mike Glover (left) explains his concept in the middle of the *Betula utilis*

Deepdale Trees, Sandy, www.deepdale-trees.co.uk

The German Mathias Anton has been running a nursery producing specimen plants over an area which has now expanded to 60 ha for 25 years. The company has 22 employees, 6 of whom work in the office. Product starts from 25-30 cm and goes up to 80-90 cm trunk circumference. Only transport limits the size of the plants. Almost all of the plants are cultivated in spring rings, with gravel underneath and Mypex fabric on top.

Due to the low degree of self-sufficiency with trees in England (just 10% according to Mr Anton), a lot of acquisition is required. This occurs from Germany, Italy and the Netherlands, among others. There are of course concerns about the risk of bringing in quarantine problems - pathogens such as xylella and pests like citrus long-horned beetles and the like.

Mathias Anton from Germany summarising the company

All of the plant grow almost exclusively in spring rings

According to Mr Anton, there is some uncertainty in the English market. The reasons given were the flattening construction boom in the greater London area and the unpredictable consequences of Brexit.

Majestic Trees, Flamstead, www.majestictrees.co.uk

The nursery was founded in 2000 by Steve McCurdy, who previously worked in landscaping in California. It employs 29 people, 3 of whom have a Master's degree in Horticulture. A wide range of around 400 types and species is cultivated in containers of between 50 and 5,000 litres. All of the trees are cultivated in spring rings.

Marketing is almost exclusively directly to end customers with a corresponding delivery service up to and including digging a tree hole. The office building has special rooms for customers and architects. These can be rented, as traditionally in England architects often do not have their own premises.

The company is often involved in national competitions and has been UK Grower of the Year several times. It also won the silver medal at the International Grower of the Year competition twice, in Xian (China) and Essen (Germany).

Company buildings made of wood, including visitor rooms for architects and customers

Spring rings prevent root circling and offer a great deal of flexibility

2 Summary

All of the participants on the study trip were impressed by the friendly reception they received from the companies and the hospitality at the nurseries. The discussions were very open and involved a high level of technicality.

The nursery economy in Great Britain is also subject to considerable structural change. Some traditional companies such as Notcutts no longer exist while others are meeting the new challenges and have thrown off the ballast, such as the Hillier, which used to have its own arboretum.

The number of young companies is, however, a positive thing. With new concepts and digital media, they are approaching their customers directly and finding their markets.

The companies are particularly worried about the availability of seasonal workers from Eastern Europe. The impending Brexit means uncertainty exists in the industry.

