Trialling and Advisory Circle
VuB
Schleswig-Holstein

Chamber of Agriculture
Schleswig-Holstein
Horticultural Centre

Annual report
2018

Summer 2018 was characterised by high temperatures and low rainfall.
Seed beds of *Rosa* ‘Laxa’ shown here.

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Annual report 2018
(Dr Heinrich Lösing, Director)

In 2018, the Trialling and Advisory Circle was able to continue its successful work. A total of 268 nurseries, over 3,057 hectares, and 42 supporting members were regularly informed of new findings from practical experience, science and industry, in particularly fertiliser and plant protection measures which protect the environment, by means of 38 newsletters via telephone/fax/email and 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 during 2018. The same was true of the production area, this reduced by 13 ha relative to the previous year. This trend was similar across the entire country.

After three years, Sebastian Heise left VuB in December to gain more experience abroad. The board, management and colleagues wished him well. We were able to appoint Lilli Fröhlich as his successor as a specialist in fertilisers, among other things, and she joined VuB in November 2018. This enabled a planned successional handover to be carried out. Ms Fröhlich studied commercial horticulture at Osnabrück University of Applied Sciences and then completed several internships. She most recently worked in plant protection product trialling.

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

The demonstration of the autonomous device Dino by Naio from France, (www.naio-technologies.com) at Elbers Nursery in Nettelkamp garnered a great deal of attention.

First, in June, we looked at the latest developments in weed control in outdoor vegetables. We had a tour of Elbers Nursery in Nettelkamp, to which all of the VuB members were invited.

We also had a tour of the Clasen & Co Nursery in Rellingen. We viewed the HV-100 nursery robots, which are sold by Hauert (www.hauert.de) in Germany. These robots can automatically place pots from around 2 L upwards at various spacings. Unfortunately, thus far the device can only pick up pots from the ground and the working width is limited to 6 m production beds.

HV-100 nursery robot.

Aebi mulcher, controlled by Robot Makers, being used on standard trees.

On the same day there was also a presentation of an autonomous mulching device. A standard device by the Swiss manufacturer Aebi was supplemented with laser control from the company Robot Makers from Kaiserslautern (www.robotmakers.de). Mulching and spraying work can be carried out even under trees with this device, where GPS-controlled devices sometime have problems.

Air assisted application devices can be used to improve crop penetration with plant protection products in larger stands of trees. To date, most devices consist of two booms, including those by the brand Hardi, but these devices are less suitable for container-grown nurseries. The manufacturer ASM (www.asm-ostervang.de) from Denmark also offers devices that work from a single boom with a maximum of 12 working widths. These are used in Christmas tree production and on container-grown nurseries.

After two and a half years, the EIP project on thermal soil treatment is now complete. Various new findings were able to be obtained in close collaboration with nurseries in the region. The project was financially supported with funds from the European Community and the state of Schleswig-Holstein. The contractor was BTB GmbH. Despite the high costs in terms of both capital and time, around 50-60 ha per year are currently being treated.


Counting aphids in a large trial.

The intensive trialling of plant protection products and possible alternative products continued during 2018. More active ingredients are being lost to horticulture than new ones are being approved. In addition to the product approval situation, there is more or less a voluntary waiver of certain plant protection products in order to meet customer requirements. A great deal of advice is needed to maintain the high standards of product quality.

Around 30 people took part in the open day examining the weed control trials on seed beds. Various residual herbicides were examined to determine their efficacy and safety in sand-covered seed beds.


Inspection of seed bed trials in Rellingen.

As part of the EAFRD (European Agricultural Fund for Rural Development) consultation, a total of 32 nurseries used the opportunity to receive intensive advice on integrated and biological pest management in 2018. The implementation of this is the responsibility of BTB GmbH.

Promotion of beneficial insects with ‘insect hotels’.

The activities were supported by VuB employees. This was especially true in terms of support with biological crop protection. The support was initially limited to two years but has now been extended by a further three years.

Since many plant protection products do not have the necessary approvals for nurseries, the single applications in accordance with Section 22 (2), formerly Section 18b, of the Plant Protection Act are still being processed. A total of 39 plant protection products are currently approved for use 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. Due to the joint efforts of BdB Landesverband SH and VuB the funds can now be used for a further 18 months after the end of the approval.

The disposal of empty and rinsed plant protection product and fertiliser containers continues thanks to the Pamira system. Via collaboration with HaGe in Uetersen, an on-site collection point has been established in the past few years. The containers have been collected across the country on a voluntary basis for 20 years.


Consolidated containers with empty packages, lids separated.

Fertiliser advice for nurseries continues to be a focus of our advisory work. Fertiliser recommendations were provided for 459 growing media samples from container-grown crops, 831 soil samples and 240 N_{min} tests. This number of samples shows the high level of awareness of the requirement for needs-based and environmentally sound nursery fertiliser

programme. A further 183 samples were tested to determine their nitrogen contents using the rapid nitrate test.

The guideline values in accordance with the Fertiliser Ordinance Section 3 for nitrogen in the soil are also set out. The determination of the contents in spring before the start of growth was a requirement for nurseries under the previous Fertiliser Ordinance, however, this is no longer compulsory with the entry into force of the new Ordinance. The importance of the element nitrogen and the risk of leaching associated with over application mean that guideline values should continue to be determined for nurseries on a voluntary basis. The costs that arose for the sampling and laboratory analyses were shared between the Chamber of Agriculture, Horticulture Division and the VuB. The results for 2018 can be found in the annual report under ‘nitrogen contents for nursery soil guideline values for 2018’.

Trials on the use of urea to supply trees with nitrogen were continued. As only stabilised urea fertilisers will be available for use in the near future, trials were carried out with Alzon neo-N in various production systems. Cost aspects play a significant role.

Further trials examined the option of using coated fertilisers on deciduous tree and conifer seedbeds. The aim of this was to apply the fertiliser in the rows of seeds together with the seeds themselves. This should then prevent the need for time-consuming subsequent fertiliser application with a row fertiliser spreader and minimie any nutrient loss.

The analysis of heat loss from nursery cold stores was new in 2017. 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 an infra-red heat imaging camera.

Many of the trials were supported by fertiliser and plant protection product manufacturers, growing media suppliers and nursery supply companies. For 2018, particular thanks go to Arysta, BASF, Bayer CropScience, Belchim, Biofa, Compo Expert, DowAgroSciences and DuPont, (Corteva Agriscience), Flügel, Gowan Crop Protection, Haifa North West Europe NV, Hauert MANNA Düngerwerke, Heinrich Harden, ICL Specialty Fertilizers, Jost Mikronährstoff- u. Spezialdünger, H. Meyer, Mivena BV, Neudorff, Plantacote NV, Syngenta, Spiess-Urania Chemicals (Certis), 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 2018:

Bornholdt, U., Barmstedt	Kordes Söhne, Sparrieshoop	Röttger, T., Heist
Breckwoldt, Ellerbek	Krohn, R., Tangstedt	Sander, Tornesch
Bruhn, Barmstedt	Lüdemann ,F., Pbg	Schnoor, G., Appen
Deutschmann, Ellerbek	Mohr, T., Bullenkuhlen	Schrader, Kölln-Reisiek
Ellerbrock, Tangstedt	Ostermann, J., Ellerbek	Schröder, H., Ellerbek
Glismann, Bullenkuhlen	Ostermann, M., Ellerbek	Schuldt, Ellerhoop
Grelck, Halstenbek	Paulsen, Rellingen	Schurig, Barmstedt
Harder, L., Ellerhoop	Pein, G, Appen	Stahl, Gr. Nordende
Heinrich, Ellerhoop	Pein, H., Appen	Vogt, H., Rellingen
Heydorn, Kl. Nordende	Pein, T., Ellerhoop	Wilke, Kummerfeld
Hoyer, Bullenkuhlen	Pein, U., Appen	Wrage, Ellerhoop
Kleinwort, Gr. Nordende	Rosen-Tantau, Uetersen	Zorn, Tangstedt

The 2018 study trip was to Belgium. A total of 10 nurseries and a research institute in Destelbergen were visited. Twenty-three people took part in the study tour.

‘Courage to have green walls’ - a new trend in major cities. The image shows members of the travel group at the Destelbergen research institute in front of a demonstration unit.

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

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

Collaboration with the Horticultural Department of the Chamber of Agriculture and crop protection advisors continued taking into account environmental protection in particular with a focus on the collection and dissemination of information.

In the entire BdB, contributions were made to the committees on ‘production and environment’, ‘IT’, ‘deciduous trees’ and the ‘working group on horticultural research’.

Written and telephone questions from within Germany and abroad continued to be answered as they had previously.

Residual pre-emergence herbicides for use on tree seed beds
(B. Zielke, Dr H. Lösing)

1. Introduction

Trials were carried out previously on residual soil herbicides for use on seed beds in 2015 and 2016 (2016 annual report, page 28). Various herbicides were tested as a replacement for the product Terano, which was used in some instances on soil-covered seed beds on heavier soil types until the end of its approval.

Another important objective in 2016 related to the end of the use-up period for the product Protugan. The herbicides Arelon Top and Protugan, both containing the active ingredient isoproturon, were safe to use on many seed bed grown crops. The active ingredient can no longer be used anywhere in Europe and alternatives were needed.

The herbicide options for use on sand-covered seed beds before crop emergence are very limited. Products containing the active ingredient pelargonic acid can be used until shortly before crop emergence to 'burn off' weeds. The products Goltix Gold and Stomp Aqua can also be applied until one week before crop emergence. In addition to their contact action, these products also give residual control.

The trial described below examines the efficacy and safety of other residual soil herbicides in various soil-covered and sand-covered seed beds prior to crop emergence.

Fig. 1: Sand-covered, spring seed beds at the start of the trial on 18 April 2018.

2. Trial methodology

Spring seed beds of various genera and species (see Table 1), some soil-covered and some sand-covered, were treated with the herbicides listed in Table 2 after the seeds were sown but

before crop emergence. The treatments were applied using a plot spraying device using a Lechler injector nozzle ID 120-03 in blue at a pressure of 3.5 bar and a speed of 3 km/h. This corresponds to a water volume of 512 l/ha. The treatments were applied twice to each species being examined. The beds had good soil moisture at the point at which the treatment was applied. Irrigation was carried out as required over the course of the trial.

Table 1: Trial species, covering type, date of treatment and sowing date

Plant species	**Covering**	**Date**	**Sowing**
Carpinus betulus	Sand	18/04/18	End of week 14/start of week 15
Lonicera xylosteum	Sand	18/04/18	End of week 14/start of week 15
Malus sylvestris	Sand	25/04/18	End of week 16
Prunus avium	Soil	18/04/18	End of week 14/start of week 15
Prunus mahaleb	Sand	18/04/18	End of week 14/start of week 15
Prunus serotina	Sand	18/04/18	End of week 14/start of week 15
Rhamnus frangula	Soil	18/04/18	End of week 14/start of week 15
Rosa rugosa	Soil	25/04/18	15/04/18
Sambucus nigra	Sand	18/04/18	End of week 14/start of week 15

Table 2: Treatment list

Treatment	**Rate**	**Active ingredient**	**Approval**	**Notes**
Untreated	-	-	-	-
Boxer	5 l/ha	Prosulfocarb (800 g/l)	Article 51 ZG	N, Xi, B4
Debut	15 g/ha	Trisulfuron (486 g/kg)	Turnips, beetroot	N, Xn, B4
Flexidor + Boxer	0.5 l/ha + 3 l/ha	Isoxaben (500 g/l) + Prosulfocarb (800 g/l)	B Article 51 ZG	N, B4 N, Xi, B4
Goltix Gold	3 l/ha	Metamitron (700 g/l)	Section 22 (2) B, St	N, Xn, B4
Proman	2 l/ha	Metobromuron (500 g/l)	Section 22 (2) B, St	GHS08, GHS09, B4
Quantum	1.5 l/ha	Pethoxamid (600 g/l)	Sweetcorn, cut flowers	N, Xn, B4
Spectrum	0.75 l/ha	Dimethenamid-P (720 g/l)	Article 51 ZP	N, Xn, B4
Stomp Aqua	2.5 l/ha	Pendimethalin (455 g/l)	Article 51 ZG	N, Xn, B4
Vulcanus	0.3 l/ha	Flufenacet (600 g/kg)	-	-

3. Results

3.1 Safety

Any signs of phytotoxicity were recorded until the start of July. Records over a longer period could have been made, but would probably not have yielded any further results. Growth differences occur over the course of the year as a result of the different amounts of growing space and available fertiliser.

The results were not always so clear. With *Prunus mahaleb,* the crop emergence results were very low overall, including in the untreated plots. The second application to the *Prunus avium* resulted in general losses that were not due to the herbicide treatment. At the location with *Rosa rugosa* where the beds had been steam sterilised before seeding, significant damage occurred as a result of hail after emergence. Cockchafer grubs were identified on the trial bed later in the year. There were, however, significant losses that were specifically due to the herbicide treatments.

Fig. 2: After determination of herbicide efficacy around four weeks after treatment, the weeds have to be removed so the growth of the tree seedlings is not impeded and the safety of the herbicides can be further monitored.
Fig. 3: Stomp Aqua plot on 7 October, damage after treating *Sambucus nigra* The seedlings did emerge and even formed a few leaves, but as the trial continued they started to die out eventually almost completely dying out.

The Flexidor + Boxer tank mix was the least well tolerated by the crop species. This mix led to damage in the form of losses or delayed growth in all of the genera/species examined. When applied alone, Boxer, for which there are a very large number of trial results from Belgium, was somewhat safer. However, only *Malus sylvestris* and the soil-covered *Rhamnus fragula* were entirely undamaged when this herbicide was used.

Malus sylvestris tolerated all of the other herbicides trialled. *Carpinus betulus* also showed only slight damage after the use of Boxer alone and when tank mixed with Flexidor. The *Prunus* species trialled were sensitive to Boxer, Proman, Quantum and Spectrum. Goltix Gold, Stomp

Aqua and Vulcanus were, however, safe. Soil-covered *Rhamnus frangula* were so badly damaged by the Flexidor + Boxer tank mix in this trial that the resultant seedling thinning was still visible in early July. All of the other herbicides trialled tended to have a somewhat delayed or thinning effect by mid-May. The differences compared to the untreated plot decreased with time, however. The tolerance is nevertheless marked with '+ -' in the overview table below.

With *Lonicera xylosteum*, the damage that appeared in May did not get worse relative to the untreated plots. Only the products Goltix Gold and Stomp Aqua were safe. *Sambucus nigra* was also sensitive to the herbicides. Overall, only the products Goltix Gold and Vulcanus were well tolerated. While shortly after germination it still looked as if Stomp Aqua was tolerated despite expectations, however the *Sambucus* in this treatment died out almost completely as the trial continued. With *Rosa rugosa,* there were delays in germination during the early phase as a result of the use of the herbicides Boxer, Debut, Flexidor + Boxer, Stomp Aqua and Vulcanus. The herbicides Goltix Gold, Proman, Quantum and Spectrum were the best tolerated. Problems with hail and cockchafer grubs, however, meant that many of the seedlings were lost so it was not possible to draw any conclusions regarding herbicide tolerance. They are therefore marked '+ -'.

Table 3: Overview of herbicide phytotoxicity

Treatment	**Rate**	*Carpinus betulus*	*Lonicera xylosteum*	*Malus sylvestris*	*Prunus avium*	*Prunus mahaleb*	*Prunus serotina*	*Rhamnus frangula*	*Rosa rugosa*	*Sambucus nigra*
Boxer	3 l/ha	+-	+-	+	+-	-	-	+-	-	-
Debut	15 g/ha	+	+	+	+	+	+-	+	-	-
Flexidor + Boxer	0.5 l/ha + 3 l/ha	+-	-	+-	+-	-	-	-	-	-
Goltix Gold	3 l/ha	+	+	+	+	+	+	+-	+-	+-
Proman	2 l/ha	+	-	+	-	-	+-	-	+-	-
Quantum	1.5 l/ha	+	-	+	+-	+-	+-	-	+-	+-
Spectrum	0.75 l/ha	+	-	+	+-	+-	+-	+-	+-	+-
Stomp Aqua	2.5 l/ha	+	+	+	+	+	+	+-	-	-
Vulcanus	0.3 l/ha	+	-	+	+	+	+	+-	+-	+

3.2 Efficacy

Fewer weeds emerged in the *Rosa* plots as this area had been steamed sterilised before sowing. In the *Malus* plots, treatment with Finalsan was carried out shortly before the seedlings emerged to burn off the weeds. This decreased the weed pressure but made it more difficult to assess the efficacy.

The efficacy of the herbicides was determined in the plots containing the plant species *Carpinus betulus* and *Prunus serotina*. Since these and the other species trialled were sown in the same area in Rellingen, the weed spectrum was similar here. One weed species was particularly dominant in this trial. This must be taken into account when interpreting total average weed cover.

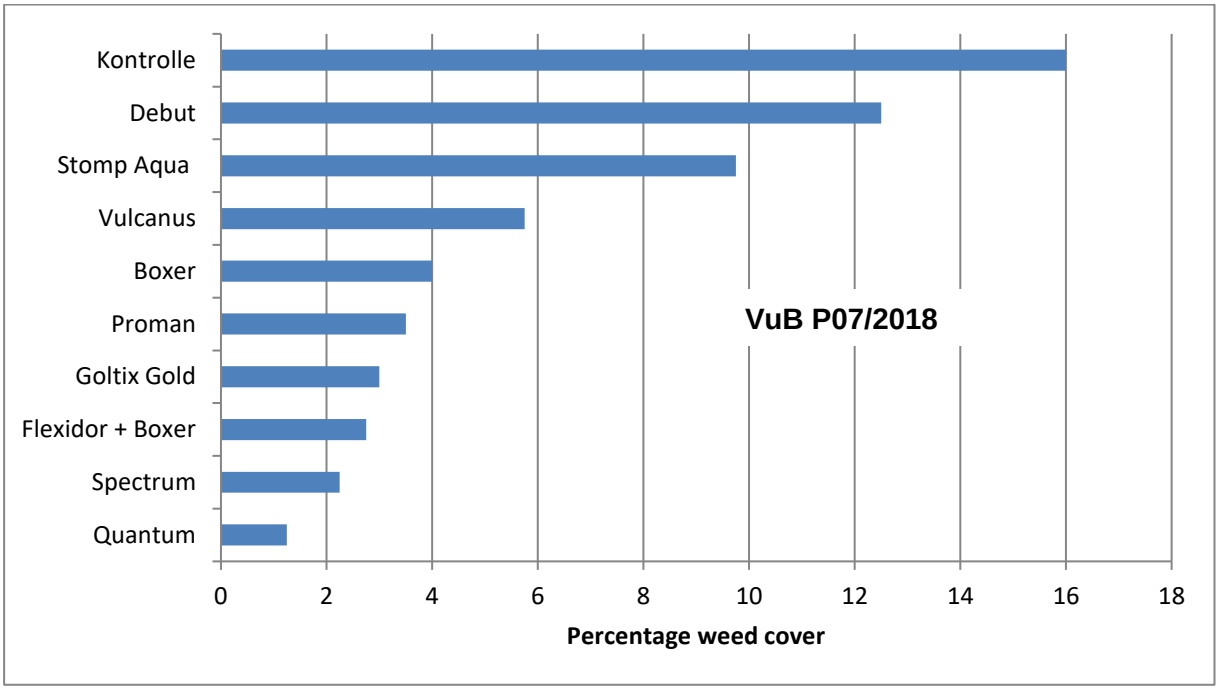


Fig. 4: The average percentage weed cover in spring seed beds of *Carpinus betulus* and *Prunus serotina* on 15 May 2018, around 4 weeks after the start of the trial (mean value of two species and two replicates). Groundsel dominated in the area making up 85% of the total weeds. The percentage weed cover in this assessment therefore very much depends on the effect of the products examined on groundsel.

Groundsel was by far the most common weed in this trial, with an average of 85% of the total weed population. As a consequence, the degree of weed control attained by the treatments with a gap in effectiveness against this weed was particularly low. The herbicides Debut and Stomp Aqua had no effect against groundsel. The herbicides Quantum, Spectrum, Goltix Gold, Proman and Boxer and the herbicide combination Flexidor + Boxer were effective against this weed.

Fig. 5: Section from the trial plot treated with Goltix Gold. The herbicide had a good effect on groundsel.
Fig. 6: Section from the trial plot treated with Stomp Aqua. The herbicide has no effect on groundsel.

An estimate of the level of control was made for the other weed species that grew in the *Carpinus* and *P. serotina* plots which had a percentage weed cover of between 2% and 5%. Black nightshade, small-flowered gallant soldier and cockspur grass occurred in the seed beds of both species; shepherd's purse, annual meadow-grass, yellow field cress and fat hen occurred at a level of at least 2% coverage in just one of the beds. The effect of the herbicides on these weeds is shown in Figure 8 on the next page.

The lesser trefoil (*Trifolium dubium*) in the *Rosa rugosa* plot, which emerged despite soil sterilisation, was prevented from germination by the herbicides Boxer, Boxer + Flexidor and the herbicide Proman.

Fig. 7: Section from an untreated plot in the *Rosa rugosa* plot. Lesser trefoil (*Trifolium dubium*) germinated despite soil sterilisation before sowing. It was clear which herbicides had an effect despite the cockchafer grubs eating some of the plants, including the lesser trefoil.