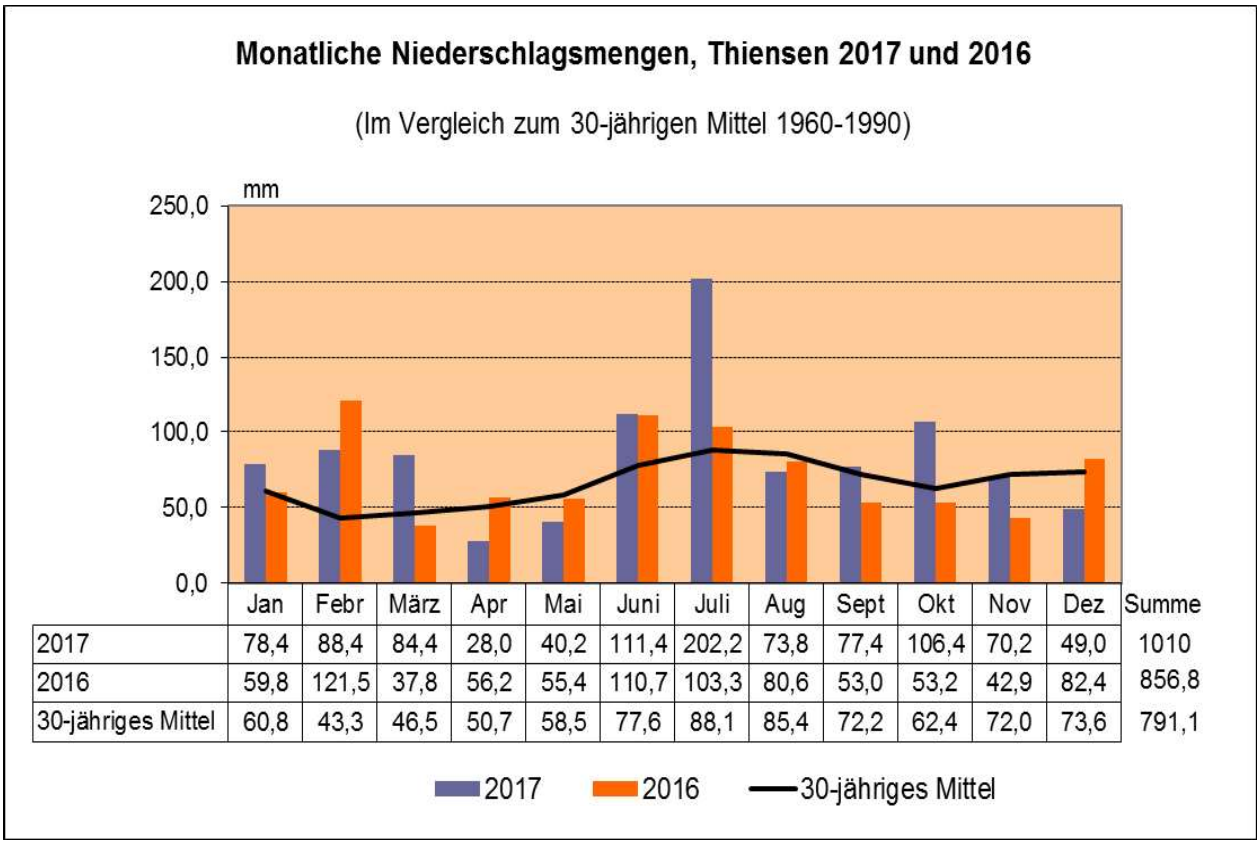
The degree of self-sufficiency when it comes to ornamental trees in Great Britain is relatively low according to the company owners. The need to buy trees in from the continent will remain, as no new production capacities can be built up in the short term. Brexit will likely increase the currency risks, introduce tariffs, and all of the processing of contracts with Great Britain will revert to the situation that occurred before Britain joined the European Single Market.

In the field of forest plants, an attempt is already being made to foreclose the market following the outbreak of ash shoot dieback in *Fraxinus excelsior* in a matter unrelated to Brexit. Plants for the forest have to be grown in Great Britain too. After the outbreak of this disease in particular the concern is essentially understandable. Whether the degree of self-sufficiency can be increased to the extent that it would cover the demand in the short term remains to be seen in forest plants.