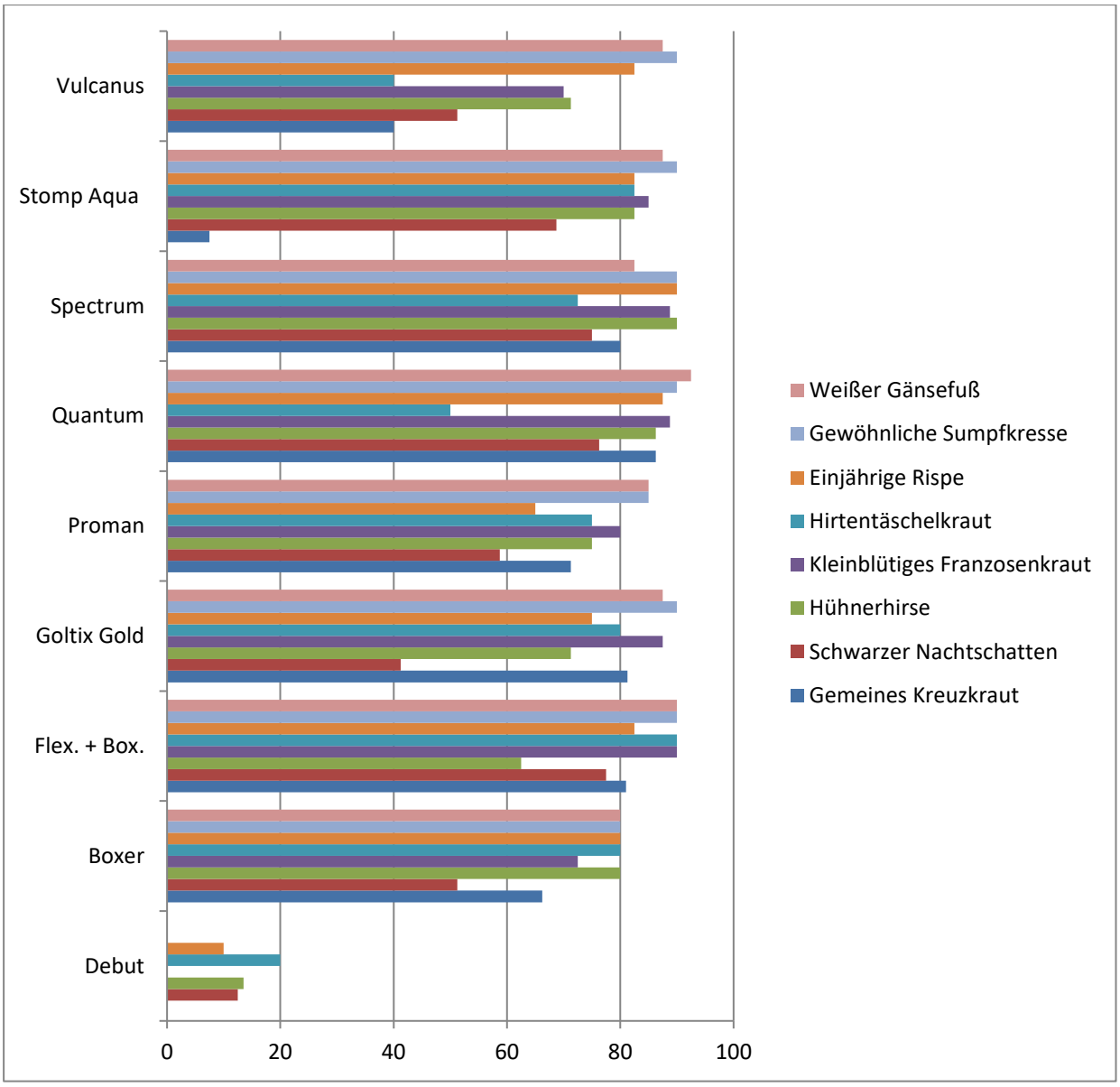


Fig. 8: Effect of the herbicides on the various weed species. Mean values from two plots with two replicates in each case. Groundsel (navy blue) made up 85% of the coverage with weeds, with the other weeds making up between 2% and 5% respectively. Black nightshade (red), small-flowered gallant soldier (purple) and cockspur grass (green) occurred in both locations; shepherd's purse (light blue), annual meadow-grass (orange), yellow field cress (grey) and fat hen (pink) occurred in just one of the locations.

4. Summary

A trial was carried out on sand-covered spring seed beds of hornbeam, honeysuckle, myrobalan, bird cherries, wild cherries and wild apple and on soil-covered seed beds of Japanese roses and buckthorn.

The hope of identifying new, safe herbicides for this area of use in addition to Goltix Gold and Stomp Aqua was not fulfilled. Broadly, safe herbicides such as Debut and Vulcanus were not particularly effective in this trial. The effective herbicides Boxer (particularly Boxer in combination with Flexidor), Quantum, Proman and Spectrum caused phytotoxicity issues in

the more sensitive species trialled such as *Lonicera*, *Prunus* species, *Rhamnus*, *Rosa* and *Sambucus*. These herbicides were partially tolerated by the more robust *Capinus* and *Malus.*

Some of the species were treated with Goltix Gold or Stomp Aqua. A combination of these two products proved to be particularly good in terms of efficacy. In species that tolerated the herbicides, the addition of Vulcanus to Stomp Aqua or Goltix Gold can also be considered, particularly if annual meadow-grass or fat hen are to be expected. The herbicide Vulcanus is not yet approved.

The use of herbicides on sand-covered tree seed beds remains a difficult topic to resolve. The matter becomes even more significant against the background of the likely end of the approval for the product Betasana for subsequent treatment of emerged seedlings.

One option for reducing weed pressure in sand-covered seed beds is to ‘burn off’ weeds on seed beds using herbicides containing pelargonic acid. This method works if there is a certain amount of time between sowing and the emergence of the tree seedlings in which weed seeds can germinate. Other measures that are used in practice, and are likely to become increasingly significant, are various methods of mechanical weed control.

Herbicides against yellow field cress
(B. Zielke, Dr H. Lösing)

1. Introduction

As a result of the use of the herbicide Terano (flufenacet + metosulam) since 2003, field cress species have become less significant weeds in northern Germany (see VuB 2003 annual report, page 42 et seqq.). However, the use up period for Terano ended in June 2016, and since then these weeds have been increasing again in nursery production (VuB 2013 annual report, page 24). The active ingredient metosulam was responsible for the good effect of the herbicide Terano. No herbicides containing this active ingredient are currently available in Germany.

In addition to the annual or biennial 'ordinary field cress' (*Rorippa palustris*), the perennial 'creeping yellow cress' (*Rorippa sylvestris*) is also becoming an issue. The species are easier to differentiate while they are flowering because of the size of the petals. Both species occur in nurseries, but it is particularly the perennial species that is problematic as it reproduces rapidly both generatively and vegetatively via offshoots.

The trial aimed to investigate which herbicides are suitable to control yellow field cress now the product Terano is no longer available.

Fig. 1: Ordinary marsh yellow cress (*Rorippa palustris*) with small petals; this species reproduces annually or biennially through seeds.
Fig. 2: Yellow field cress (*Rorippa sylvestris*), also known as creeping yellow cress with large petals; this species is persistent and forms both seeds and offshoots.

Fig. 3: Offshoots of the creeping yellowcress (*Rorippa sylvestris*).

2. Trial methodology

The trial was carried out in early April on a uniform area with significant amounts of yellow field cress. There were no nursery trees in the beds.

On 6 April 2018, the herbicides and herbicide combinations listed in Table 1 were applied using a plot spraying device equipped with a Lechler nozzle ID 120-03 at a pressure of 3.5 bar and a speed of 3 km/h. The water volume per hectare was 512 l.

Overview 1: Treatment list

Treatment	**Rate**	**Active ingredient**	**Approval**	**Notes**
Untreated	-	-	-	-
Atlantis WG + wetting agent	0.5 kg/ha + 2 l/ha	Iodosulfuron (5.6 g/l) mesosulfuron (29.20 g/kg)	Grains	N, Xn, B4
Broadway + wetting agent	0.275 kg/ha + 1l/ha	Florasulam (22.8 g/kg) pyroxsulam (68.3 g/kg)	Grains	N, GHS09, B4
Debut	30 g/ha	Trisulfuron (486 g/kg)	Turnips, beetroot	N, Xn, B4
Husar	0.1 l/ha	Iodosulfuron (93.2 g/l)	Grains	N, Xi, B4
MaisTer Fluid	1.5 l/ha	Foramsulfuron (30 g/l) iodosulfuron (0.93 g/l)	ZG, use up by June 2019	Xn, B4
Monsoon	2 l/ha	Foramsulfuron (22,5 g/l)	Sweetcorn	N, Xi, B4
Primus	0.125 l/ha	Florasulam (50 g/l)	Grains	GHS09, B4
Sencor Liquid	0.5 l/ha	Metribuzin (600 g/kg)	Section 22 (2) ZG	N, GHS09, B4
Terano	0.8 kg/ha	Flufenacet (600 g/kg) metosulam (25 g/kg)	-	N, Xn, B3

3. Results

At the start of the trial, the dormant yellow field cress had only just emerged. The plants had formed a rosette with 10-15 leaves and were still slightly red. The effect of the herbicide applications was able to be observed around three weeks after the start of the trial. While the yellow field cress had continued to grow on the untreated plots, the yellow cress on many of the treated plots had turned yellow and appeared to be dying out.

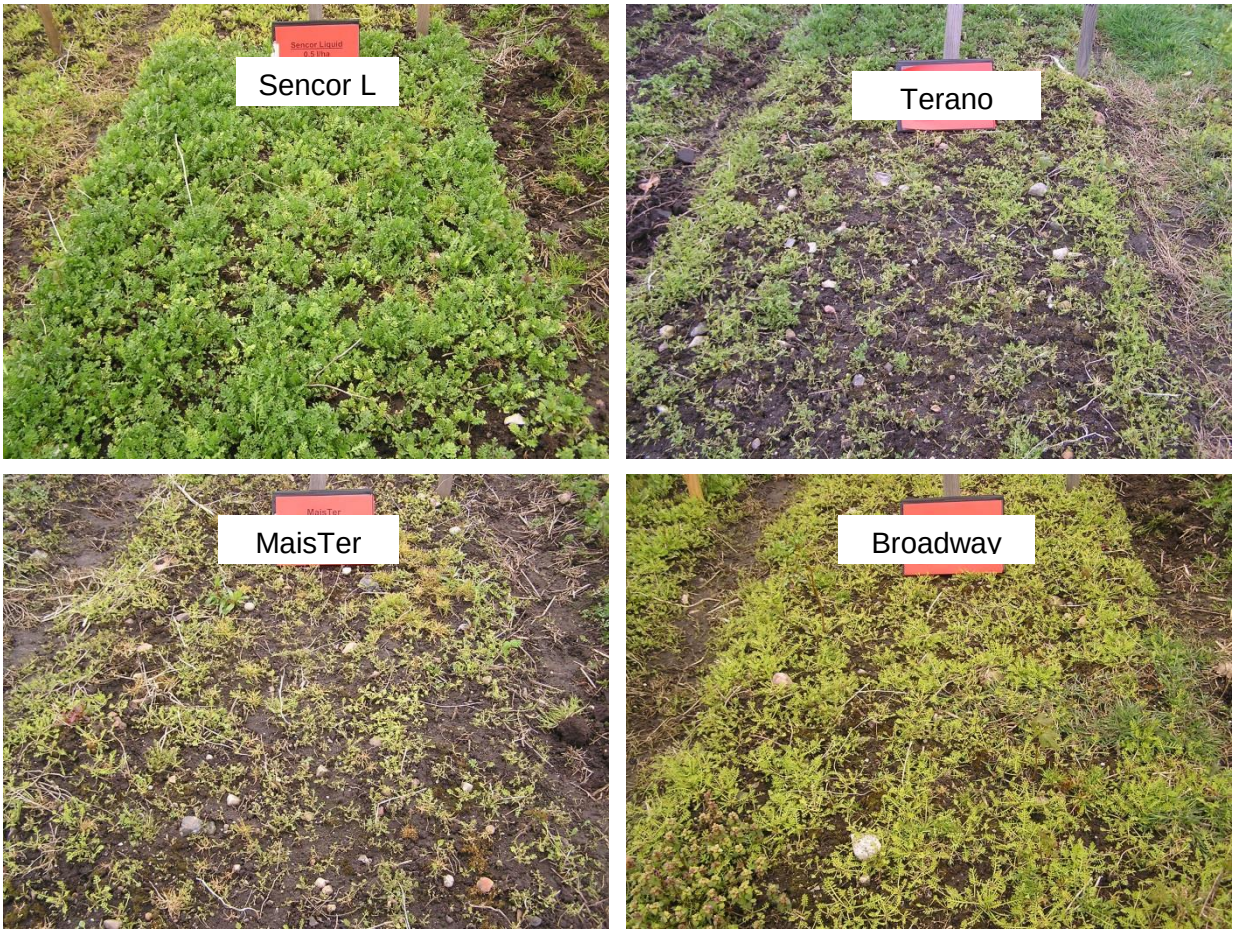


Fig. 4-7: Trial plots on 25 April, around three weeks after treatment. The herbicide Sencor Liquid had no effect on *Rorippa*.in this trial.

On 1 June the yellow field cress in the untreated plots was in full bloom. A final observation was carried out. In addition to the yellow field cress there were only individual, odd other weeds in the trial area. These were small-flowered willowherbs, annual meadow-grass and some perennial grasses. Cockspur grass also grew in plots where there was light and space.

The effect on the yellow field cress was determined in percentage terms. The herbicide Sencor Liquid had no effect on the yellow field cress. Since it is effective against annual meadow-grass and is the only product in this trial that was effective against willowherbs in the rosette

stage, the yellow field grass grew strongly in the Sencor plots with no competition from other weeds.

The other products examined all belonged to the group of sulfonylureas and had an effect on the yellow field grass. The effect of the turnip herbicide, Debut, was lowest at 30% relative control. By trialling the individual active ingedients foramsulfuron (Monsoon) and iodosulfuron (Husar), both of which are found in the herbicide MaisTer Fluid, we determined that the active ingedient iodosulfuron was responsible for the very good effect on yellow field cress of the herbicide MaisTer Fluid. However, the product Monsoon (foramsulfuron) was more effective than the product Husar (iodosulfuron) on annual meadow-grass.

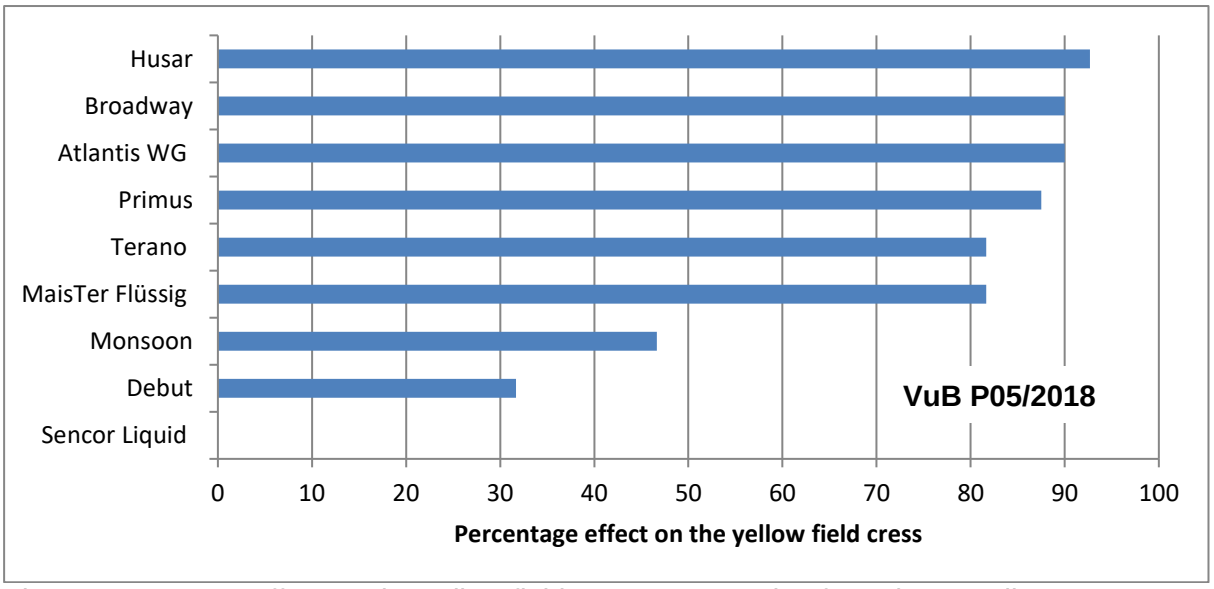


Fig. 8: Percentage effect on the yellow field cress, mean value from three replicates.

Fig. 9: The trial yielded good results in terms of which herbicides are effective against yellow field cress by the beginning of June.

The effect of the sulfonylureas on grass weeds varied. The products Broadway, Debut and Primus did not have an effect on the annual meadow-grass present. The products Atlantis WG and Husar had an effect on this grass species, but it was not as significant as that of the products MaisTer Fluid and Monsoon. None of the sulfonylureas examined prevented emergence of cockspur grass two months after application.

4. Summary

Following the revocation of the approval for Terano, the herbicide MaisTer Fluid was available as a replacement for use in some nursery crops to control creeping yellow cress. The approval for the herbicide MaisTer Fluid has now lapsed too and the product needs to be used up by June 2019. At the point at which the trial was carried out, it was not yet clear whether Monsoon and Husar, containing individually the two active ingredients in MaisTer Fluid, were going to be marketed in the future. This means it will not be possible to recreate the herbicide MaisTer Fluid simply by tank mixing the individual active ingredients in these two products.

Other products from the group of sulfonylureas have, however, proven to be very effective against yellow field cress in the trial in terms of their efficacy against this weed.

Trials on crop safety have already been carried out with the products Primus and Broadway, which are effective and authorised for use in agriculture (see VuB 2009 annual report, page 11 et seqq. and 2013 annual report, page 24 et seqq.). Further trials on crop safety in nursery trees were carried out in winter 2018 and will be evaluated in 2019.

In general, particular attention will need to be paid to weeds which spread via roots. The loss of effective herbicides makes control more difficult. In future, control needs to happen in good time to avoid the weeds seeding and/or the vegetative spread of them.

Effectiveness and safety of pre-emergence herbicides with *Tagetes*
(B. Zielke, Dr H. Lösing)

1. Introduction

The cultivation of *Tagetes* species as plants to control free-living nematodes has been practised in the Pinneberg region of Germany for almost three decades. Initial trials on this were published as far back as 1990 (see VuB 1990 annual report, page 32 et seqq.). Extensive trials carried out in 2009 and 2010 once again highlighted the positive effect of growing *Tagetes* species prior to cropping on free-living nematodes in the soil (see VuB 2010 annual report, page 33 et seqq.).

As few weeds as possible should ideally develop to ensure growth of the *Tagetes* is maximised to make full use of their nematode repelling effect. Since *Tagetes* have a slow juvenile development phase, supportive weed control measures are mostly essential. The standard method is treatment with Goltix Gold or Stomp Aqua before germination. Both herbicides are approved for this area of use according to Article 51. *Tagetes* can be treated with grass herbicides, Goltix Gold or Betasana SC after germination.

The herbicide Betasana SC is likely to lose its approval. Against this background, good pre-emergence treatment for weed-free *Tagetes* areas has become significant once again. The aim of this trial was to investigate the suitability of other herbicides for this area of use.

Fig. 1: Young *Tagetes* with competition from gallant soldier
Fig. 2: *Tagetes* ‘Nema Mix‘ in bloom (photo: H. Lösing)

2. Trial methodology

Tagetes of the type ‘Nema Mix‘ was sown at 10 kg/ha on prepared ground on 29 May 2018. The seeds were incorporated using a harrow and then rolled over. Lack of rain meant that the trial area was irrigated after sowing.

On 30 May 2018, the herbicides listed in Table 1 were applied three times using a plot spraying device equipped with a Lechler injector nozzle ID 120-03 in blue at a pressure of 3.5 bar and a speed of 3 km/h. This resulted in a spray volume of 512 l/ha. At the start of the treatment neither weeds nor *Tagetes* seedlings had germinated.

Table 1: Treatment list

Treatment	Rate	Active ingredient	Approval	Notes
Untreated	-	-	-	-
Bandur	2.5 l/ha	Aclonifen (600 g/l)	Weeds, vegetables	N, Xn, B4
Beflex	0.5 l/ha	Beflubutamid (500 g/l)	Winter grains	N, B4
Goltix Gold + Stomp Aqua	3 l/ha + 2 l/ha	Metamitron (700 g/l) + pendimethalin (455 g/l)	Article 51 *Tagetes* Article 51 *Tagetes*	N, Xn, B4 N, Xn, B4
Lentagran WP + Gallant Super	1.5 kg/ha 0.5 l/ha	Pyridate (450 g/kg) + haloxyfop-P (104 g/l)	Section 22 (2) B B	N, B4 N, Xi, B4
Onyx + Gallant Super	1 l/ha 0.5 l/ha	Pyridate (600 g/kg) + haloxyfop-P (104 g/l)	Sweetcorn B	- N, Xi, B4
Proman	3 l/ha	Metobromuron (500 g/l)	Section 22 (2) B	N, Xn, B4
Quantum	1.5 l/ha	Pethoxamid (600 g/l)	Article 51 Cut flowers	N, Xn, B4
Stomp Aqua	3 l/ha	Pendimethalin (455 g/l)	Article 51 *Tagetes*	N, Xn, B4
Spectrum Plus (Wing-P)	3 l/ha	Dimethenamid-P (212.5 g/l) pendimethalin (250 g/l)	Sweetcorn, lupine	GHS07, GHS08, GHS09, B4

3. Results

The *Tagetes* germinated quickly and on 4 June the seedlings had mostly emerged. Weeds had also germinated on some plots at this point. On 14 June the *Tagetes* seedlings covered 50% of the surface of the untreated plots. An assessment of the safety and efficacy of the herbicides was carried out. The trial results from 2010 (P15-2010) indicated that *Tagetes* is sensitive to the active ingredient dimethenamid-P, this was again confirmed. The herbicide Spectrum Plus, which contains the active ingredient dimethenamid-P in addition to pendimethalin, badly damaged the *Tagetes*. The seedlings did not develop well and some of them were stunted. The herbicide Quantum containing the active ingredient pethoxamid from

the same chemical group did not cause as significant damage to the *Tagetes*, but was also not well tolerated.