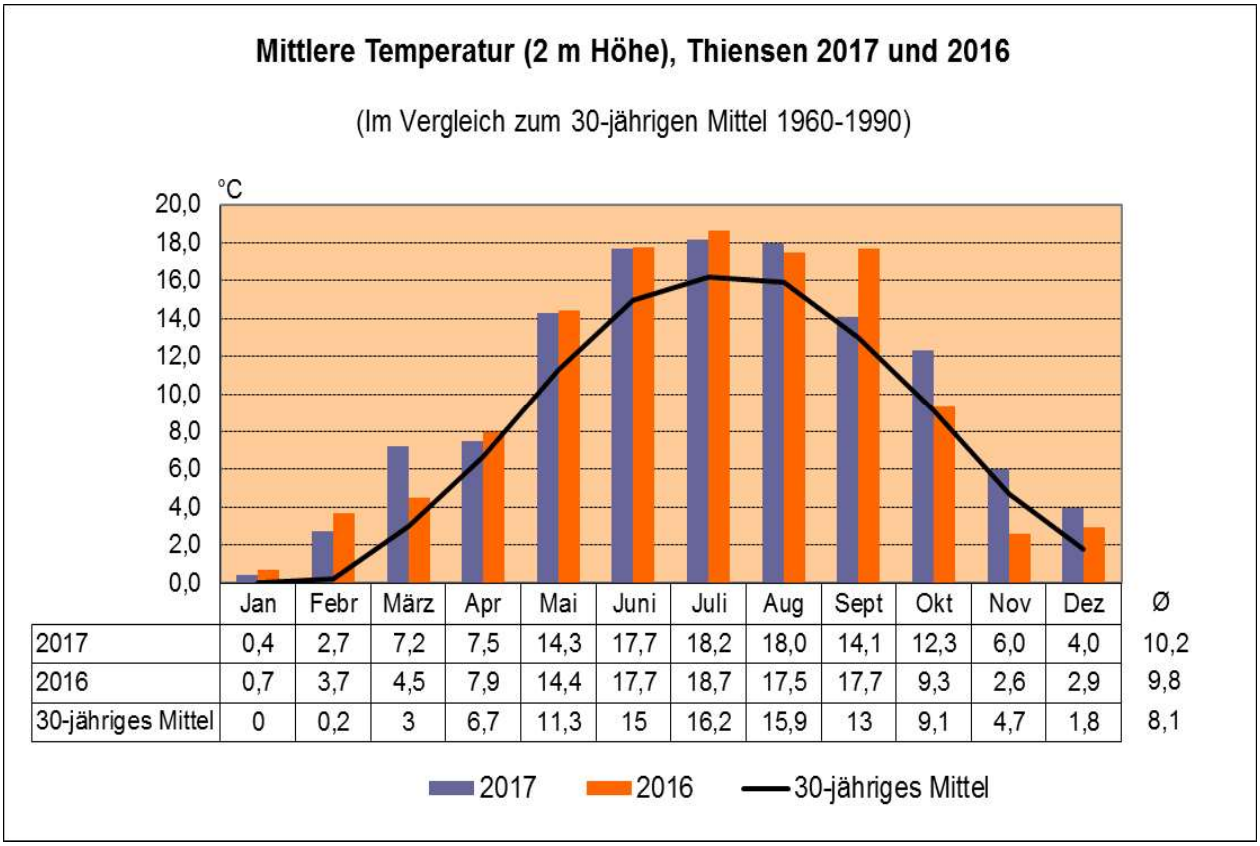
Participants in the travel group in the show garden at the Austin Roses nursery in Wolverhampton

Data from the weather station in Thiensen

Comparison of the periods of 2016 and 2017 with the 30-year average (1960 – 1990)



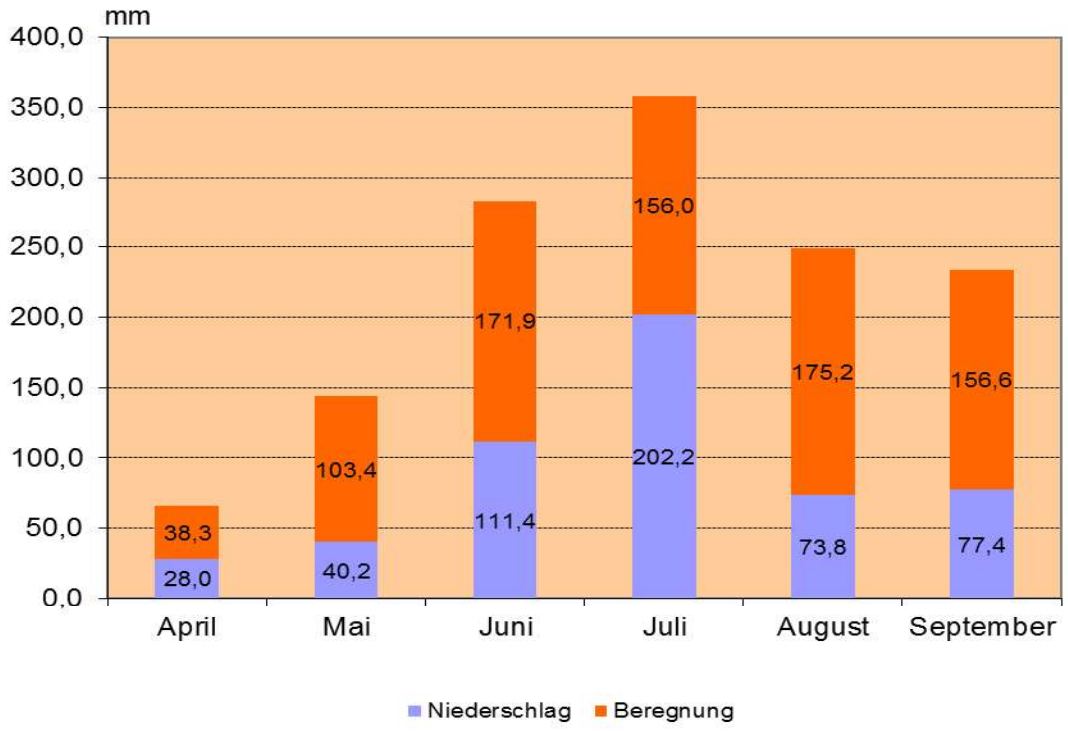
	Jan	Febr	März	Apr	Mai	Juni	Juli	Aug	Sept	Okt	Nov	Dez	Summe
2017	78,4	88,4	84,4	28,0	40,2	111,4	202,2	73,8	77,4	106,4	70,2	49,0	1010
2016	59,8	121,5	37,8	56,2	55,4	110,7	103,3	80,6	53,0	53,2	42,9	82,4	856,8
30-jähriges Mittel	60,8	43,3	46,5	50,7	58,5	77,6	88,1	85,4	72,2	62,4	72,0	73,6	791,1