Fig. 3-6: Close-ups of trial plots on 11 June 2018

Fat hen, knotweed species, cockspur grass and small-flowered gallant soldier grew on untreated plots in this trial. The herbicides examined differed very significantly from one another in terms of their efficacy. The herbicide Spectrum Plus (Wing-P), which was damaging, had the best weed control effect in this trial. The herbicides Proman, Quantum, Stomp Aqua and a combination of Goltix Gold and Stomp Aqua were also very effective.

The effect of the two herbicides containing pyridat (Lentagran WP and the recently approved liquid product Onyx) in combination with the grass herbicide Gallant Super was not sufficient. Only cockspur grass grew more sparsely on these plots than on the control plots. The herbicides Bandur and Beflex also showed weed spectrum weaknesses, particularly against monocotyledonous weeds and gallant soldier. The following figure shows the degree of coverage with weeds for all treatments.

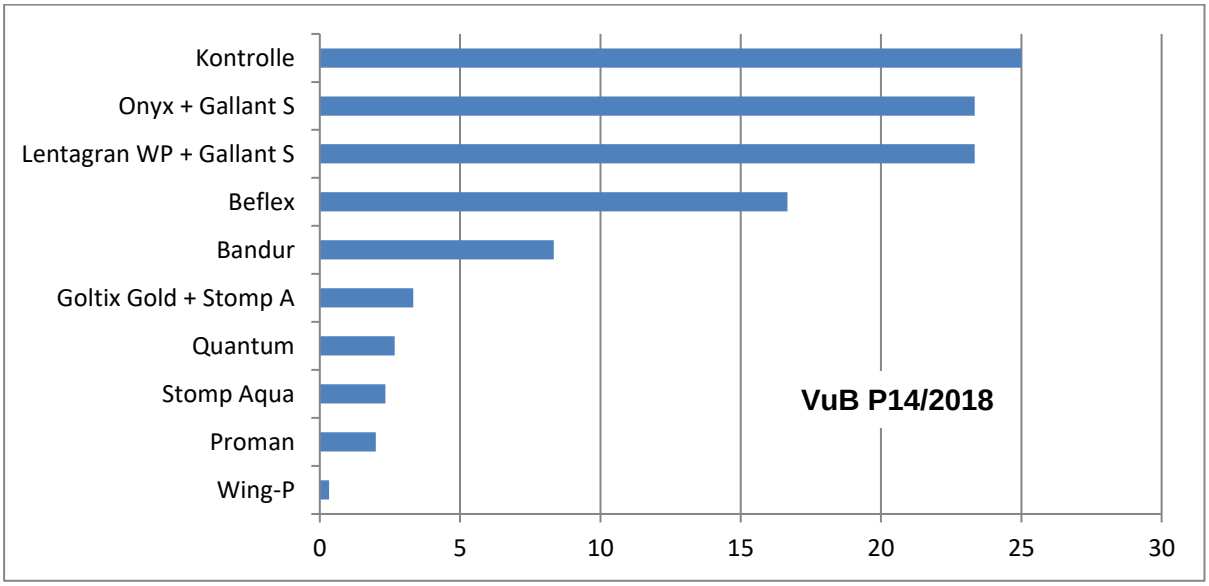


Fig. 7: Degree of coverage with weeds on 14 June 2015 (average value from three replicates).

4. Summary

Various herbicides were trialled one day after sowing and before emergence of *Tagetes* ‘Nema Mix‘ as part of a trial examining herbicide efficacy and safety.

The standard herbicides Stomp Aqua (pre-emergence) and Goltix Gold (pre- and post-emergence) used in practice, and the product Proman, which has only very recently been approved for this area of use, proved to be safe to apply with *Tagetes* ‘Nema Mix’ when used a day after sowing in 2018 when there were low levels of precipitation.

Supportive weed control measures when growing *Tagetes* are essential for a good effect on nematodes. Proman has a very good effect on weeds that like the warmth such as amarath, gallant soldier and fat hen and can be used on *Tagetes* prior to emergence if these weeds are likely to grow. If black nightshade and fat hen are problematic in the *Tagetes* areas, a standard treatment with 3 l/ha Stomp Aqua after sowing, but before emergence, should still be carried out.

Herbicides for the control of common horsetail
(B. Zielke, Dr H. Lösing)

1. Introduction

Common horsetail species are among the oldest plant species in history. Their extinct relatives were found in coal woodlands 300 million years ago, were woody and grew up to 30 m in height.

In horticulture and agriculture, common horsetail (*Equisetum arvense*) is known as a perennial weed that is very difficult to control. It reproduces vegetatively via rhizomes running horizontally up to 2 m under the ground. They can spread via pieces of these rhizomes stuck to machines and young plants. They can also reproduce using spores. The chlorophyll-free, spore-bearing shoots, which appear before the leaves, ensure further dissemination over distance.

Common horsetail is increasingly developing in nursery areas. Trials from 2009 to 2012 against this problematic weed showed that it is not possible to kill common horsetail with a single herbicide treatment (VuB 2011 annual report, page 30 and 2012 annual report, page 24). Treatments with the soil herbicide Katana delayed emergence in spring but did not have a lasting effect. Foliar acting herbicides such as Basta (authorisation ended in December 2015) and U 46 M-Fluid burned off the parts of the plant that were above the ground but also did not have a lasting effect. Repeat treatment may weaken the plants by preventing photosynthesis. The frequency of use of the herbicide U 46 M-Fluid is limited to one treatment, so herbicides such as Beloukha and Quickdown were tested to determine their suitability to burn off common horsetail.

Fig. 1: Spore bearing structures appear before the green stems.
Fig. 2: Sterile fronds of the common horsetail sprout in May after the last frost.

2. Trial methodology

The trial area was an area of open land that was relatively thickly and uniformly overgrown with common horsetail. The common horsetail had fully developed fronds and these had fully matured as a result of quite a number of sunny days before the start of the trial. There were no crop plants in the trial area. The herbicides listed in Table 1 were applied on 15 June 2018 using a knapsack sprayer with an 8004 flat spray nozzle at a pressure of 2 bar. They were applied in a water volume of 500 l/ha. On the treatment day it was sunny and 18°C.

Assessments were carried out one week and four weeks after the treatment. A final assessment was carried out in late July.

Table 1: Test agent

Treatment	Rate	Active ingredient	Approval	Notes
Basta	3.75 l/ha	Glufosinate ammonium (200 g/l)	-	-
Beloukha	40 l/ha	Pelargonic acid (680 g/l)	Potatoes	GHS05, 07, 09, B4
Quickdown + Toil	0.8 l/ha	Pyraflufen-ethyl (26 g/l)	Section 22 (2)	N, Xi, B4
U 46 M-Fluid	2 l/ha	MCPA (500 g/l)	Coniferous wood	GHS05, 07, 09, B4
MaisTer Power	1.5 l/ha	Foramsulfuron (30 g/l) iodosulfuron (0.93 g/l) thiencarbazone (9.77 g/l)	Sweetcorn	N, Xi, B4

3. Results

The effect of the herbicides started quickly. A week after the treatment, the herbicides Basta, Beloukha, Quickdown and U 46 M-Fluid had achieved a visible effect on the common horsetail. After treatment with Basta and U 46 M-Fluid, the fronds had turned brown and after treatment with Beloukha they had turned light brown. The use of Quickdown did not lead to the stems dying out completely, they merely turned blotchy. The product MaisTer Power did not have any visible impact on common horsetail whatsoever in 2018. In an unpublished trial from 2014, MaisTer Power applied during emergence of the common horsetail in May had a reducing effect on this weed. Unlike MaisTer Fluid, MaisTer Power (must be used up by June 2019) is not tolerated by nursery trees.

In contrast to this, four weeks after the start of the trial the parts of the common horsetail that were above the ground had died out completely in plots treated with the herbicides Basta, Beloukha and U 46 M-Fluid. The stems were striped black and green in the plots treated with Quickdown. Around two weeks later, new, green stems were growing on plots treated with the herbicides Basta, Beloukha, Quickdown and U 46 M-Fluid.

Fig. 3-6: Sections from plots on 21 June 2018, a week after the start of the trial. The products Beloukha and U 46 M-Fluid discoloured the common horsetail. The fronds of the common horsetail treated with the product Quickdown became blotchy but did not completely die out.

4. Summary

We do not feel that long-term control of common horsetail using a single herbicide treatment is currently possible. Repeated treatments are needed to contain any spread. Following the end of the use up period for the product Basta, there are few herbicides remaining which have an effect on the green fronds. In addition to the product U 46 M-Fluid, which is not tolerated by all nursery crops, even when it is used under the crop canopy, safe products based on pelargonic acid (e.g. Finalsan and Beloukha) can also be used. Finalsan is authorised for use with ornamentals, while Beloukha is authorised for use with potatoes, but is now approved according to Section 22 (2) of the Plant Protection Act, at an application quantity of 16 l/ha.

In this trial, the herbicide Quickdown did not act sufficiently on the green fronds of the common horsetail despite being applied on an extremely bright day. Neither U 46 M-Fluid, Beloukha nor Quickdown impaired the common horsetail's root system. These herbicides also generally do not affect monocotyledonous weeds. A grass herbicide should be added to control a mixture of weeds.

Controlling common horsetail remains difficult. It is therefore important to prevent carryover and dissemination of common horsetail within the nursery. Common horsetail is particularly problematic in long terms crops with lots of light such as Christmas tree production. Regular soil movement and high levels of shadow inhibit its growth.

The purchase or leasing of areas infested with common horsetail should be carefully considered and machines and devices extensively cleaned after working in areas overgrown with common horsetail.

‘Bee friendly’ aphid control in container-grown rose production
(B. Zielke, Dr H. Lösing)

1. Introduction

Various species of aphid are often found in nurseries where container-grown roses are being produced. In severe infestations, dense colonies can form that impair the growth of plants. However, even low levels of aphid are not tolerated in horticultural practice, particularly if the plants are produced to be marketed in garden centres.

In the past few years, the subject of ‘insect control and bees’ has increasingly been the focus with both the media and consumers. The subject, which is popular with the public, has been appropriated by non-governmental organisations, which are issuing lists of which plant protection products they deem to be harmful to bees. The classifications deviate from the categories allocated when authorising the plant protection products (B4 = not harmful to bees to B1 = harmful to bees) in some cases. Some garden centres and DIY shop chains have adopted these and developed their own labels for ‘ornamental plants produced in a bee-friendly manner’. They specify to their suppliers which plant protection products are not allowed to be used in production. Paradoxically, when supplying plants there is still a zero tolerance for aphids, otherwise there are complaints. Since there are in any case few plant protection products classified B4 that are approved for ornamental plants, this puts the producers of container-grown roses in a very difficult position.

A trial carried out in winter 2017 on potted roses intended for Mother’s Day 2018 aimed to demonstrate which plant protection products were suitable for the production of ‘bee-friendly’ container-grown roses of this type. Conventional plant protection products whose active ingredients were not on ‘black lists’ and plant tonics or plant protection products for organic nursery production were examined.

Fig. 1: Trial greenhouse containing *Rosa* ‘Clementine‘® on the day of the first treatment.
Fig. 2: Trial plants on 12 April 2018.

2. Trial methodology

The trial was carried out in on a commercial nursery. An 8 m wide polythene covered greenhouse owned by Roses Tantau in Uetersen was able to be used for this. The plants used in the trial were *Rosa* 'Clementine'®, which had been potted in white peat growing media in winter 2017. The roses were grown in 4 L rose containers. Four rows of 14 plants were treated in each plot. In order to ensure selective treatment and facilitate the assessment of each individual plant, narrow paths were created between the container-grown roses within the spaced crop (see Fig. 4). The trial was designed as a randomised block design.

Fig. 3: Spaced plants before the start of the trial. This arrangement offers the best use of the space and gives the individual plants the most light and space.
Fig. 4: A control plot the day before the second treatment. At the start of the trial, narrow paths were created in the crop. Plants had to be respaced again in early May.

The trial relied on natural aphid infection. The potato aphid (*Macrosiphum euphorbiae*) appeared in the greenhouse, probably because of winged adults flying in. The aphid species was determined by entomologists.

The treatments listed in Table 1 were applied using a Birchmeyer REB 15 AZ2 battery-operated knapsack sprayer, which was equipped with a hollow nozzle, at a pressure of 2 bar. Two different spray quantities were used in the trial. Most of the products were applied in 500 l/ha water volume. The product BreakThru S301 was applied in 1000 l/ha on the first two dates and 500 l/ha on the second two. A water volume of 1000 l/ha was also used with treatments 5, 6 and 7. This was stipulated on the approval for the treatments Neudosan Neu and Spruzit

Neu (treatments 5 and 7). An application rate of 3 l/ha was used in the case of the Neem Azal T/S treatment. Since it is known that this product can cause phytotoxicity in roses when applied at high concentrations, a spray volume of 1000 l/ha was used for this treatment. This spray volume was sufficient to good coverage, even at the end of the trial, when the leaf area of the roses had increased considerably.

Table 1: Treatments and rates applied

	Treatment	**Conc.**	**Spray volume**	**Rate**	**Active ingredient**	**Approval**
1	Untreated	-			-	
2	BreakThru S301	a) 0.15% b) 0.3%	1000 l/ha 500 l/ha	1.5 l/ha	-	Wetting agent
3	Karate Zeon	0.015%	500 l/ha	75 ml/ha	100 g/l lambda-cyhalothrin	Article 51 ZP N, Xn, B4
4	Movento OD	0.06%	500 l/ha	0.3 l/ha	150 g/l spirotetramat	ZP N, Xn, B1
5	Neudosan Neu	1.8%	1000 l/ha	18 l/ha	515 g/l potassium salts of fatty acids	ZP Xi, B4
6	Neem Azal T/S	0.3%	1000 l/ha	3 l/ha	10.6 g/l azadirachtin	ZP GHS 09, B4
7	Spruzit Neu	0.6%	1000 l/ha	6 l/ha	4.59 g/l pyrethrins 825.3 g/l rapeseed oil	ZP GHS 09, B4
8	Tafari	0.048%	500 l/ha	0.24 kg/ha	500 g/kg pymetrozin	ZP N, Xn, B1
9	Teppeki	0.016%	500 l/ha	0.08 kg/ha	500 g/kg flonicamid	Article 51 ZP (UG) B2
10	Joker SL	0.2%	500 l/ha	1 l/ha	Silicon + garlic oil	Strengthener
11	BAY 17390I	0.15%	500 l/ha	0.75 l/ha		-
12	BAY 20130I	0.5%	500 l/ha	2.5 l/ha		-

The applications were carried out during the morning on the dates shown in Table 2. When conditions were windy, the standing wall ventilation on the greenhouses was able to be manually closed on the side facing the wind to create calm conditions. The standing wall ventilation on the greenhouse was, however, normally permanently open to ensure a good exchange of air and compact growth of the plants. This meant that the temperatures in the greenhouse were not significantly higher than outside.

Table 2: Treatment times and weather conditions

Date	BBCH stage	Plant size in cm	Weather
12/04/18	33	13 cm	Cloudy, 14°C
20/04/18	51	20 cm	Changeable, 17°C
27/04/18	51	25 cm	Cloudy, 15°C
04/05/18	51	30 cm	Cloudy, 18°C

Assessments were carried out on 12 April, 16 April, 19 April, 24 April, 2 May and 7 May 2018. All of the plants in every trial plot were inspected and evaluated on the first five assessment dates. On the final assessment date, only the two central rows in the four rows in each plot were able to be assessed. After the assessment on 2 May, the paths created for the trial had to be removed and the plants put back in their original positions to ensure that each individual plant was getting enough light all the way around. The final application was therefore no longer quite as selective. Only the middle two rows were taken into account in the final assessment on 7 May.

Aphid infestations were categorised as one of the following: 0 = no infestation; 1 = individual aphids; 2 = one or more shoots have a number of aphids; 3 = one or more shoots are infested with aphid colonies. The various assessment classes are represented in the following figures. The plants were also inspected for possible damage caused by the treatments used during each assessment.

Fig. 5: Infestation class 1: individual aphids

Fig. 6: Infestation class 2: some aphids

Fig. 7: Infestation class 3: many aphids

Fig. 8: Close-up of *M. euphorbiae*

The plants were treated with an insecticide by a nursery employee after the final assessment on 7 May 2018 to prepare them for Mother's Day. Aphid cast skins and dead aphids had to be washed off the plants by irrigation before they were sold.

3. Results

No significant damage occurred on the roses in any of the treatments over the course of the trial. There was slight scorch of very young leaves in individual cases as a result of the BAY 20130I treatment (see Fig. 9).

Fig. 9: Slight scorch caused by the insecticide BAY 20130I

Fig. 10: Slight deposits after use of the product Neudosan Neu

An abnormality also occurred in the Neudosan Neu treatment. Deposits were left behind on some of the leaves (see Fig. 9). Neither the scorch nor the deposits were deemed by the nursery employees to be an impediment to sale. The rapid growth of the roses meant the scorch symptoms were quickly hidden under new leaves and the deposits were dissolved and rinsed off by regular irrigation.

Treatments usually commence in practice even in the case of a very low level infestation of aphids in greenhouses. The aphid infestation in the greenhouse increased continuously, having started from just a few individual plants in the crop, despite the spray treatments applied.

The infestation pressure was determined by adding up the assessment grades. The mean of the sums of the four replicates was determined for each treatment. The infestation intensity over the trial period is shown in the following figure.

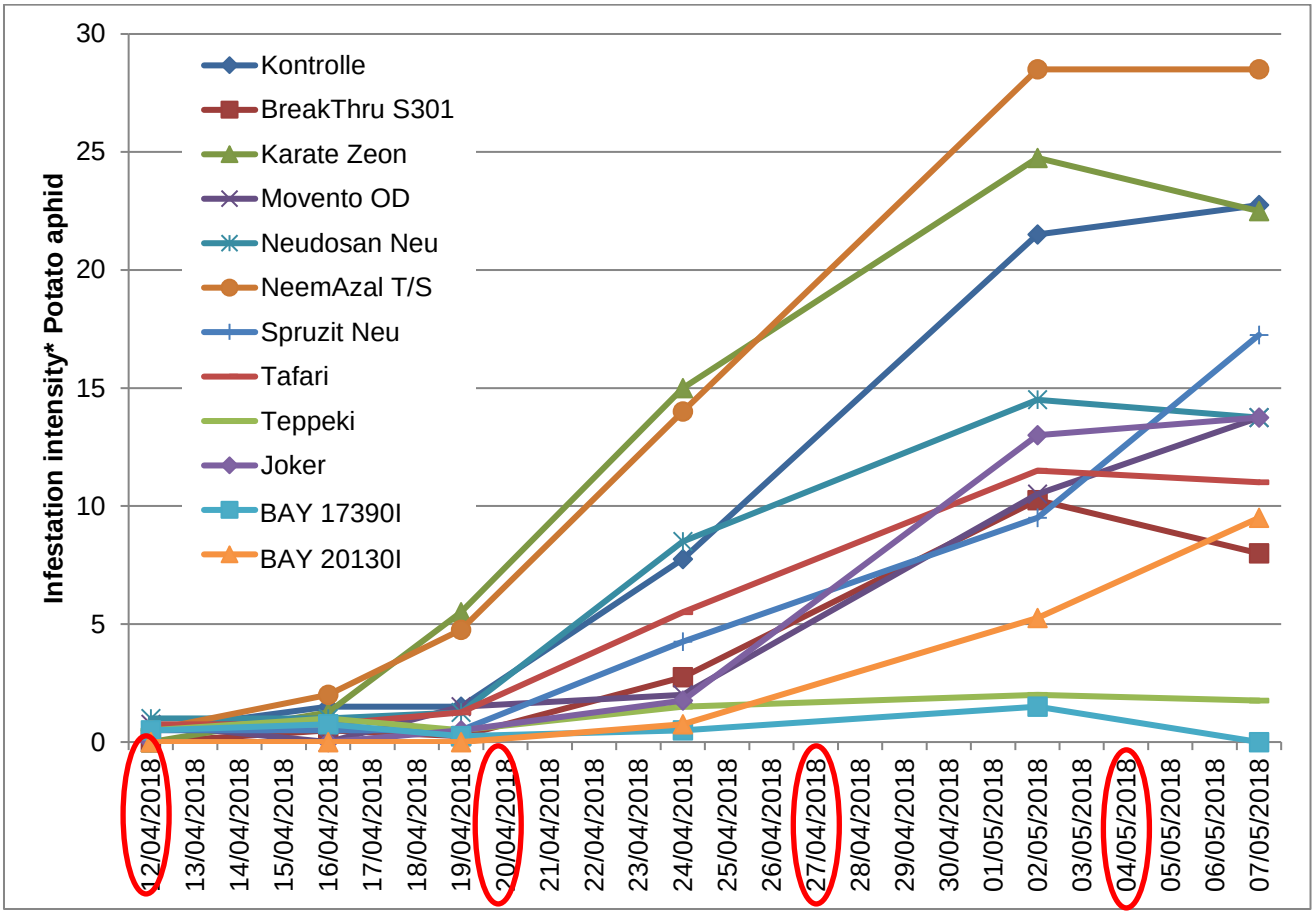


Fig. 11 The infestation intensity is a mean value of four replicates. It is created by adding up the assessment grades for the 56 (or in the case of the final assessment 28) individual plants per plot (0 = no infestation; 1 = minor infestation; 2 = moderate infestation; 3 = severe infestation).

The treatment dates are marked on the graph.

Over the course of the trial, it was only possible to keep the infestation intensity low using the product Teppeki and the insecticide BAY 17390I, which is not yet approved. At the start of the trial it appeared that the strong-smelling products BAY 20130I and Joker SL were also delaying infestation with aphids. The infestation intensity in these treatments was low until the assessment on 24 April, but by the end of the trial it had increased to an average level.

The plants treated with the products Karate Zeon and Neem Azal T/S had infestation intensities that were comparable to those of untreated plants.

The insecticide treatments Movento OD, Neudosan Neu, Spruzit Neu and Tafari and the wetting agent BreakThru S301 all reduced the infestation intensity compared to untreated treatment, but the infestation intensity continuously increased over the course of the trial instead of stagnating or reducing after the treatments.

The increase in the infestation intensity per plot was primarily linked to an increase in the number of plants infested.

4. Summary

The efficacy and crop safety of eleven products was compared in a trial to control potato aphid in the production of container roses in a greenhouse. The products were applied four times at intervals of around a week from the first infestation. The infestation intensity (made up of the number of infested plants and the strength of the infestation) increased significantly over the trial period in the untreated control. Only the products Teppeki and BAY 17390I managed to keep the infestation intensity at a low level. In the other treatments, the infestation intensity increased more slowly than in the untreated control, but the infestation would have been too significant to sell the plants in garden centres as in many cases these have a zero tolerance policy towards aphids.

The product Teppeki is approved in ornamental plants under glass according to Article 51 and can be used three times. Members of the VuB have Section 22 (2) approval for field-grown crops, which permits two applications. It is important to use an effective insecticide in the event of an aphid infestation shortly before delivery to prevent complaints. The product Teppeki has a somewhat delayed effect, but it lasts longer. The trial confirmed that growers were in some cases only able to achieve minimal successes in controlling aphids with the insecticide Karate Zeon (Article 51 for field-grown ornamental plants against cutworms and cicada), which is often used in nurseries.

Testing the efficacy of fungicides against powdery mildew on *Ribes*
(B. Zielke, Dr H. Lösing)

1. Introduction

European and American gooseberry mildew (*Microsphaera grossulariae* and *Sphaerotheca mors uvae*) can both infect crops of *Ribes*. Both are powdery mildew fungi. The white to brownish mycelium grows on the leaves, and in the case of the American gooseberry mildew, also on the fruit. The growth and the visual quality of infested plants are significantly impaired.

In the past, the Trialling and Advisory Circle have carried out repeated trials on powdery mildew fungi treatments. Products developed for use on cereals were trialled in nursery trees and enabled the intervals between treatments to be increased from 7-14 days to over 28 days (see 1994 annual report, page 37 et seqq. and 1997 annual report, page 35 et seqq.). In later years, too, regular trials were carried out with new products to prevent powdery mildew (see 2011 annual report, page 14 et seqq., 2012 annual report, page 15 et seqq., 2014 annual report, page 17 et seqq.). Trials were generally carried out on oaks, as these plants are very susceptible to powdery mildew infection. In 2018, a trial was carried out on the efficacy and crop safety of fungicides to prevent powdery mildew on *Ribes.*

Fig. 1-2: plots at the start of the trial; the plants were free of infection

2. Trial methodology

The trial was replicated three times. Each replicate consisted of a different *Ribes* species. These included *Ribes rubrum* ‘Jonkheer van Tets‘, *Ribes sativum* ‘White Versailles‘ and *Ribes uva-crispa* ‘Achilles‘. The plants were grown in 3-litre containers and were intended to be sold to garden centres. Since end consumers only have a low tolerance of leaf diseases, treatments against powdery mildew in practice are generally applied preventatively.

Starting on 11 June 2018, the treatments listed in Table 1 were applied five times at intervals of around two weeks (see Table 2) using a knapsack spraying device with a spray boom equipped with 110-02 Teejet nozzles in yellow at a pressure of 2 bar at a water volume of around 500 l/ha.

Table 1: Treatment list

Treatment	Rate	Active ingredient	Approval	Notes
Control				
Askon	1 l/ha	Difenoconazole (125 g/l) azoxystrobin 200 g/l	Section 22 (2) ZG, St	N, Xn, B4
Ceralo	1.2 l/ha	Tebuconazole 167 g/l triadimenol (43 g/l) spiroxamine (250 g/l)	Section 22 (2) ZG, St	N, C, B4
Elatus ERA	1 l/ha	Benzovindiflupyr (75 g/l) prothioconazole (150 g/l)	Grains	GHS05, GHS07, GHS08, GHS09
Luna Sensation	0.8 l/ha	Fluopyram 250 g/l trifloxystrobin 250 g/l	Section 22 (2) ZG, St	N, Xn, B4
Trial product	1 l/ha	Mefentrifluconazole	-	-
Dynali	0.8 l/ha	Difenoconazole (60 g/l) cyflufenamid (30 g/l)	Vines	B4
Dynali + Breakthrough S 301	0.8 + 0.2 l/ha	Difenoconazole (60 g/l) cyflufenamid (30 g/l)	Vines	B4
Signum	0.75 kg/ha	Pyraclostrobin (67 g/kg) boscalid (267 g/kg)	Article 51 ZG	N, B4

Table 2: Treatment times and weather conditions

Date	Temperature	Wind	Weather
11/06/18	18°C	2-3 m/sec	Changeable
26/06/18	17°C	2-3 m/sec	Cloudy
09/07/18	18°C	3-4 m/sec	Cloudy
25/07/18	25°C	2-3 m/sec	Sunny
09/08/18	25°C	2-3 m/sec	Sunny

Summer in Schleswig-Holstein was characterised by low levels of rain, sunny weather and warm temperatures. Large amounts of irrigation water were applied to container-grown crops. On very hot days, the *Ribes* were irrigated twice a day.

Assessments were carried out on 26 June, 9 July, 18 July, 9 August and 24 August 2018. The percentage of infected leaf surfaces was estimated in 50 leaves from the upper area of the plants in each plot. Mean values were calculated. The size of the plants was also determined at the end of the trial.

3. Results

The *Ribes* species used had different levels of susceptibility to powdery mildew. The 'Jonkheer van Tets' type tended to be somewhat less susceptible than the two others. The first signs of powdery mildew infection occurred in the untreated plants on 9 July 2018. On 18 July, a low level of powdery mildew was identified in the plots treated with Askon. On 9 August, some of the plants treated with Ceralo also developed a low level of powdery mildew. At the final assessment on 24 August, plants treated with Dynali and Dynali + Breakthrough S301 were also infected. The addition of Breakthrough S301 had no impact on the efficacy of the product Dynali.

By the end of the trial, many of the treated plots except the control plots had a minor infection. The Elatus ERA, Luna Sensation and the trial product treatments remained entirely free from powdery mildew until the end of the trial. In the untreated plots, the infection level increased significantly in all *Ribes* species. Powdery mildew led to deformed leaves and premature leaf drop. The figure below shows the average leaf surface infected with powdery mildew at the final assessment for all treatments.

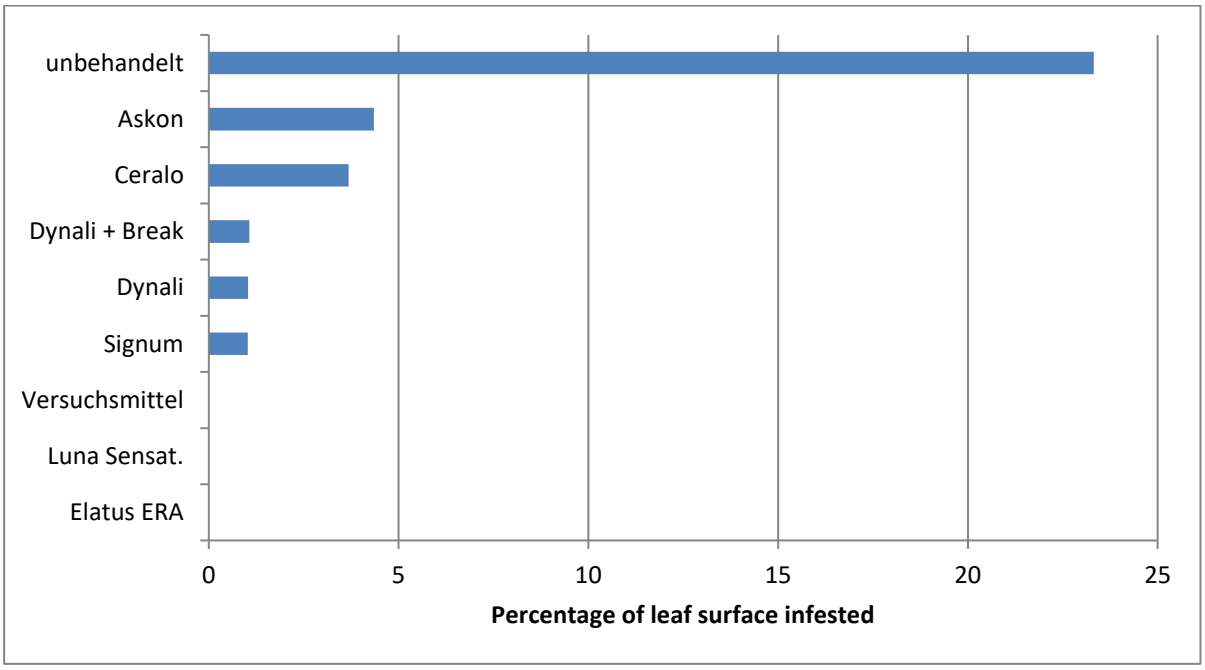


Fig. 3: Percentage of leaf surface infected with powdery mildew at the last assessment on 24 August 2018 (unbehandelt – untreated, versuchsmittle – trial product).

The following figures show plants from plots on 18 July 2018.

Fig. 4: Untreated plot on 18 July 2018

Fig. 5: Askon 1 l/ha treatment on 18 July 2018

The following figures show plants from the plots on 24 August 2018.

Fig. 6: Untreated plot on 24 August 2018

Fig. 7: Askon 1 l/ha treatment

Fig. 8: Ceralo 1.2 l/ha treatment

Fig. 9: Dynali 0.8 l/ha treatment

Fig. 10: Elatus ERA 1 l/ha treatment

Fig. 11 Trial product

No phytoxicity damage was noted on the *Ribes* by any of the plant protection products applied over the course of the trial.

The plants were pruned by nursery staff multiple times during the trial, therefore size differences between the treatments could not be determined, but the plants treated with Ceralo were slightly smaller.

4. Summary

In a trial of the efficacy and safety of products to control powdery mildew on *Ribes* grown in containers, all of the treatments showed a good effect when applied at approximately two-week intervals. Elatus ERA and the trial product which has yet to be named, prevented mildew infection entirely. The interval between applications could probably even have been increased with these products. The products Askon, Ceralo, Luna Sensation and Signum can already be used in nurseries with approvals according to Section 22 (2) of the Plant Protection Act.

The approval holder for the product Dynali is attempting to get an extension of the approval according to Article 51 of the Plant Protection Act for ornamental plants.

The VuB also applied for approval according to Section 22 (2) for the product Sercadis in spring 2019. Sercadis showed very good results against powdery mildew in a trial in 2014 and can also be used on protected crops. This means numerous effective products to control powdery mildew are available to nurseries.

Promotion of cutting health using biopesticides
(B. Zielke, Dr H. Lösing)

1. Introduction

In practice, during or after the rooting of woody cuttings, infections by ‘propagation diseases’ can occur repeatedly (for example *Phytophthora*, *Rhizoctonia* et al.). The use of plant protection products during this sensitive phase in production is therefore important to minimise losses.

Various microorganism-based products claim to strengthen crop plants and protect them against infection from root and stem fungal pathogens when used preventatively.

Products based on naturally occurring soil fungi were used by five nurseries over a period of two years as a trial. According to the manufacturers’ statements, these fungi colonise the surface of the roots of crop plants and protect them against harmful fungi by creating competition for the habitat or even parasitising them.

Fig. 1 and 2: cutting propagation facilities on commercial nurseries.

2. Trial methodology

In 2016, the trial was carried out on two plant species at two nurseries. The first company (A) produced summer cuttings of *Cotoneaster,* the second company (B) produced late cuttings of *Prunus lusitancia* ‘Angustifolia‘.

Company A added Prestop into the growing medium in two different ways on 18 July 2016. In the case of one treatment it was mixed into the rooting medium at 200 g/m³ and *Cotoneaster* ‘Eichholz’/’Oakwood‘ were stuck into these plug trays. For the other treatment, Prestop was dissolved in water and applied using a watering can after the plug trays had been filled, but

before the cuttings were inserted. *Cotoneaster* ‘Coral Beauty‘ was stuck into these trays. Ten untreated trays were used in each case as the control treatment.

At company B, in addition to Prestop, Promot Plus was also applied used in these two ways. The trial commenced on 17 October 2016. At least 20 trays per treatment were used. *Prunus lusitanica* ‘Angustifolia’ was stuck into all of the trays.

In 2017, two treatments were carried out in four different companies with different crops. At least two, but in most cases four, plug trays were used for each plant species and treatment. At company C, *Cotoneaster* ‘Eichholz’/‘Oakwood’ was stuck into trays in mid-August and a solution of Prestop or Promot Plus was poured in. A few days later, a large number of tree and shrub species were stuck into trays treated in this way at company D. Some species also had the solutions poured in a few days after the cuttings were stuck. Quickpot trays filled with growing medium with the solution poured in were used for sticking Cytisus cuttings at company E. Wild-type rhododendrons were stuck in trays in this way from October.

Table 1 provides an overview of the products trialled and the treatments. Table 2 lists the plant species and the respective date of treatment.

Other than the pre-treatments of the growing media, the cuttings were otherwise covered with film as is standard or cultivated under spray mist.

Table 1: Treatment list. The treatments with a white background were only used in 2016.

Var.	**Product**	**Approval**	**Active ingredient**	**Quantity used and type of treatment**
1	Control			
2	Prestop	ZP uGlas	*Clonostachys rosea* Stamm J 1446 320 g/kg	mix 200 g/m³ into the growing medium
3	Prestop	ZP uGlas	*Clonostachys rosea* Stamm J 1446 320 g/kg	pour 0.5%, 1.5l/m²
4	Promot Plus	Strengthener	*Trichoderma konigii* 3x 10 E7CFU/g *T. harzianum*: 2 x 10 E7CFU/g.	mix 100 g/m³ into the growing medium
5	Promot Plus	Strengthener	*Trichoderma konigii* 3x 10 E7CFU/g *T. harzianum*: 2 x 10 E7CFU/g.	pour 0.1%, 1.5l/m²

Table 2: Trial plants, size of tray and application dates in 2016 and 2017 trials

Plant	Plate	Date	Treatment
Cotoneaster 'Coral Beauty', 'Oakwood'	QP 104	18/07/16	1-3
Prunus lusitancia 'Angustifolia'	QP 60	17/10/16	1-5
Cotoneaster 'Oakwood'	QP 73	18/08/17	1; 3; 5
Cytisus various species	QP 209	13/09/17	1; 3; 5
Amelanchier 'Smokey'	QP 77	15/08/17	1; 3; 5
Aronia 'Nero'	QP 104	15/08/17	1; 3; 5
Carpinus 'Select'	QP 104	15/08/17	1; 3; 5
Heptacodium miconioides	QP 77	15/08/17	1; 3; 5
Kolkwitzia 'Rosea'	QP 104	15/08/17	1; 3; 5
Prunus cerasifera 'Nigra'	QP 77	15/08/17	1; 3; 5
Weigela 'Nana Variegata'	QP 77	15/08/17	1; 3; 5
Weigela 'Red Prince'	QP 77	15/08/17	1; 3; 5
Rhododendron wild species	QP 96	10/10/17	1; 3; 5

3. Results

3.1 Results for 2016

Differences between the treatments were able to be identified a week after the start of the trial. The growing medium surface of the trays treated with Prestop looked moist, and it also appeared that the cuttings in the treated trays had developed more. The cuttings in these treatments aligned their leaves with the light more quickly, formed the first roots and in individual cases side shoots had even emerged. The differences became even clearer over the course of the trial. Even in December the differences between the treated trays were still clear because of the better roots and larger cuttings.

Fig. 3 (left): *Cotoneaster* 'Coral Beauty' on 16 August 2016, a month after the start of the trial.
Fig. 4 (right) *Cotoneaster* 'Oakwood' on 16 August 2016, a month after the start of the trial.

The later sticking of the *Prunus lusitancia* ‘Angustifolia’ meant the cuttings developed more slowly. Around a month after sticking, it appeared that the cuttings that were treated with watering cans of solutions of the products had swollen somewhat more in the base. The callus formation in the base region could be clearly seen two months after the start of the trial. Cuttings in treated trays appeared to have developed more than those in the untreated trays.

Fig. 5-6: Cuttings of *P. lusitanica* ‘Angustifolia‘ around two months after the start of the trial.

Further assessments were carried out in early February, mid-March, mid-April and early May. No differences were observable in the quantity and quality of shoots and stems in 2017. Cuttings in treated trays were no longer more developed.

Fig. 7-8: Cuttings of *P. lusitanica* ‘Angustifolia’ in early May 2017, around four months after the start of the trial. There were no longer any differences between the treatments.

3.2 Results for 2017

The trials were also regularly examined in 2017, specifically in early, mid and late September, mid-October and early November. No differences between the different treatments were observable in the aerial parts of these plants.

Fig. 9: In 2017, the *Cotoneaster* cuttings from all the treatments put down roots equivalently quickly and well.

The roots of the cuttings also needed to be considered at the final assessment. The number of plants with roots growing through the base of the cell was determined so as not to have to remove all of the cuttings from the trays and destroy the rootballs that were not yet solid.

There were no differences in the *Cotoneaster* cuttings. Almost all of the plants had good roots. Like in other years, there were some losses of *Cytisus*, but there were no differences between the treatments. The same was true of the wild-type *rhododendrons*. These plants were first assessed in April of the subsequent year.

There were differences in the roots between the various tree species trialled in company D. These differences between the tree species were, however, greater than those between the treatments. In some cases, treatment with beneficial fungi appeared to improve the roots but

in other cases the untreated control appeared to have better roots. However, the spread of the values was rather large, so that no real trend could be seen from the results.

Fig. 10-11: View of the propagation facilities in early December.

Fig. 12: Lower side of the rooting trays containing *Heptacodium*. The roots were better in trays with Prestop or Promot Plus poured into them. The reverse was true for two of the *Weigela* species, more roots were visible from trays without beneficial fungi.

4. Summary

Six nursery companies used preventative biopesticides to prevent fungal root and stem diseases in cuttings (e.g. *Rhizoctonia, Phytium* or *Phytophthora*). One of the products trialled was the plant protection agent Prestop, which is already approved in ornamental plant production and contains the beneficial fungus *Clonostachys rosea* (previously known as *Gliocladium).* The second product trialled, Promot Plus contained *Trichoderma* strains as the active ingredient and is marketed as a 'plant strengthening agent'.

In two companies, the products were mixed into the growing medium before the cutting trays were filled, but in most cases they were applied over filled trays using a watering can before the cuttings were stuck. Losses as a result of fungal pathogens were primarily observed in gorse species and wild-type rhododendrons in the 2016-2017 trial period. The losses occurred to a roughly equivalent extent in all of the treatments.

A significant acceleration of rooting and shoot development in the cuttings in the treated plots was only observed at one of the companies in which *Cotoneaster* was grown in the summer. The improved callus formation initially observed at a different company in treated trays of late stuck *Prunus lusitanica* 'Angustifolia' did not lead to improved root development. All treatments with this species led to very good rooting.

There was no clear trend in the various slow rooting tree species examined, in some cases better and in some cases worse root development in treated trays was noted. Since the variability in these species was very high in the trial, it is difficult to conclude if the effects were even linked to treatment of the growing media with beneficial fungi. In summary, it was found that the effects of biopesticides were not easy to determine in the trial.

In order to prevent cutting losses, hygiene and good crop management (irrigation, lighting conditions, ventilation etc.) play a significant role, as does the selection of suitable mother plant material and the ideal time to take cuttings. Optimisation of these factors has a significant impact on the growth rate of the cuttings. Treatment with rooting hormones can lead to more reliable root development. Rhizopon products containing the active substance indolebutyric acid have been approved again since October 2017.

Companies can also use biopesticides during propagation as a preventative measure, treatment of only some of the trays will highlight any improvements achieved by their use.

Nitrogen content in nursery soils – guideline values for 2018

(Lilli Fröhlich)

There is no specific obligation for nurseries to determine the fertiliser requirement of their soils. It is sensible, however, to monitor the difference between the nitrogen required by a crop and the nitrogen available in the soil over the course of the growing season and to adjust this as necessary.

If too much nitrogen is leached into the environment this can be harmful, for example the quality of both ground water and surface waters can be negatively affected. Efforts need to be made to ensure an optimal supply of nitrogen for crop production for resource conservation reasons. Nurseries are very aware of their responsibility and emphasise that they aim to ensure a sustainable and protective approach to cultivation within production areas.

The determination of the nitrogen quantity available in the nursery's own production areas does not necessarily have to be in the form of a number of N_{min} tests over the area, but rather values from representative locations determined by the Advisory Circle can be used for the company's own production areas.

The N_{min} content of soils on 40 nurseries were investigated again in March 2018. The sites selected represent the main crop groups, as can be seen in the following table. The results have already been provided to nurseries via newsletters and publications. The costs of these tests were borne equally by the Schleswig-Holstein Chamber of Agriculture and the Trialling and Advisory Circle.

The results of the N_{min} tests shown in the table can be used as guideline values to adjust the fertiliser strategy of nurseries to current requirements. If nurseries have not carried out their own nitrogen tests, the values mentioned should be deducted from the intended nitrogen fertiliser quantity to be applied 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, nurseries in Schleswig-Holstein carried out N_{min} tests on a further 240 cropping areas over the course of 2018.