	Jan	Febr	März	Apr	Mai	Juni	Juli	Aug	Sept	Okt	Nov	Dez	Ø
2017	0,4	2,7	7,2	7,5	14,3	17,7	18,2	18,0	14,1	12,3	6,0	4,0	10,2
2016	0,7	3,7	4,5	7,9	14,4	17,7	18,7	17,5	17,7	9,3	2,6	2,9	9,8
30-jähriges Mittel	0	0,2	3	6,7	11,3	15	16,2	15,9	13	9,1	4,7	1,8	8,1

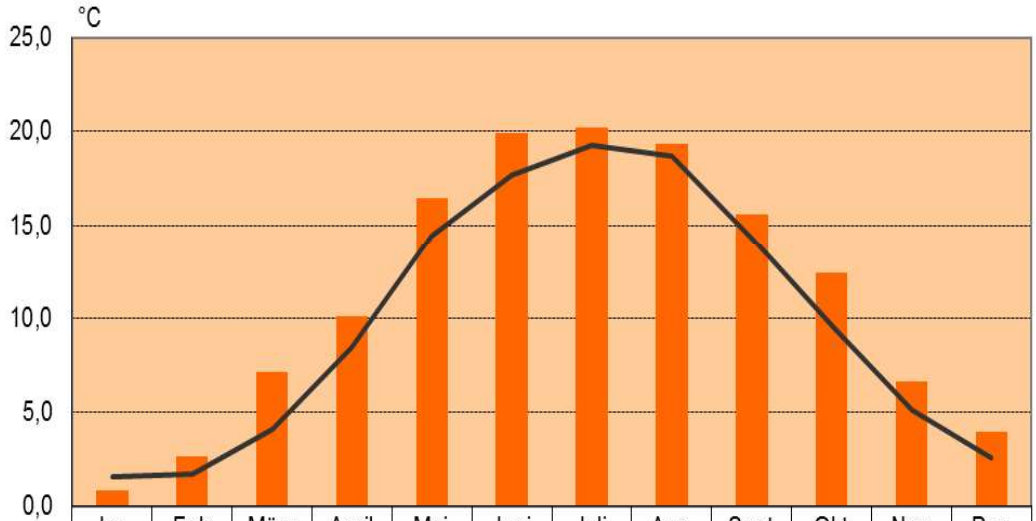
Niederschlag und Zusatzberegnung in Containerkulturen

Rosen, Co 3-4 l (Standort Rellingen 2017)

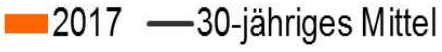


Mittlere Bodentemperaturen (10 cm Tiefe), Thiensen 2017

(Im Vergleich zum 30-jährigen Mittel 1960-1990; Standort: DWD, HH-Fuhlsbüttel)



	Jan	Feb	März	April	Mai	Juni	Juli	Aug	Sept	Okt	Nov	Dez
2017	0,9	2,7	7,2	10,1	16,4	19,9	20,2	19,4	15,6	12,4	6,6	3,9
30-jähriges Mittel	1,6	1,7	4,1	8,4	14,4	17,7	19,3	18,7	14,3	9,6	5,1	2,6



Explanation of the diagrams:

An extensive explanation of the diagrams is available in the 'yellow list' of plant protection agents for integrated nursery production.