N_{min} – guideline values 2018		
Crop	**Soil type**	NO_3-N +NH_4-N [kg/ha] (0 - 60 cm soil depth)
Areas for cuttings, rose rootstocks and fruit tree rootstocks	Clayey sands and sandy clays	**30**
Deciduous woody seedlings and transplant beds	Clayey sands and sandy clays	**14**
Coniferous woody seedlings and transplant beds	Clayey sands and sandy clays	**17**
Budded rose crops	Clayey sands and sandy clays	**22**
Shrubs, light feathers and hedging plants	Clayey sands and sandy clays	**18**
Fruit-bearing trees	Clayey sands and sandy clays	**23**
Coniferous trees	Clayey sands and sandy clays	**19**
Evergreen deciduous trees	Clayey sands and sandy clays	**29**
Standard trees	Clayey sands and sandy clays	**27**
Christmas trees	Clayey sands and sandy clays	**12**

If no N_{min} tests are available for the relevant areas, this table can be used as a guide to the nitrogen content in the soil for nursery crops and can be used to ensure that fertilisation meets the plants' needs.

Comparison of stabilised nitrogen fertilisers for field-grown trees
(S. Heise)

1. Introduction

Fertilisers are available in the most varied of compositions (organic, organic and mineral, mineral), modes of action (soil or leaf), duration and nutrient ratios. In two preliminary trials carried out in 2017 and one detailed trial in 2018, three different fertiliser types (single nutrient, partially coated nutrient and mineral complex fertiliser) were compared with one another. The advantage of a multi-nutrient fertiliser is that in one operation, a high level of nutrients in relation to a small level of salt can be applied. The disadvantage is the fixed nutrient ratio and the mostly higher price per kg. In large-scale field cultivation, the use of single nutrient fertilisers dominates. In agricultural cultivation, the nutrient requirements are known and single nutrient fertiliser can be applied accordingly in a targeted manner. The price per kg is also often lower, which is important over large areas.

The following fertiliser products were examined in the trials:

NovaTec premium 15-3-20 (Compo Expert) a mineral, reduced-phosphorous complete fertiliser with ammonium stabilisation (nitrification inhibitor DMPP). The duration of the nitrification inhibitor depends upon the climate, weather conditions and soil and can be up to 10 weeks.

Agromaster 2-3 M 19-5-20 (ICL Specialty Fertilizers) a partially coated complete fertiliser with a nitrogen longevity of two to three months. Thirty-four percent of the total nitrogen is coated with an organic resin coating that releases the nitrogen depending on the soil temperature and moisture.

ALZON neo-N 46-0-0 (SKW Piesteritz GmbH) a nitrogen fertiliser with two nitrogen stabilisers (2-NPT and MPA). The conversion of urea to ammonium is slowed by up to two weeks by a urease inhibitor (2-NPT). The nitrification inhibitor (MPA) delays the conversion of nitrogen from the stable ammonium to the mobile nitrate form by six to ten weeks.

Figure 1: NovaTec premium 15-3-20

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

Figure 3: ALZON neo-N 46-0-0

2. Trial methodology

In the two preliminary trials in 2017, 2/1 *Carpinus betulus* and 2/2 *Abies nordmanniana* were used as trial species. In addition to the application of the fertilisers mentioned, pure urea (46% N) was also used. This served as a control to the mode of action of ALZON neo-N. The plots were 1.5 m x 12 m in the case of *Abies* and 25 m in the case of *Carpinus*. All of the treatments were replicated four times. The fertilisers were broadcast manually at a total of 120 N/ha for each treatment.

Table 1: Trial plan – preliminary trials, 2017

Trtment	Fertiliser	N content	Number of applications	Quantity used in kg/ha
1	NovaTec premium	15	2	400
2	ALZON neo-N	46	1	261
3	Urea	46	2	130
4	Agromaster 2-3 M	19	2	315

Figure 4: View of the test area on 2 May 2017

The first fertiliser application to all treatments was made on 16 March 2017. Additional fertiliser was applied to treatments 1, 3 and 4 on 10 May 2017 for the *Abies* and 16 June 2017 for the *Carpinus*. In a direct comparison with the complete fertilisers, a compensation fertiliser with potassium and magnesium, for example in the form of Patentkali, would have been necessary, but this did not occur as the two trials were preliminary. Both trials were regularly assessed and Nmin (nitrate NO_3^-) samples taken.

A detailed trial was carried out the following year using the experience from the preliminary trials. In this case, 2/1 *Fagus sylvatica* `Purpurea` was used as the trial species. The length of the plots was 15 m and the treatments were replicated four times. The N, K and Mg nutrient contents were balanced out with Patentkali (30% K_2O potassium and 10% MgO magnesium) and Kieserite (25% MgO magnesium) so the same nutrient ratio/nutrient supply was ensured for all treatments. The total quantities applied were nitrogen 120 kg N/ha, potassium 160 kg K_2O/ha and magnesium 53 kg MgO/ha. Both of the complete fertilisers (Agromaster and NovaTec premium) also contained phosphate, but this was not included in the calculation. The

nursery soil had sufficient phosphate due to the regular application of horse manure. As a result it was assumed that the phosphate in the complete fertilisers would not have an effect. The trial plan and the dates of fertiliser application are shown in Table 2 below.

Table 2: Trial plan – detailed trial 2018

Dates/trtment	1 Agromaster 2-3 M	2 NovaTec premium	3 ALZON neo-N
12/04/18	331 kg/ha Agromaster + 113 kg/ha Patentkali	400 kg/ha NovaTec + 58 kg/ha Kieserite	260 kg/ha ALZON + 198 kg/ha Patentkali
12/06/18	300 kg/ha Agromaster + 68 kg/ha Kieserite	400 kg/ha NovaTec + 58 kg/ha Kieserite	335 kg/ha Patentkali

The fertilisers were broadcast manually over the individual plots. Appropriate additional fertilisers were applied on 12 June 2018 based on the progression of the nitrate content (see Section Nmin progression) in the soil (0-30 cm).

3. Weather conditions in 2017 and 2018

The year 2017 was one a year of high precipitation, 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 double in these months and in July they were three times the average. Overall, the average temperatures in 2017 were always above the long-term average.

The year 2018 started with higher average temperatures and higher quantities of precipitation. In February there was a cold snap and the temperature was an average of 0.7°C. There were cool temperatures in March and April with strong winds, and the average temperature in April was 11°C. Only moderate levels of precipitation fell in April - 40% less than the 30-year average at 33 mm. The temperatures increased significantly in May. With an average temperature of 17°C, it was around 6°C warmer than the long-term average. Almost no precipitation was recorded at all, with levels of 1.2 mm. June had an average temperature of 17.8°C and some heavy rainfall totalling around 60 mm. The average temperature in July increased to 21°C and there was just 18 mm of rain compared to the 30-year average of 88 mm. There was also a high average temperature in August at around 19°C. Thirty-one millimetres of rain fell, spread over several small showers. You can find overview of the annual weather patterns for 2017 and 2018 at the end of the annual report as usual.

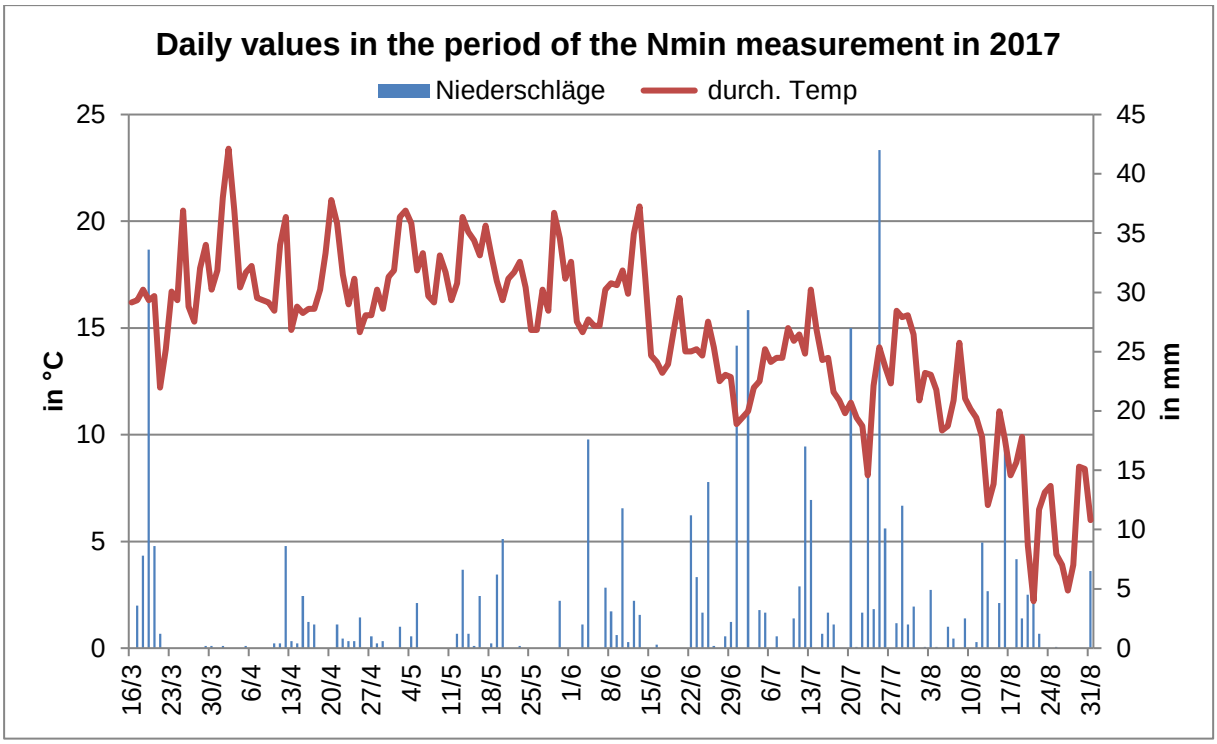


Figure 5: Weather conditions (rain and temps) during the period of Nmin measurement in 2017.

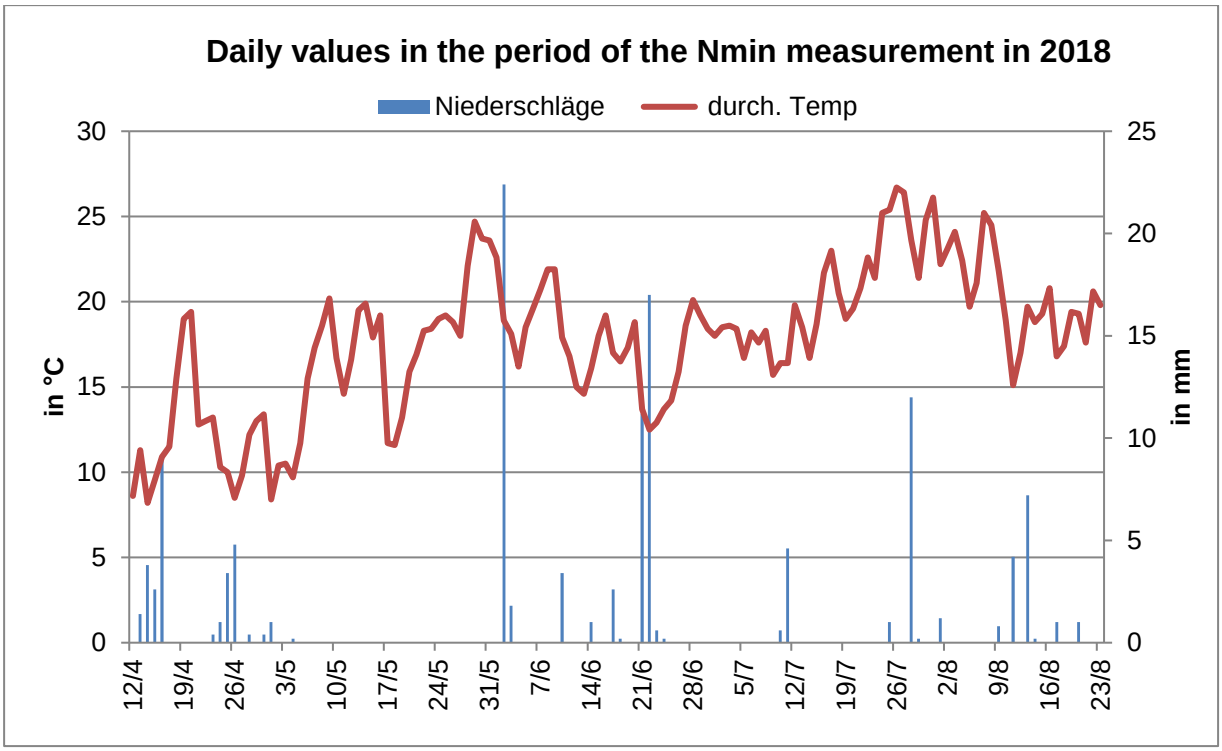


Figure 6: Weather conditions (rain and temps) during the period of Nmin measurements in 2018.

4. Nmin progression

The nitrate (NO_3^-) nitrogen values were determined using a Nitracheck 404 device. Only the currently available nitrate content in the soil was determined, not the ammonium content. These were snapshots taken on the day of sampling. The treatment areas were sampled in the 0-30 cm layer and a mixed sample was created from the four replicates. No unfertilised control plots were created in either of the trials which would have shown how much nitrate was supplied to the soil by mineralisation. The plant extraction (quantity of nitrate taken up) is also not known.

4.1 Nmin progression in 2017

In March 2017, the area had a nitrate content of just 8 kg N/ha (0-30 cm), good conditions for setting up a fertiliser trial. The treatment areas showed a different availability of nitrate compared to the start after the application. In the first measurement after the application taken on 16 March, the nitrate values measured in the NovaTec premium treatment were higher than those in the other treatments. Another 14 days later, the nitrate level for urea was the same as that in the NovaTec premium plots. The contents decreased in the urea and NovaTec premium treatments before the additional fertilisation on 10 May 2017, but the Agromaster 2-3 M and ALZON neo-N plots showed a continuous increase in nitrate concentration in the soil. After the additional fertiliser (NovaTec premium, urea, Agromaster 2-3 M), the nitrate values in the soil increased to a similar level. All of the products had reached their peak supply by the measurement taken in early June. The highest nitrate content was associated with the ALZON

neo-N treatment, followed by urea, Agromaster 2-3 M and NovaTec premium. This order remained unchanged in the final nitrate contents determined in late June 2017. The heavy rain (Figure 5: daily values for 2017, Figure 7: nitrate progression) caused the nitrate contents in the 0-30 cm layer to decrease sharply so it was no longer possible to determine any differences and the measurements were discontinued.

The nitrate progression in 2017 is shown in the following figure taken from the *Abies nordmaniana* crop.

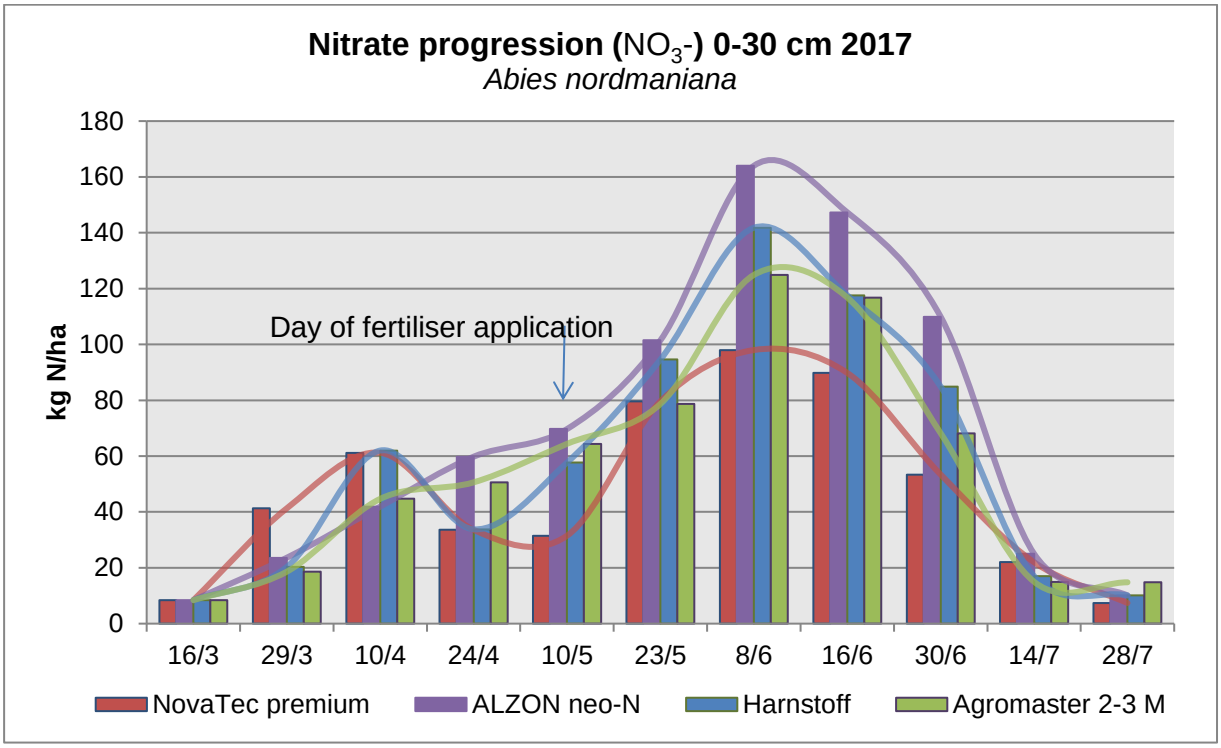


Figure 7: Nitrate progression in 2017 (harnstoff – urea).

4.2 Nmin progression in 2018

The nitrate content determined at the start of the trial was just 9 kg N/ha (0-30 cm), providing good initial conditions for a fertiliser trial. The nitrate contents were measured for the first time around two weeks after the application of the fertiliser. The treatments ALZON neo-N and Agromaster 2-3 M showed lower nitrogen contents (see Figure: nitrate progression in 2018). Another four weeks later, the nitrate values in all three treatments were at the same level, which was also the peak nitrate availability. At the start of June, the nitrate values for the Agromaster 2-3 M and the ALZON neo-N treatments were almost unchanged, but the value for NovaTec premium had decreased. On the day of additional fertiliser application (Agromaster 2-3 M and NovaTec premium), the ALZON neo-N plots had the highest nitrate content, followed by NovaTec premium and Agromaster 2-3 M. The nitrate content in the ALZON neo-N fertilisers continuously decreased from that point onwards to the end of August.

NovaTec premium showed a similar nitrate level to the previous measurement in the measurement taken on 25 June. The measured nitrate contents then decreased. In the plots of the Agromaster 2-3 M treatment, the nitrate value increased again considerably and then continuously decreased. The nitrate progression in 2018 from the *Fagus sylvatica* `Purpurea` crop is shown in the following figure:

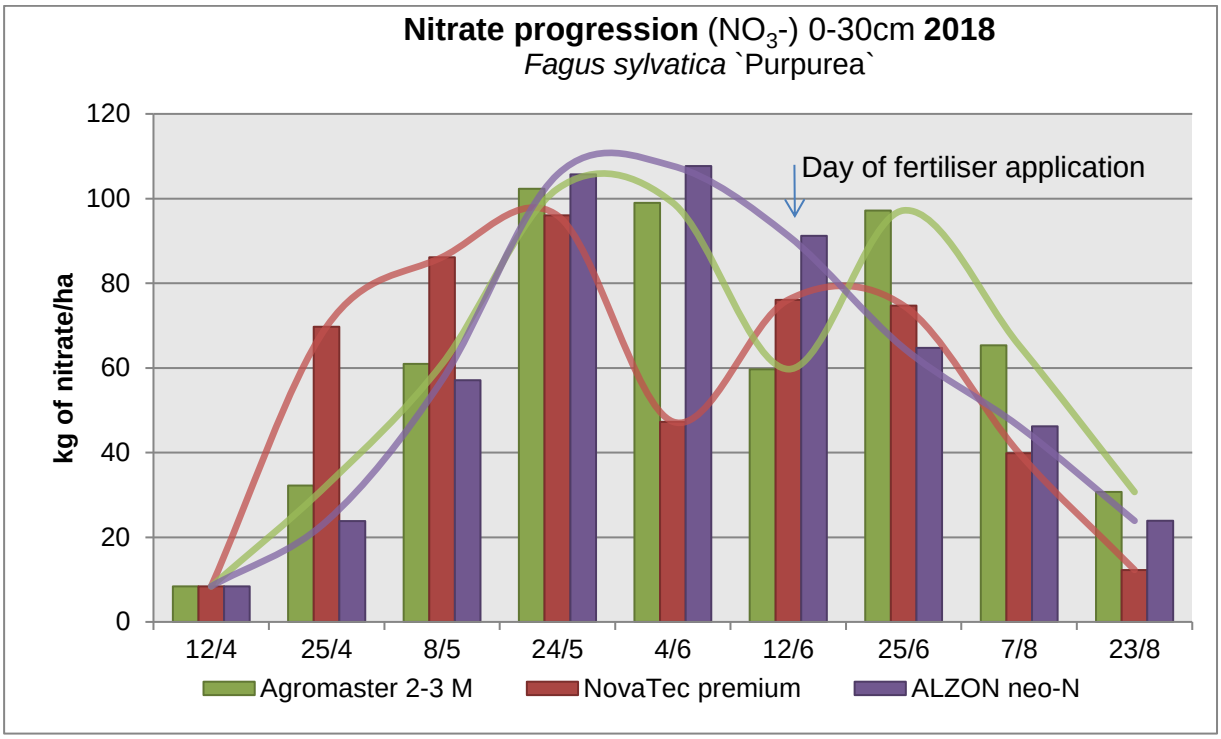


Figure 8: Nitrate progression in 2018.

5. Growth results

5.1 Growth of *Carpinus betulus*

Figure 9: View of the *Carpinus* on 28 July 2017.

The growth of the *Carpinus betulus* started in early April. The stock developed in a uniform manner. When the additional fertiliser was applied on 16 June 2017, no differences were able to be identified between the treatments. The *Carpinus* continued to grow until the end of the growing season with no differences.

5.2 Growth of *Abies nordmaniana*

Figure 10: New growth with *Abies* on 23 May

The *Abies nordmaniana* started growth later, from around 10 May. The additional fertiliser application was carried out at this point. The growth was very uniform in all of the plots (the plants used some of the nutrients stored during the previous growing season). There were initially no differences as the growth further progressed. Only in October/November did differences in the individual plots become visible. In the case of the single nutrient fertilisers (urea and ALZON neo-N), there were some cases of potassium and/or magnesium deficiencies.

Potassium deficiency could be identified on the *Abies* (Fig. 11) as a discolouration of the tips of older needles, initially a light yellow becoming brown, followed by needle loss. Magnesium deficiency on the *Abies* gave rise to (Fig. 12) gold tips, yellow-white discolouration of the needles, followed by needle loss in older plants.

Figure 11: Potassium deficiency in *Abies nordmaniana.*

Figure 12: Early magnesium deficiency in *Abies nordmaniana.*

The trial area was further assessed over the winter months. Figures 13-16 show the treatments on 14 March 2018. We can see that individual plants have a light green colour or are slightly yellow. The total height and the respective growth were measured in the treatments to determine differences. The measurement of the height and growth showed no differences. No impact of the fertilisers was able to be determined when counting the whirl buds (number of newly formed buds).

Figure 13: View of treatment 1 on 14/03/2018

Figure 14: View of treatment 2 on 14/03/2018

Figure 15: View of treatment 3 on 14/03/2018

Figure 16: View of treatment 4 on 14/03/2018

5.3 Growth of *Fagus sylvatica* `Purpurea`

The growth of *Fagus sylvatica* `Purpurea` started in late April/early May. The plants developed very evenly. Figures 17-22 show the individual treatments at the point at which additional fertiliser was applied.

Figure 17: Agromaster 2-3 M on 12 June 2018.

The plants in treatment one had good levels of growth. Some of the plants also had fresh, red, new shoots and leaves.

Figure 18: View of treatment 1.

Figure 19: NovaTec premium on 12 June 2018.

The plants in the NovaTec plots developed well and were vibrant. At the point at which the additional fertiliser was applied, some of the plants had new shoots.

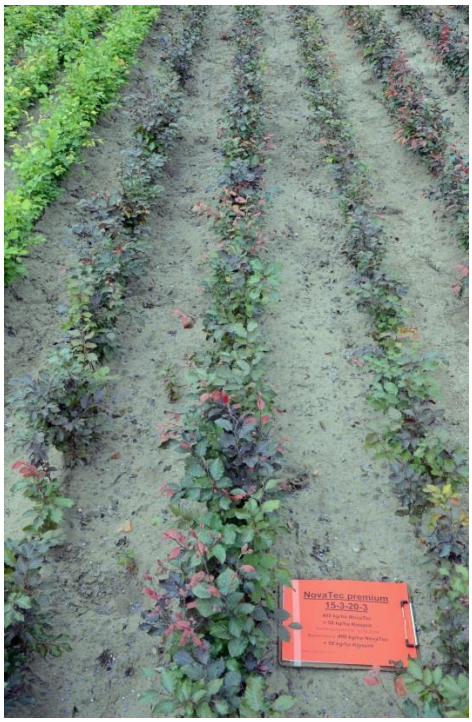


Figure 20: View of treatment 2.

Figure 21: ALZON neo-N on 12 June 2018.

In treatment 3, the plants showed a significant level of new leaves and shoots. The growth was strong.

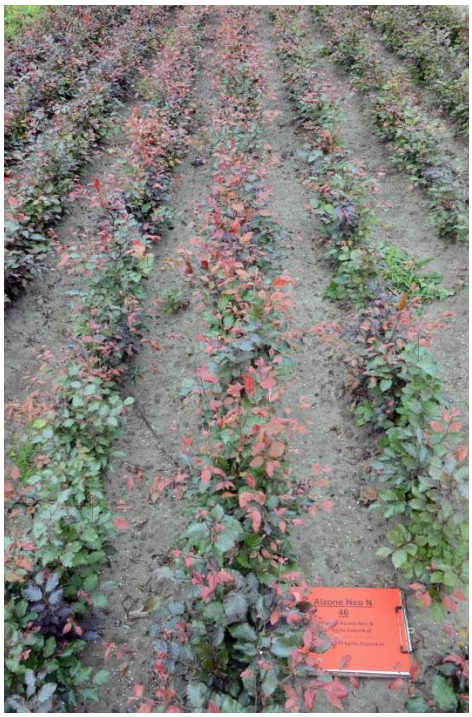


Figure 22: View of treatment 3.

Further growth corresponded to the individual treatments. By the middle of July, the plants started to suffer from drought stress despite irrigation via an irrigation cannon. Leaf scorch occurred during the early part of the trial that impaired the plant growth regardless of the treatments. The differences between the plots were also minimised. The plots were lifted on 7 November 2018 to determine the differences in growth. Some plants from the central row in each plot were collected during lifting and subsequently measured. No significant differences were able to be determined.

6. Cost calculation

The following figures from the KTBL nursery in 2012 were used to calculate the costs:

- Salary costs €11.94/h + 65% incidental wage costs = €19.70/h
- Machine costs consist of the tractor (standard tractor with all-wheel drive, 75 – 92 kW, continuously variable transmission) €41.92/h and spinning fertiliser spreader (fitted, 800l) €12.96/h. The machine costs (tractor + fertiliser spreader) come to a total of €54.89/h.

The fertiliser prices as determined at 2018:

Fertiliser	**Nutrient content (%)**	**Price per 100 kg Ø**	**Prices per 1 kg of the nutrient**
NovaTec premium	15-3-20	€ 62.95	€ 1.64
ALZON neo-N	46	€ 41.00	€ 0.89
Agromaster 2-3 M	19-5-20	€ 82.50	€ 1.87
Patentkali/Kalimagnesia	30 K_2O – 10 MgO	€ 38.25	€ 0.95
Kieserite	25 MgO	€ 37.75	€ 1.51

The fertilisers applied in the trial were used when calculating the application costs. In practice, separation of the various fertilisers occurs, and the use of smaller quantities (in the trial with Kieserite or Patentkali) is difficult to achieve over large areas. The combination of the applications e.g. with the application of Patentkali would be possible. This does not impact the calculation, as two passes were carried out for each treatment in the calculation.

Fertiliser (quantity used)		**Task**		**Machine costs**
	€/ha	Time h	Costs	
1. Fertiliser application:				
Agromaster 2-3 M (331 kg/ha)	273.08	0.3 Akh	€ 5.91/ha	€ 16.47/ha
Patenkali (113 kg/ha)	43.22			
				Total: € 338.68/ha
2. Fertiliser application:				
Agromaster 2-3 M (300 kg/ha)	247.75	0.3 Akh	€ 5.91/ha	€ 16.47/ha
Kieserite (68 kg/ha)	25.67			
				Total: € 295.80/ha
Total costs Fertilisation treatment 1: **€ 634.48/ha** and **year**				

Fertiliser (quantity used)		Task		Machine costs
	€/ha	Time h	Costs	
1. Fertiliser application:				
NovaTec premium (400 kg/ha)	251.80	0.3 Akh	€ 5.91/ha	€ 16.47/ha
Kieserite (58 kg/ha)	21.89			
				Total: € 296.07/ha
2. Fertiliser application:				
NovaTec premium (400 kg/ha)	251.80	0.3 Akh	€ 5.91/ha	€ 16.47/ha
Kieserite (58 kg/ha)	21.89			
				Total: € 296.07/ha
Total costs Fertilisation treatment 2: **€ 592.14/ha** and **year**				

Fertiliser (quantity used)		Task		Machine costs
	€/ha	Time h	Costs	
1. Fertiliser application:				
ALZON neo-N (260 kg/ha)	106.60	0.3 Akh	€ 5.91/ha	€ 16.47/ha
Patentkali (198 kg/ha)	75.74			
				Total: € 204.72/ha
2. Fertiliser application:				
Patentkali (335 kg/ha)	128.14	0.3 Akh	€ 5.91/ha	€ 16.47/ha
				Total: € 150.52/ha
Total costs Fertilisation treatment 3: **€ 355.24/ha** and **year**				

The cost comparison shows that single nutrient fertilisers such as ALZON neo-N in combination with Patentkali could have an advantage in terms of the purchase price.

The trace elements found in the complete fertilisers (Agromaster, NovaTec premium) are not taken into account in this calculation and other properties or technologies that would justify a higher price for the product are not included in the cost calculation. The nursery soils in Schleswig-Holstein often have many times more phosphate than are needed, so fertilisation with phosphate can often be avoided.

7. Conclusion/summary

In a two-year trial with the most extreme weather contrasts, two applications of fertiliser in the form of Agromaster and NovaTec premium were compared with a single application of ALZON neo-N in combination with Patentkali in the cultivation of *Abies nordmanniana, Carpinus betulus* and *Fagus sylvatica* `Purpurea`. The fertilisers in question all have a stabilised nitrogen

form to reduce the possible leaching of nitrate and minimise the application frequency while optimising plant growth. Urea was also investigated in a first preliminary trial (2017).

All of the fertilisers used resulted in uniform crops. No differences in size, fresh weight or any other parameters were able to be determined. Only *Abies nordmanniana* showed slight signs of potassium and magnesium deficiency in the plots fertilised with urea towards the end of the growing season.

Both of the urea fertilisers used (urea, ALZON neo-N) showed release appropriate to the plants' needed over the period in question without a second application being needed. The fertilisers that were also trialled (Agromaster, NovaTec premium) required a second application during the middle of the year. Plants with a high nitrogen demand during the spring, such as spruces and Nordmann firs, will probably react positively to the stronger nitrogen release provided by Agromaster and NovaTec premium. Other plant genera with a continuous requirement during the growth phase, such as hornbeams and copper beeches, either need additional fertiliser or were sufficiently well supplied with nitrogen with a single application of ALZON neo-N. Ensuring a potassium, magnesium and other nutrient supply was not taken into account.

Information on the shift in nitrogen to deeper soil layers would definitely have been very interesting too, but it was not possible to obtain this information during these trials.

The use of ALZON neo-N definitely has advantages in terms of the cost situation at first glance. Additional, separate costs for the application of other nutrients that are required may quickly reduce this cost advantage.

The use of Agromaster and NovaTec premium with a stabilised N form has proven beneficial in the cultivation of trees over many years. Initial trials and practical reports with fertilisers containing urea are definitely showing interesting perspectives, particularly taking into account cost aspects. Further trials are needed for clarification.

Determination of reference values for sufficient nitrate and potassium contents in plant sap from *Hydrangea paniculata* and common hornbeam - results of a Master's Thesis

Marie-Luise Schachtschneider, Diemo Daum and Henning Schacht (Osnabrück University of Applied Sciences), Heinrich Lösing (VuB)

Introduction

In addition to temperature and light and water availability, plant growth is also affected by the availability of nutrients. Alongside analysing soil samples for the nutrients available to plants, plant analysis is another option for optimising the nutrition of crops. Testing a soil sample provides information about the current nutrient content and the levels of nutrients available to plants in the growing medium. The uptake of nutrients, however, is affected by a large number of other factors. By determining the nutrient contents in the plants, the quantity of nutrients actually taken up can be deduced. Plant analysis identifies a nutrient deficiency (or excess) before the first symptoms of deficiency appear. Conventional plant analyses look at the nutrient contents in leaves after drying and pulping in the laboratory. Rapid tests can be considered an alternative to the relatively time-consuming and expensive laboratory analyses. In these rapid tests, the sap content can be determined directly in the field using special test sticks and/or portable measuring devices. The aim of the paper presented here is to determine reference values for sufficient nitrate and potassium contents in nursery tree sap.

Trial methodology

A total of four fertiliser trials were carried out in the field, two of them in container crops at the University of Osnabrück experimental facility (Fig. 1) and two in the soil at the Schachtschneider nursery, Dötlingen-Aschenstedt. All of the trials were carried out in 2017. The focus was on the nutrients nitrogen (N) and potassium (K), large quantities of which are required by plants. Two crops of economic significance in nursery tree production were used as trial plants: *Carpinus betulus and Hydrangea paniculata* 'Limelight'. Conifers were not included as measurements of the sap in needles proved to be difficult in previous trials (see VuB 2016 annual report, pages 56-60). The plants were cultivated in a peat-based, zero fertiliser growing medium and a low-nutrient sandy soil. This meant it was possible to cover the entire fertiliser supply spectrum from nutrient deficiencies to excess nutrients in these trials.

Fig. 1: Overview of the container trial carried out at Osnabrück University of Applied Sciences (15 April 2017).

The following fertiliser levels were selected for nitrogen and potassium (total fertiliser quantity over the trial period):

Fertiliser levels for nitrogen	Fertiliser levels for potassium
N0: 0 mg N/plant	K0: 0 mg K_2O/plant
N1: 1500 mg N/plant	K1: 1100 mg K_2O/plant
N2: 3000 mg N/plant	K2: 2200 mg K_2O/plant
N3: 4500 mg N/plant	K3: 3300 mg K_2O/plant

The treatments N_2 and K_2 were used as controls as they correspond to the plants' nutrient requirements. Two low nutrient and one excess treatment were created on the basis of these. The eight trial treatments were each laid out in a randomised block arrangement with four replicates. In total, the trials carried out comprised 128 plots each containing 10 plants. All of the remaining nutrients needed for plant growth were provided at an optimal quantity. This meant that impairment of plant growth caused by a nutrient other than nitrogen or potassium was able to be ruled out.

Fertilisers were exclusively applied in the form of liquid feeds (Fig. 2). The appropriate nutrient content in the fertiliser was able to be achieved by combining various liquid fertilisers.

Fig. 2: Liquid fertilizer application to the trial plants using a Dispensette.

The nitrate and potassium concentrations in plant sap from leaves were analysed over the entire growing season. In order to do this, a reflectometer (RQflex®, Merck) was used to evaluate test sticks (Reflectoquant® nitrate, Merck) and an ion-selective electrode (LAQUAtwin B-731, Horiba) was used. Leaf samples were also taken for conventional plant analysis and soil samples taken to determine the nutrient content in the soil.

In terms of the subsequent use of rapid nutrient tests in practice, it was necessary to determine whether there were differences between plant species. In order to clarify this, in another trial the nitrate and potassium contents of eleven different varieties of *Hydrangea paniculata* under the same cultivation conditions (same quantities of fertiliser) were compared with one another.

The sampling method can also have a significant impact on the nutrient contents of plant saps. According to the literature, the time of day and the position of the leaves play a major role. These factors were therefore also investigated in greater detail.

Results

Only some of the results obtained can be set out in this report for space reasons. Fig. 3 shows the nitrate content in the sap of the *Hydrangea paniculata* from the container trial. The level of fertiliser applied is clearly reflected in the plant sap content. As the nitrogen fertiliser rate increases, the nitrate concentration in the sap also increases. After the third measurement there was a significant reduction in the concentration. This was caused by high levels of

precipitation in just a few days. The heavy rains led to leaching losses and therefore impacted the results.

When the nitrogen provided was optimal (N2 trial treatment), the nitrate content in the plant sap fluctuated between 100-120 mg/l in May and 350 mg/l in June. The growth spurt meant more nutrients were taken up and required in June. Similar links were able to be demonstrated for potassium. The level of potassium fertiliser applied is also reflected in the potassium concentration in the plant sap.

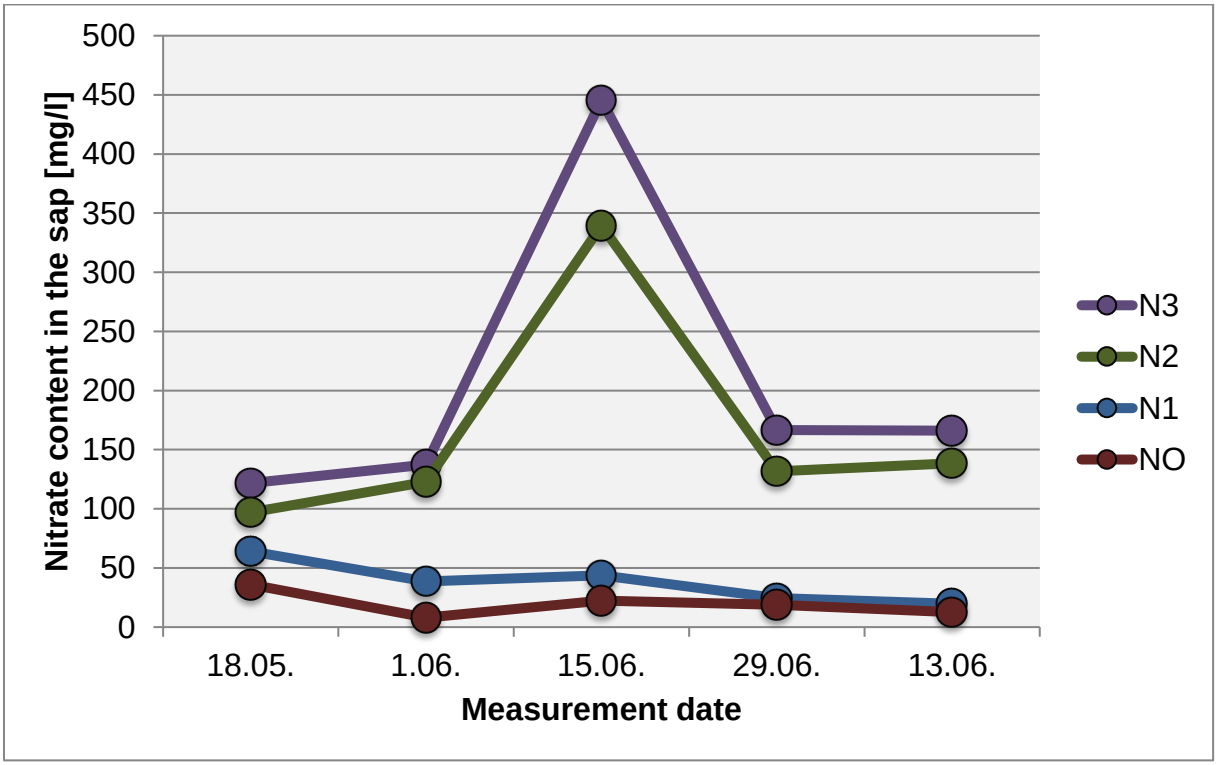


Fig. 3: Progression of the nitrate concentration in the plant sap of *Hydrangea paniculata* in the container trial over the first five measurement dates.

The level of nitrogen and potassium fertiliser applied not only influences the nutrient concentrations in the plant sap but also the growth of the trial plants. Fig. 4 shows the growth of *Hydrangea paniculata* in response to various fertiliser levels in mid-July. Significantly decreased growth can be seen in the null treatments. While significant differences were able to be measured in the plant sap at the start of the trial, the trial plants only reacted with depressed growth after a few weeks. Plant sap analyses therefore clearly enable nutrient deficiencies to be identified and counteracted early.

Fig. 4: Growth of the plants in response to the various nitrogen and potassium fertiliser levels on the fifth measurement date (13 June 2017).

Fig. 5 shows the results of the time of day and the leaf position in relation to the nitrate content. An impact of the time of day was able to be identified for both *Hydrangea paniculata* and the hornbeam.

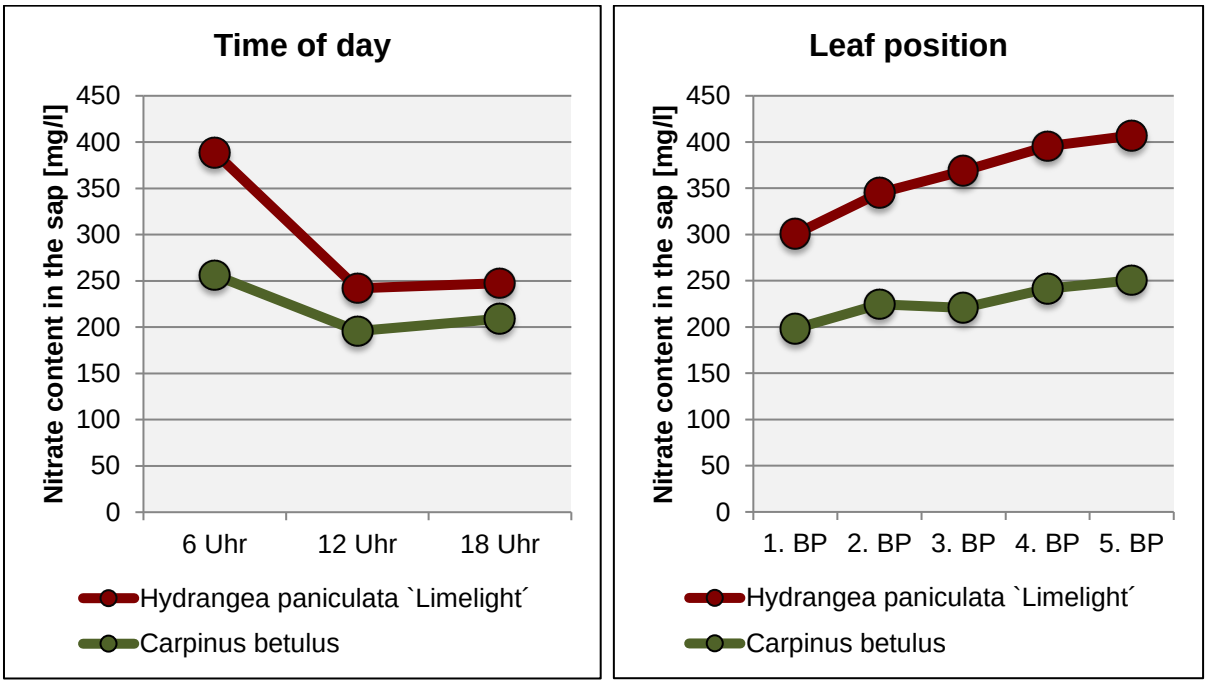


Fig. 5: Influence of time of day and leaf position on the nitrate content of *Hydrangea paniculata* and hornbeam (container crops, fertilisation levels N2 and K2, 15 June 2017)

Fig. 6 shows species-dependent differences in the nitrate and potassium contents of various varieties of *Hydrangea paniculata*. For reasons of clarity, only five of the total of 11 varieties investigated are listed here. Clear differences were able to be identified in terms of the nitrate and potassium content of the sap. It was particularly noticeable that the plant sap of 'Bobo' and 'Diamond Rouge' had nitrate concentrations that were almost twice as high as the other varieties examined. This is linked to plant size. These two species are small species. The lower level of new growth means the plants were able to accumulate more nitrate in their sap than the larger species with the same amount of nitrogen available in the growing medium.