ZP = Zierpflanzen (ornamental plants), ZG = Ziergehölze (ornamental shrubs), B = Baumschule (nursery), O = Obstbau (orchard), F = Forst/Forstgehölze (forest/forest trees),
St = Stauden (shrubs), nur uG = nur unter Glas (only under glass)

Xi = irritant, Xn = harmful to health, T = toxic, T+ = very toxic, F = highly flammable,
C = corrosive, N = harmful to the environment

Explanations of the bee protection regulations:

B1	(= NB661 and NB6611) harmful to bees
B2	(= NB662) harmful to bees except when used after the daily bee flight until 11pm
B3	(= NB663) bees are not at risk from the use of the agent in line with the authorisation
B4	(= NB664 and 6641) not harmful to bees

The harmfulness to bees changes in the case of mixtures of insecticides, particularly in the case of the products Karate Forst, Karate Zeon, Mavrik, Mospilan SG and Trafo with a fungicide from the group of ergosterol biosynthesis inhibitors (e.g. Folicur, Luna Experience, Matador, Mirage 45 EC). Mixtures must be used in such a manner that blossoming plants are not also affected.

The **new bee protection regulations NB501, NB502, NB504** apply to the B1 products Dantop, Confidor WG 70 and Warrant 700 WG. Confidor WG 70 and Warrant 700 WG may only be used on plants that will not blossom again in the year of treatment on open land. This also applies to weeds in the stocks. Treatment of plants under glass with Dantop, Confidor WG 70 and Warrant 700 WG is only permissible before blossoming if the use of the plants in open land is not intended in the year of treatment after this point.

Labelling to protect bodies of water:

NW 468	Application liquids and their residues, agents and their residues, empty containers and packaging and cleaning and rinsing fluids should not get into bodies of water. This also applies to indirect entry via the sewage system, farmyard and street run-off and rain and waste wastewater pipes.
NW 642	The use of the agent in or immediately adjacent to above ground bodies of water or artificial bodies of water is not permissible (Section 6 paragraph 2 of the Plant Protection Act). Separately of this, the minimum distance from surface waters set out in a binding manner in accordance with state legislation must also be complied with. Infringements of this may be prosecuted with a fine of up to 50,000 euros.
NG 403	No application onto drained areas between 1 November and 15 March.
NG 405	No application onto drained areas.
NG 407	No application on the soil types pure sand, slightly silty sand and slightly clayey sand.
NG 408	No application onto drained areas between 1 June and 1 March.

The herbicides Stomp Aqua, Stomp Raps and Boxer have received new requirements (NT 145, NT 146, NT 170). In accordance with these, the water volume must be at least 300 l/ha, the wind speed must not exceed 3 m/sec and the driving speed may not exceed 7.5 km/h. Furthermore, spraying must be carried out with a device to decrease losses with a drift reduction level of at least 90%.
For more details see the 'Yellow List'.

Information on the handling and storage of plant protection agents is available online at http://www.iva.de/praxis/pflanzenschutz.

More information explaining additional distance requirements can be found online at http://www.bvl.bund.de where you can enter them in the search function "code list".

You can find more information on the definition of storage classes from VuB.

Important note: VuB disclaimer

We call attention to the fact that all of the recommendations made and information provided by us are given to the best of our knowledge to the exclusion of any liability.

They are based on trial results, practical experience and industry recommendations and correspond to the current level of our knowledge. They can only be used as tools to facilitate the making of decisions. This applies in particular to all trial reports and trial results, which cannot be transferred to practice without taking into account the specific operational conditions. In the case of any doubt, we recommend that companies carry out their own small-scale trials to obtain local experience. In this context, we also refer to careful compliance with all regulations, instructions for use and precautionary measures.

Many conditions have an impact on the effect of plant treatment agents and fertilisers such as the condition of the plants, the nature of the soil, the physical location, the crop management, the interaction with other agents and factors and the weather. Since these conditions and the proper use are outside the control and potential influence of the Trialling and Advisory Circle for Nurseries, liability for the efficacy and the consequences of use is excluded.

Important note: UK/AHDB disclaimer

The VuB publication is a translation of a document reporting research results from work conducted in Germany and consequently the information is only accurate in terms of active ingredients registered for use in Germany. Individuals are responsible for checking whether the use of these actives is legal within the UK and if so whether the doses and rates are the same.

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