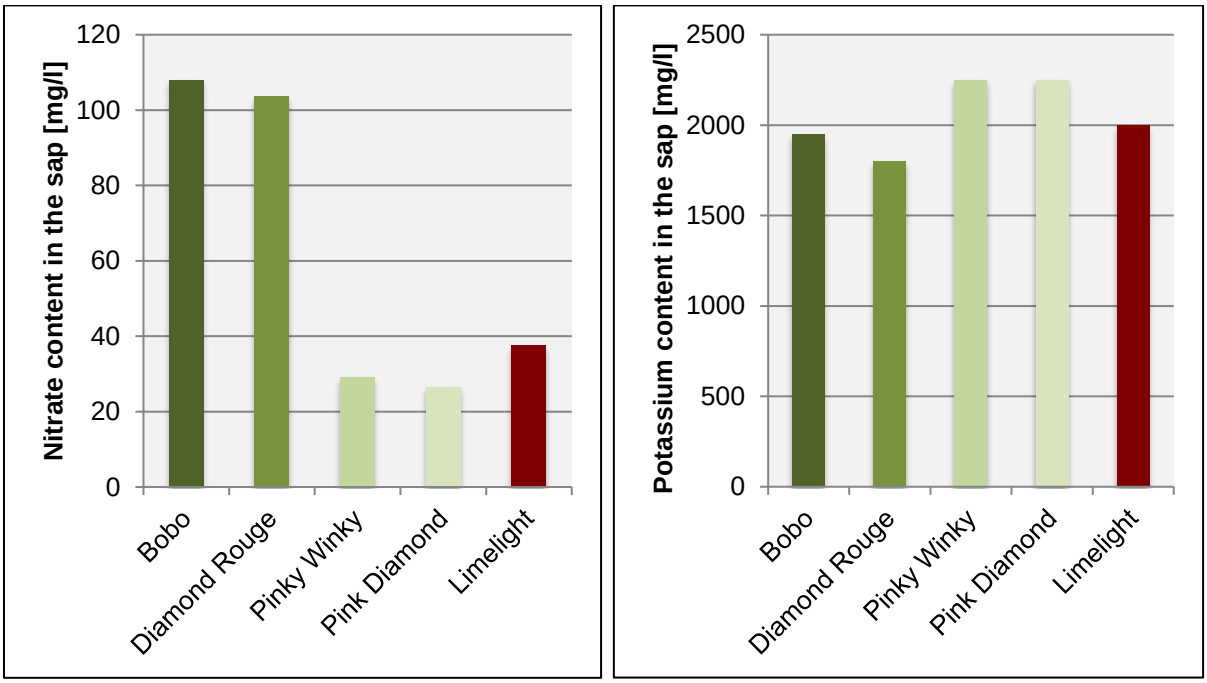


Fig. 6: Impact of five *Hydrangea paniculata* species on the nitrate and potassium content in the plant sap (container crops, fertilisation levels N2 and K2, 15 June 2017)

It is conceivable that a lower level of nitrogen would be sufficient for the optimal growth of smaller species, and that under these conditions the nitrate content in the plant sap would also have been lower. Since the variety comparison was only carried out at one fertiliser level, it is not currently possible to assess whether a uniform nitrate reference value can be used as the basis within this plant species with optimal supply of nitrogen. Further trials are needed for this.

Conclusion and outlook

The results of the trials carried out indicate that the nitrate and potassium contents in the plant sap are sensitive indicators of the nitrogen and potassium nutritional status of *Hydrangea paniculata*. Differences between the fertiliser levels applied were clearly identifiable. The impacts of the leaf age (younger leaves < older leaves) and the time of day (morning > evening) must be taken into account, however, when determining the nitrate content in the plant sap. These parameters therefore need to be standardised when sampling in order to assess the

nitrogen nutritional status of the plants reliably using the rapid nitrate test. Further fertiliser trials under various weather and location conditions are needed to determine reliable reference values. In light of the wide range of nursery types, it is also important to clarify the extent to which various tree/shrub genera and species differ from one another in terms of their nitrate and potassium requirements. It will only be possible to finally assess the suitability of the rapid test method to optimise fertiliser application to crops when further experience is available covering these points.

Comment

Various rapid test devices used to determine nutrients from the sap in leaves and needles were subjected to a practical test as part of a Bachelor's Thesis in 2016. The nutrients nitrate, ammonium and potassium were taken into account. No practicable devices are currently available for other nutrients. The results were published in the VuB 2016 annual report, pages 56-60.

Suitable reference values are also needed for use in nursery practice. These vary significantly by plant genera and can even be very different within a species and variety.

When assessing the symptoms of deficiency in trees, laboratory tests on leaves and needles continue to be essential taking into account all relevant nutrients. The problem of the many missing reference values has been known for many years.

Shoot regulation in *Abies nordmanniana*

(B. Zielke, Dr H. Lösing)

1. Introduction and objective

When cultivating Nordmann firs as Christmas trees, very long terminal shoots often occur in well maintained areas, with strong growth from the fourth year after planting. The goal is to achieve a length of 30-40 cm, but under good conditions the shoots can reach almost twice this length. Various methods are therefore employed to limit this growth in length.

Fig. 1: In the months of May and June the shoots of Nordmann firs grow by several tens of centimetres.

Two products containing the active ingredient 1-naphthylacetic acid have been approved in Germany since 2017, and in Denmark Christmas tree producers used the product Conshape containing the active ingredient abscisic acid for the first time on the basis of an emergency approval according to Article 53 of the EU Regulation. The aim of this trial was to investigate the effect and tolerance of these products compared to conventional methods.

2. Trial methodology

Trees with a height of a maximum of 95 cm and a terminal shoot of at least 35 cm were marked and clearly labelled before bud break in an area planted with Nordmann firs to produce Christmas trees. The length of the tree and the length of the terminal shoot, which grew the previous year, were recorded. The trial was carried out twice with 20 trees per treatment and

replication. Since the trial was carried out on a commercial nursery, no replication was carried out on the control treatment so as not to generate too many unsaleable trees.

On 30 May 2018, the owner of the nursery used the standard commercial treatment, TopStopp tongs, on all trees in treatment 5. One day later, on 31 May 2018, the first pass with the chemical growth regulators was carried out using an Easy Roller. At this point, the new shoots had an average length of around 13 cm. All trees in treatments 2 and 4 were treated. It was 25°C with strong sunshine on that day. On 12 June 2018, treatments 2 and 4 were treated again. The average shoot length for these variants was 31 cm at the point at which the treatment was applied. On 20 June, the trees in treatment 3 were treated using the Easy Roller. The terminal shoot length was an average of 37 cm for the Conshape treatment at this point.

Assessments were carried out on 29 May, 12 June, 19 June, 26 June, 3 July, 10 July, 30 July and 27 August 2018. The length of the terminal shoot was measured. The plants were also inspected for damage caused by the shoot regulation treatments applied.

Table 1: Treatment list.

Trt.	Product	Concentration	Active ingredient	Authorisation/notes
1	Untreated	-	-	-
2	Camposan Extra	0.5%	Ethephon (660 g/l)	Section 22 (2) needed N, C, B4
3	Conshape + Silwet Gold	5% + 0.05%	Abscisic acid (100 g/l) Wetting agent	Requested
4	Proagro NAA SL	0.225%	1-naphthylacetic acid (100 g/l)	Section 22 (2) needed, GHS 05, GHS 08, B4
5	TopStopp tongs	-	-	Not needed

Fig. 2: Trial area before the start of treatment.

Fig. 3: Mechanical methods to regulate shoots using TopStopp tongs.

Fig. 4: Second application with the Easy Roller.

Table 2: Assessment and treatment dates.

Date	Activity	Weather
17/05/18	Preliminary assessment, tree and shoot length in 2017	
29/05/18	Assessment	
30/05/18	Use of TopStopp tongs	
31/05/18	First application (treatments 2 and 4 using the Easy Roller)	25°C, sunny
12/06/18	Assessment and second application (treatments 2 to 4 using the Easy Roller)	20°C, cloudy
19/06/18	Assessment	
20/06/18	Application of treatment 3 using the Easy Roller	25°C, sunny
26/06/18	Assessment	
03/07/18	Assessment	
10/07/18	Assessment	
18/07/18	Assessment	
30/07/18	Assessment	
27.08.18	Assessment	

3. Results

The preliminary assessment showed that the trees had reached terminal shoot lengths of an average of 41 to 44 cm in the previous year, 2017. In 2018, the almost weekly measurements made clear that the strongest growth in the trees occurred in the month of June. The figure below shows the average growth progression of trees of all treatments.

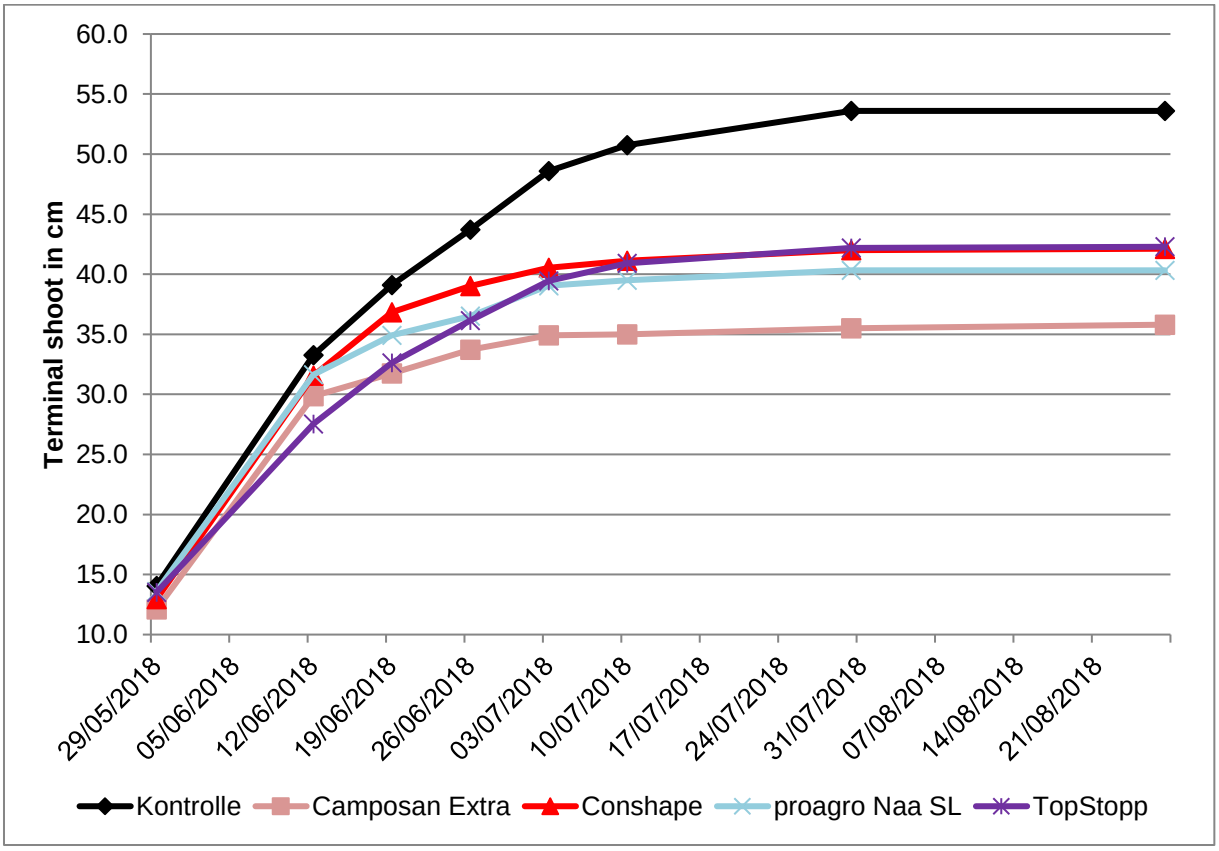


Fig. 5: Average terminal shoot length over the course of the trial. The Camposan Extra and Proagro NAA SL were applied on 31 May and 12 June 2018. Conshape was applied on 20 June 2018.

The trees in the untreated control area reached their tallest in late August with an average shoot length of just under 54 cm. Of the treatments applied, the trees treated twice with Camposan Extra remained the shortest. They reached an average shoot length of just under 36 cm. The treatments Conshape, Proagro NAA SL and TopStopp pliers had a similar impact in terms of length, with average shoot lengths of between 40.3 and 42.3 cm.

A box plot graphic was created to enable a differentiated consideration of the terminal shoot lengths as part of the final assessment. The boxes represent the middle 50% of the values and the horizontal line the median. What are known as the whiskers, or error indicators, show the minimum and maximum values and therefore the range in which the lowest and highest 25% of the values lie. The graphic makes clear that the methods taken to regulate the shoots in the trial decreased the value range. Upward outliers, in other words those with a shoot length of more than 50 cm, were rare in the treated plots.

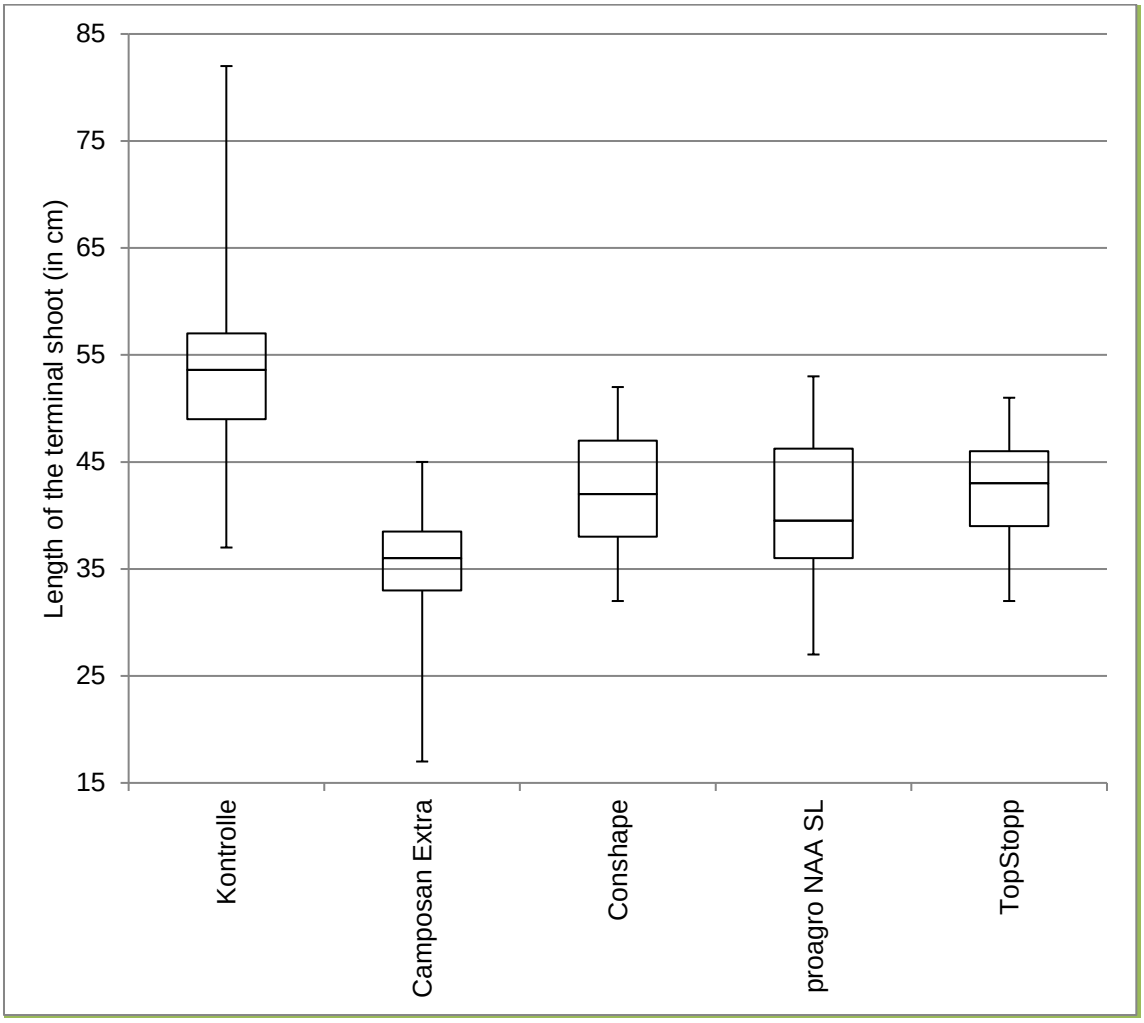


Fig. 6: Terminal shoot lengths during the final assessment. The box plot graphic shows the middle 50% of the values in the ‘boxes’; the ‘whiskers’ indicate the range within which the 25% lowest and highest values lie.

The treatments carried out for terminal shoot regulation caused various abnormalities on the trees.

The TopStopp tongs caused cuts in the bark which scarred over. Two trees in the TopStopp treatment were removed from the trial because they had no scars. The nursery owner evidently missed them and did not treat them. On 27 August 2018 these trees had reached a shoot length of 58 cm and 65 cm respectively.

Fig. 7: Steep upright side shoots and needle losses on the terminals caused by the two applications of Camposan Extra.

Fig. 8: Maximum curvature of the terminals after treatment with Proagro NAA, photographed on 27 August 2018.

The treatments with the product Camposan Extra using the Easy Roller also caused abnormalities. Four trees had slightly damaged needles or bark on the terminal shoot; five trees had some steep upright side shoots. One tree was unsaleable as a result of an extremely curved terminal.

The use of the products Proagro NAA SL or Conshape resulted in slightly curved terminal shoots in some cases. This was not, however, to the extent that the tree would have been unsaleable in any of the cases.

The following figures show images from the various treatment plots on 27 August 2018.

Fig. 9: Untreated control, many trees reached shoot lengths of over 60 cm.

Fig. 10: Camposan Extra reduced the shoot length the most but caused damage in some cases.

Fig. 11: Proagro NAA SL was applied using the Easy Roller on two occasions.

Fig. 12: Conshape + Silwet Gold was only applied once using the Easy Roller.

4. Discussion

There was very little rain in summer 2018. In some locations in Schleswig-Holstein, Christmas trees grew insufficiently during the year even without terminal shoot regulation. The fertilisers applied to the crop did not dissolve and were not available to the trees.

The trial area was irrigated multiple times, providing interesting results. The Nordmann firs with no terminal shoot regulation often reached terminal shoot lengths of 50 cm or more. The use of TopStopp pliers and the three products for chemical growth regulation reduced the growth of the terminal shoots significantly.

In this trial, the greatest reduction in terminal shoot length was achieved by a double application of the product Camposan Extra at a concentration of 0.5%. The use of Camposan Extra, however, led to some minor damage to the plants, and some of the terminal shoots remained too short. Severe damage has been reported in practice.

Very good results were obtained following the double application of Proagro NAA SL (0.225%) and the single application of Conshape with Silwet Gold (5% + 0.05%). The use of the TopStopp tongs also had a good effect. Christmas tree producers can use the products Camposan Extra (ethephon 660 g/l) and Proagro NAA SL with approval according to Section 22 (2). It would also be possible to use the product Fixor (1-naphthylacetic acid 100 g/l), which has the same active ingredient content and the same authorisation number as Proagro NAA SL. Approval of Conshape would be extremely desirable as this product only needs to be used once and can also lead to a balancing out of peak work times due to the later application date.

The Christmas trees broke bud at different times in this trial. While some trees had shoot lengths of 5 cm when the products were first applied using the Easy Roller, others had already reached terminal shoot lengths of 25 cm.

In practice, several passes are therefore often made with the Easy Roller. The growth regulator solution is coloured with a food dye so it is possible to determine which trees have not yet been treated on the subsequent pass.

During the 2018 trial, all of the shoot regulation measures examined worked very well. Mechanical and chemical methods often have to be combined in high rainfall years when the nutrient supply to the trees is high, in order to achieve a sufficient reduction in the growth of the terminal shoots.

Study trip to Belgium
(Dr Heinrich Lösing)

From 28 August to 31 August 2018, 23 nursery owners from the Pinneberg area visited ten nurseries and a research institute in Belgium. 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.

	Belgium	**Germany**
Number of inhabitants, total	11.376 million	80.621 million
Area, total	30,530 square km	348,540 square km
Population density/square km	373	231
Number of nurseries	*728	1714
Nursery production areas	5,413 ha	18,613 ha

Sources: Federal Statistical Office 2017, special series 3 series 3.1.7, * main and side businesses

The most significant and oldest nursery region in Belgium is Wetteren, south-east of Ghent on the 'De Schelde' river with around 120 nurseries and 1,500 ha of production area. This region's origins go back around 200 years. The oldest nursery in Wetteren that still exists to this day is probably Weymeersch Boomkwekerij (www.weymeerschboomkwekerij.be).

Nursery owners in Wetteren actively work to promote insects using what are known an insect hotels

We were supported by the Flanders Nursery Association when preparing for our trip, and in particular by their Chair, Lucien Verschoren. This also included an invitation to an excellent lunch.

Companies and research institute visited

Solitair N V, Loenhout, www.solitair.be

The nursery was founded around 30 years ago by Dirk Cools. Nowadays, pruned/trimmed plants, often individual pieces with a special character, are cultivated over an area of 120 ha up to a maximum root ball size of 3 m in diameter. Too many problems occur when transporting

larger plants. The company has its own tree spader for plants up to a diameter of 2.6 m. Only a few plants are grown in large containers. The company currently has 25 employees.
The plants are sold across Europe, predominantly in Belgium, England and Germany.


Chloe Cools, Owner's Daughter


Range of topiary/trimmed plants

Jan Spruyt-Van der Jeugd, Buggenhout, www.vasteplant.be

The perennial plant nursery was founded 42 years ago by the father and was taken over by the son three years ago. Around 3,000 species and varieties of perennial plants are cultivated over an area of around 4 ha, and 1.5 million plants are sold each year, primarily in 9" pots. Seventy percent of the sales remain in Belgium, 20% of which go to private customers. The company currently has 17 employees.

Propagation is limited to species required in small quantities and more difficult species and varieties. Around 2 ha of open land are also available for mother plants. The majority are bought as young plants from the Netherlands.


Owner Jan Spruyt presenting the company


View of the production area specialising in geraniums and grasses

Destelbergen research institute (PCS), www.pcsierteelt.be

The research institute can be broken down into various areas, in particular those for begonias, azaleas, ornamental plants and nurseries. The overarching topics are environmentally friendly fertiliser use, energy saving and plant protection.

The guided tour was led by Mr. Filip Rijs, who is responsible in particular for work on crop cultivation and plant protection.

The following subject areas were presented:

- Comparison of the pot-in-pot system with other containers both placed on the ground and recessed.
- Organic plant protection.
- Conventional and organic control of problematic pests such as black vine weevil and box tree moth.
- Trialling of alternative products against the powdery mildew pathogens.
- Reducing nutrient discharge in container plant production.

In the field, extensive, multi-year trials on the mobility of nitrogen and phosphorous in the soil are carried out. Another focus is on maintaining the fertility and the humus content of nursery soils.

Trial comparing the pot-in-pot system to other cultural methods

Tour of the trials in the rain

Dierick, Wetteren, www.boomkwekerijdierick.be

The nursery primarily grows young trees (8-10-12 cm) as two-year or three-year plants over an area of around 30 ha. The range covers a broad spectrum, but specialises in *Carpinus* and *Quercus* species and varieties. Grafting is carried out in the field in the summer months.

Father and son (Peter and Guy) run the company together

Tour of the Dierick nursery with Belgian colleagues

Van Poecke, Wetteren, www.vanpoecke-zn.be

The nursery produces conifers (mainly *Thuja* 'Brabant' and 'Smaragd') and species and varieties of cherry laurels in large numbers for the European market. The container area currently covers 7 ha. One, two and four-litre containers are used.

One million filed-grown roses used to be grown, but poor sales mean this number has been reduced to less than 300,000 per year. Four members of the family and four other people work for the company, with additional seasonal workers.

View of the production area with conifers in containers

View of the cultivation of young Thuja 'Smaragd'

Marc De Troy, Wetteren, www.marcdetroy.be

The current owner took the nursery over from his father in 1990 with an area totalling 20 ha of open land, and moved location in 2008. Today, plants are now also produced in containers over an area of 3.5 ha. This production process is being further expanded. A reservoir with a volume of 1,000 m^3 has already been set up to cover the water needs.

Ornamental plants, conifers and fruit trees are produced in 2, 3 and 5-litre containers. In addition to the two family workers, three other full-time employees and three seasonal workers are also employed by the company.


Marc De Troy, owner of the nursery


Conifers dominate in many areas

Calle, Wetteren, www.calle.be

Trees have been cultivated over an area of 65 ha of open land and 7 ha in containers for six generations. Some of the areas are not in Wetteren, but rather in Lochristie or Scheldewindeke. Nowadays, the nursery is run by Thomas Calle. One of their specialties is certainly the vegetative beds of *Corylus,* many varieties of *Syringa* and other fruit trees. Nineteen varieties of hazelnut are available.

The company has around 20 employees. Sales are predominantly within Belgium and to Germany and France.


Thomas Calle is the
sixth generation to run the nursery


Vegetative beds of *Corylus, Syringa* etc. are a specialty at Calle

Sylva, Waarschoot, www.sylva.eu

The forest nursery was founded in 1750 and is now being run by the eighth generation in the guise of Tim van Hulle. The company has around 45 employees. The nursery cultivates a wide

range of forest and hedge plants over around 100 ha, around 120 species in total. The annual production is around 15 million seedlings, with only poplar trees being taken as cuttings. Sales are predominantly in Belgium, with 20% of the goods being exported to 27 countries.

A particular challenge is sorting the seedlings by length and thickness. The first sorting machine was used 20 years ago. Since the ongoing maintenance costs had become too high, the company has used a new device from SMO (www.smo.be) since last summer. Initial experience has been positive, but further development work is still needed. This is the first sorting machine of this type in the world. Four people can insert plants at the same time, and various species of plants can be sorted next to one another. Bundling is planned, but this has yet to be implemented. The device needs 20 x 12 m of space, but this does not include storage space for plants or tracks for forklifts.

Owner Tim van Hulle (left) with Production Manager Jan Cousement (right)

View of the sorting machine by SMO from Eeklo

Allaert, Wingende, www.allaert-nurseries.be

Ornamental and landscaping trees are primarily cultivated over an area of 80 ha. The percentage of forest plants has significantly reduced in the past few years, among other things due to the introduction of the ZüF system in Germany. It means that nursery owners outside of Germany are only permitted to grow forest trees with this certificate to a very limited extent.

Around 10 ha are cultivated with a ‘green manure crop’ each year to maintain soil fertility, mainly with Japanese bristlegrass. The owner is of the opinion that this results in a reduction in wild nematodes, and the plant is easier to handle than *Tagetes.*

The biggest problem cited was a lack of workers. Five Belgian employees currently work for the company, and the remainder are Polish seasonal workers.


Nursery owners Marie and Etienne Allaert


View of the crops on the nursery

Vandeputte, www.vandeputtebelgium.be

The company which specialises in young plants in 9 cm pots (5 million/year) was founded in 1970 by the parents of the current owner, Piero Vandeputte. It covers an area of a total of 21 ha, of which 10 ha of production area is in open land and around 1 ha is in greenhouses. A total of 1200 species and varieties are grown, of which 400 species and varieties are conifers. Propagation is primarily from cuttings. No grafting is carried out within the company.

Nine full-time workers and 20 Polish seasonal workers are employed by the company. Plant nutrition is achieved using 1-2 g/l Basacote, then liquid fertiliser is added. A large-volume water reservoir is available and has sufficient capacity for eight weeks.


Large-volume water tank to cover shortages


Young plants as far as the eye can see; company buildings in the background

Willy de Nolf, www.denolf.com

The nursery was founded in 1985 and currently spans two locations. Cuttings are grown on a third location. A wide range of ornamental plants are grown in containers over an area of around 30 ha. One focus is on innovations such as ‘proven winners’. Sixty-five percent of the sales are exports and go to garden centres, retail and other nurseries. The company currently has around 40 employees.

Two water reservoirs with an area of around 1 ha each are available to ensure the water supply.

Willy de Nolf, owner of the nursery

View of the production of container plants

Appeltans, www.appeltansboomteelt.be

The nursery was only founded in 2000. Trees are cultivated on open land and in containers from 20 litres in size, over an area of around 70 ha. Seven full-time employees and a further 15-20 seasonal employees are employed. Sales are predominantly to southern Germany and Russia. A Russian-speaking employee was hired for this purpose. The plants are fertilised with Osmocote of different release durations depending on the potting time.

View of the pine stocks in containers

Marc Appeltans, owner of the nursery

Summary

All of the participants on the study trip were impressed by the friendly reception they received from the companies and the hospitality. Particular thanks go to the Flanders Nursery Association and their Chair, Lucien Vershoren, for their support in preparing for the trip.

The nursery industry in Belgium is undergoing a significant structural change. Many traditional nurseries have stopped operating or will do in the near future. Others are meeting the challenges of the changing markets with a great deal of drive and seem to be successful.

The large number of family businesses in the nursery sector was striking. Almost every company had several siblings and the parents still working in the company. Information on the

numbers of employees was met with astonishment. The numbers per unit of area in Germany are significantly higher.

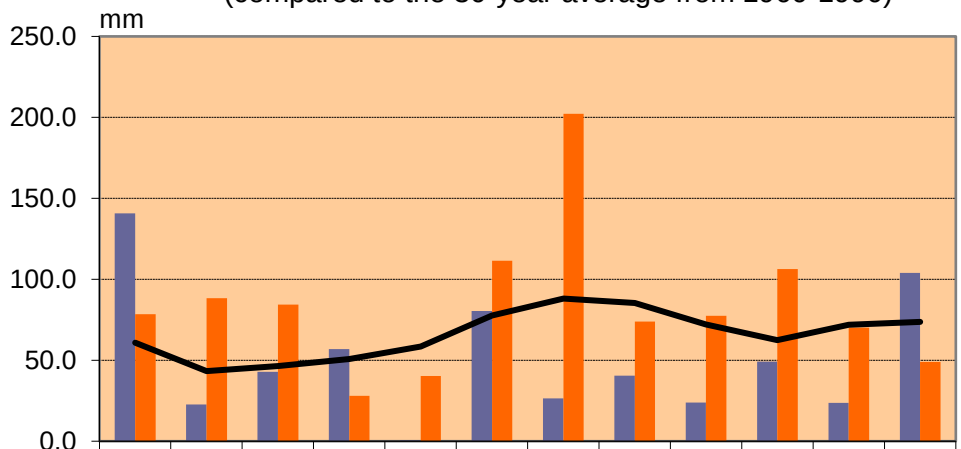
Participants on the group trip at Solitair nursery in Loenhout

Data from the weather station in Thiensen and precipitation data from the Schleswig-Holstein Chamber of Agriculture (LK SH)

Comparison of the periods of 2017 and 2018 with the 30-year average (1960 – 1990)

Monthly rainfall, Thiensen 2018 (LK SH) and 2017

(compared to the 30-year average from 1960-1990)

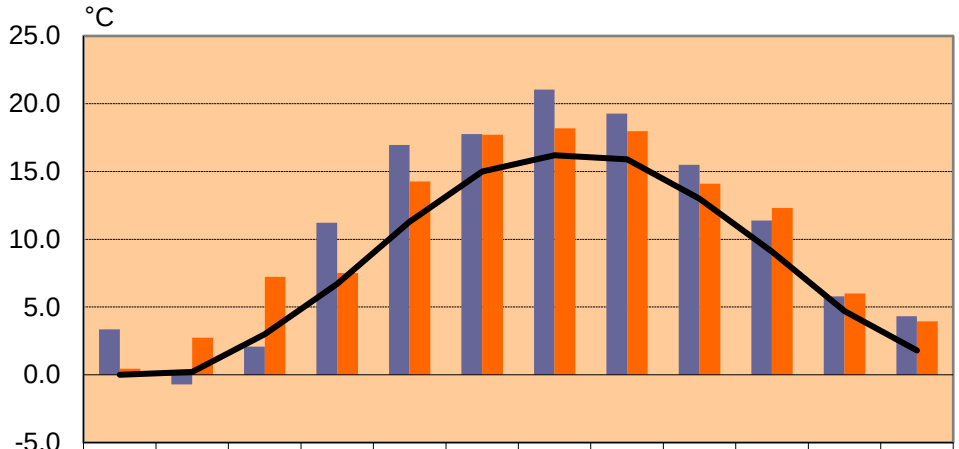


	Jan	Febr	März	Apr	Mai	Juni	Juli	Aug	Sept	Okt	Nov	Dez	Summe
2018	140.7	22.7	42.9	56.8	0.6	80.5	26.5	40.5	23.9	49.2	23.7	104.0	612
2017	78.4	88.4	84.4	28.0	40.2	111.4	202.2	73.8	77.4	106.4	70.2	49.0	1010
30-jähriges Mittel	60.8	43.3	46.5	50.7	58.5	77.6	88.1	85.4	72.2	62.4	72.0	73.6	791

2018 2017 30-jähriges Mittel

Average temperature (at a height of 2 m), Thiensen 2018 and 2017

(compared to the 30-year average from 1960-1990)

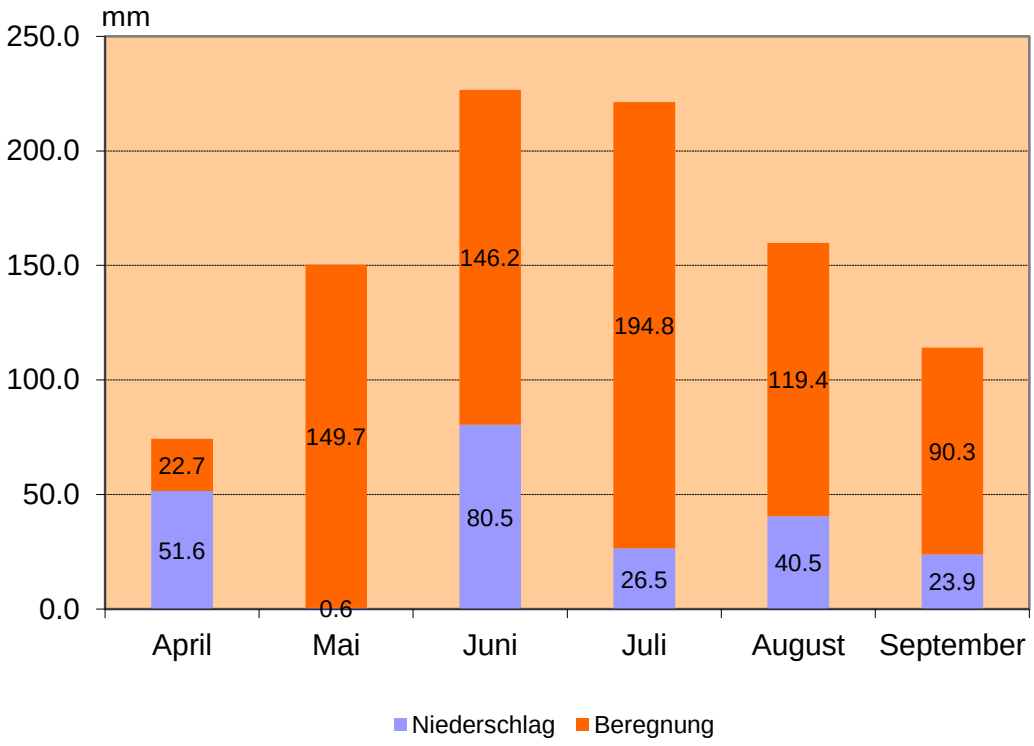


	Jan	Febr	März	Apr	Mai	Juni	Juli	Aug	Sept	Okt	Nov	Dez	Ø
2018	3.4	-0.7	2.1	11.2	17.0	17.8	21.0	19.3	15.5	11.4	5.8	4.3	10,7
2017	0.4	2.7	7.2	7.5	14.3	17.7	18.2	18.0	14.1	12.3	6.0	4.0	10,2
30-jähriges Mittel	0	0.2	3	6.7	11.3	15	16.2	15.9	13	9.1	4.7	1.8	8,1

2018 2017 30-jähriges Mittel

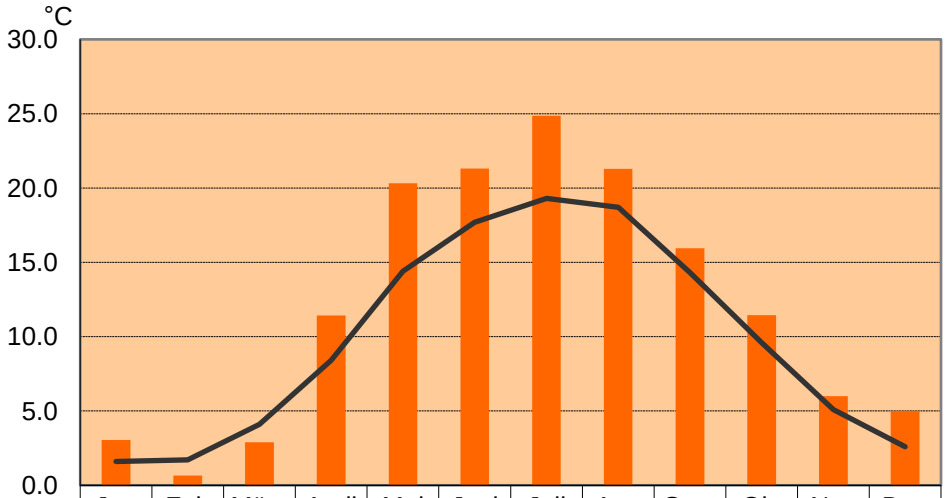
Rainfall (LK SH) and additional irrigation to container crops

Rosen, Co 3-4 l (Rellingen location, 2018)



Average soil temperature (10 cm depth), Thiensen 2018

(compared to the 30-year average from 1960-1990; location: DWD, HH-Fuhlsbüttel)



	Jan	Feb	März	April	Mai	Juni	Juli	Aug	Sept	Okt	Nov	Dez
2018	3.0	0.7	2.9	11.4	20.3	21.3	24.9	21.3	15.9	11.4	6.0	5.0
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

2018

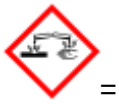
Globally harmonised system for classifying and labelling chemicals
(B. Zielke)

The **Globally Harmonized System of Classification, Labelling and Packaging of Chemicals** (GHS) by the United Nations is, as the name suggests, a harmonised global system for classifying and labelling chemicals.

These chemicals include the plant protection products we use. Previously, the packaging and safety datasheets for plant protection products were labelled with the familiar orange squares according to EU law (e.g. with the black X for 'Xi = irritants' and 'Xn = substances harmful to health'). The new labelling according to GHS has applied exclusively since 1 July 2017.

The new symbols, diamonds with a red border with some similar symbols are known as pictograms and are the same everywhere in the world. The **pictograms** and the associated **GHS abbreviations** related to plant protection products is presented below and will appear in the "Yellow List" from now on.


= flame (**GHS02**): flammable, self-heating, water-reactive etc. (only a small number of plant protection products bear this pictogram, e.g. the herbicide Onyx, the fish oil EPSOM which is used in forests to deter wildlife and the disinfectant Menno Florades).


= corrosive (**GHS05**): Has a corrosive effect on metal, corrosive to the skin, causes serious eye damage (examples of this are the fungicides Ceralo and Folicur, the herbicide Gallant Super and the insecticide Danadim Progress).


= acute toxicity (**GHS06**): only a few plant protection products are still acutely toxic substances and mixtures and bear this pictogram (examples of this are the fungicides Ceralo and Delan WG and the insecticides Trafo WG and Lamdex Forte with the active substance lambda-cyhalothrin).


= (**GHS07**): hazardous to health, irritant, skin sensitiser or harmful to the ozone layer (a large number of substances and mixtures bear this pictogram, e.g. Askon, Finalsan, Menno Florades, Teppeki etc.).


= hazardous to health (**GHS08**): substances and mixtures that cause long-term harm (e.g. Kerb Flo, Karate Zeon and many others).


= hazardous to the aquatic environment (**GHS09**): substances and mixtures that are harmful to the aquatic environment (e.g. Glyfos TF Classic, Mospilan SG, NeemAzal T/S, ParaSommer and many others).

The pictograms show at a glance the type of hazardous substance in question. They do not, however, release us from the obligation to read the full label with the regulations and instructions and the P and H statements. P statements (precautionary statements) replace

what used to be called S statements (safety statements). H statements (hazard statement) replace the R statements (risk statements).

Explanation of the drawings: **An extensive explanation of the drawings is available in the 'yellow list' of plant protection products 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	(= NB6611) harmful to bees
B2	(= NB6621) 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 product in line with the approval
B4	(= NB664 and 6641) not harmful to bees
The harmfulness to bees changes in the case of mixtures of the insecticides Calypso, 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 of Calypso or Mospilan SG with these fungicides must be used in such a manner that flowering plants are not affected (NB6612, NB 6613). Mixtures of Karate Forst, Karate Zeon, Lamdex forte, Mavrik or Trafo WG may only be used on flowering plants in the evenings after the daily bee activity and until 11pm (NB6623). The **bee protection requirement NB505** has applied since September 2018 to the B1 products Confidor WG 70 and Warrant 700 WG: '*Use is only permissible if the plants being cultivated remain in a permanent greenhouse for their entire lives'.* This means that neither of these plant protection products can be used in nursery production any more.	
Labelling to protect bodies of water:	
NW 468	Application liquids and their residues, products 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 sewerage system, farmyard and street run-off and rain and waste wastewater pipes.
NW 642, 642-1	The use of the product 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.
The herbicides Stomp Aqua, Stomp Raps and Boxer have received new requirements (NT 145, NT 146, NT 170). In accordance with these, the water consumption 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, application 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 products 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 decision making. 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 protection products and fertilisers such as the condition of the plants, the nature of the soil, the physical location, the crop management, the interaction with other products 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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