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CONTENTS

EDITORIAL

**California Asparagus Seed
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The ARN is provided without cost to those that wish to download this publication. The main focus of the ARN is, and has been, to provide a medium for the exchange and extension of asparagus research information throughout the world.

This is the third Internet publication of the Asparagus Research Newsletter. It appears that the decision to publish the Asparagus Research Newsletter (ARN) on the Internet has been correct. I have been pleased by the positive response of the many people who have downloaded the ARN this last year.

The contents of the Asparagus Research Newsletter is dependent on the contributions of the asparagus researchers and industry people around the world. This year's Asparagus Research Newsletter includes only two submitted papers for publication. This is down from the four papers that were submitted for the 2002 Internet publication of the Asparagus Research Newsletter. If you have any information regarding asparagus that you think other asparagus people would be interested in please send it to me for the next Internet Edition.

The world wide asparagus research activities have been very fruitful this last year. You will note that in this edition, the "Recent Publications" contains 45 pages, listing a great number of papers published on the topic of asparagus. The papers have been extracted from Internet search engines and from the Proceedings of the Tenth International Asparagus Symposium.

Brian Benson

SUBSCRIPTIONS AND ARTICLE CONTRIBUTIONS

There are no subscription fees for the Asparagus Research Newsletter. The Asparagus Research Newsletter is intended to be made freely available to all who wish to download this publication. Those who wish to reference or cite the contents of the ARN in other publications should do so with respect to the contributing authors.

Contributions to the Asparagus Research Newsletter should be sent to me by E-Mail and also as a hard copy and as a file or files on a floppy disc so that I can edit the text and tables to prepare a uniform presentation in the following edition.

Send Article Contributions to:

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UPCOMING EVENTS
and
ONGOING ACTIVITIES

EVENT: The Eleventh International Asparagus Symposium

When: **June 16 to June 19, 2005**
Where: **Horst/Venlo, The Netherlands**
Hosted by: **ASPARAGUS**

In association with: **Wageningen University and Research Centre**

Under the auspices of the: **International Society for Horticultural Science**

Contact Information:

IAS2005
P.O. Box 6219
5960 AE HORST
The Netherlands

Phone: **31 (0) 77 397 99 00**
FAX: **31 (0) 77 397 99 09**
E-Mail: **info@ias2005.com**

ONGOING ACTIVITY: **Third International Asparagus Cultivar Trial**
When: **Ongoing**
Where: **Worldwide**
Co-Chairmen: **Brian Benson and Chee-kok Chin**

To date: **Nineteen participants from 11 countries are evaluating 40 asparagus cultivars and breeding lines. Most trial sites have been planted and the first data from the trails will be available for posting on a Web site that is yet to be established. Please contact either Brian Benson at** <benson @davis.com> **or Dr. Chee-kok Chin at** <chin_c@aesop.rutgers.edu> **for the address of the Web site in a month or two.**

YIELDING OF 15 ASPARAGUS CULTIVARS GROWN FOR WHITE SPEARS

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Summary

The yields of the following Californian, Dutch, German and French asparagus cultivars: Andreas, Dariana, Carlim, Gynlim, Horlim, Thielim, Huchel's Alpha, Experimental Hybrid 1961-A13, Lucullus Sieg., Mars, Schwetzinger Meisterschuss-15, Vulkan, Eposs, CAST Apollo and CAST Grande were evaluated in 2000 and 2001. These years were the fifth and the sixth years of harvest. The highest yields of white spears were obtained with Gynlim. Also yields with cultivars Eposs, Carlim and Experimental Hybrid 1961–A13 belonged to the highest ones. The spears of the highest quality had the following cultivars: Carlim, Schwetzinger Meisterschuss-15, Eposs, and Gynlim. The lowest yield gave: CAST Grande, CAST Apollo, Andreas and Vulkan.

Introduction

The total production of asparagus in Poland amounts to near by 3000 tones. More than half of it is exported to Germany. Good asparagus varieties suitable for white spear production in Polish environmental conditions are needed.

Material and Method

The field trial was established in the Experimental Station „Marcelin" of the Agricultural University of Poznan in 1993. The random block design in four replications was applied in the trial. Three-month greenhouse seedlings were planted at a spacing of 1.7 m x 0.33 m and 0.2 m deep. Fifteen cultivars of different origin were included in the trial (Table 1). The first harvest was conducted in 1996. Before 1999 green spears were harvested and since 2000 white ones have been harvested. In the case of white spear production ridges were made and covered with black-white plastic. Harvested white spears were weighed and counted as well as graded into the three qualities defined below:
'Extra' – shoots of superior quality, very well-formed and practically straight, their tips very compact. There are allowed only a few slight traces of rust on the shoot, removable by normal peeling by the consumer. Minimum diameter is 12 mm.
I-st quality - shoots should be well-formed. They may be slightly curved, but their tips must be compact. Minimum diameter is 10 mm. There are allowed slight traces of rust removable by normal peeling by the consumer.
II-end quality - shoots may be less well-formed, more curved and their tips may be slightly open. Minimum diameter is 10 mm.

Results and Discussion

The highest total and marketable yields out of fifteen cultivars were obtained with the Dutch cultivar Gynlim (Table 1). High total yields over 8 t/ha were also given by the cultivars such as: Eposs, Carlim, and Experimental Hybrid 1961-A13 in both years of the trial as well as Schwetzinger Meisterschuss-15 only in 2001. Mean marketable spears weights were the highest for the following cultivars: Horlim, Dariana, Experimental Hybrid 1961-A13, Thielim and Eposs.

Table 1 - Total and marketable yields as well as mean marketable spear weight (2000-2001)

Cultivar	Origin	Total yield [t/ha]	Marketable yield [t/ha]	Mean spear weight [g]
Gynlim**	Netherlands	11.36 a*	9.86 a	34.2 def
Eposs	Germany	9.55 b	7.86 b	35.0 def
Carlim**	Netherlands	9.31 b	8.04 b	31.9 defg
Exp.Hybrid 1961-A13**	Germany	8.48 bc	7.07 bc	38.1 cd
Horlim**	Netherlands	7.60 bc	6.32 bc	42.1 c
S. M. 15	Germany	7.17 cd	5.83 cd.	34.4 def
Mars **	Germany	7.00 cd	5.65 cd.	34.4 def
Dariana	France	6.67 cd	5.37 cde	38.3 cd
Thielim**	Netherlands	6.23 cd	5.23 cde	36.4 de
Lucullus Sieg.**	Germany	5.04 de	4.20 def	29.5 fg
Huchel's Alpha	Germany	5.20 de	4.09 def	31.5 efg
Vulkan**	Germany	4.02 ef	3.44 ef	33.4 def
Andreas**	France	3.35 ef	2.64 gf	31.2 efg
CAST Apollo	USA	2.88 f	2.34 gf	26.8 g
CAST Grande	USA	1.25 g	0.98 g	29.4 fg

*the same letters indicate no differences at □=0.05 test Newman-Keuls; ** all-male cultivars

The highest percentage of hollow spears was found in Horlim (1.7 %), Alpha (1.3 %) and Thielim (1.1 %). The following cultivars: Andreas, Alpha, Experimental Hybrid 1961-A13 had the highest number of spears with open tips (10.6–7.3 %). The highest number of spears with rust traces (1.8–0.8 %) had the following cultivars: Dariana, Alpha, CAST Grande, Vulkan, Horlim and Mars. Defects of asparagus spears affected the yield structure (Fig. 1).

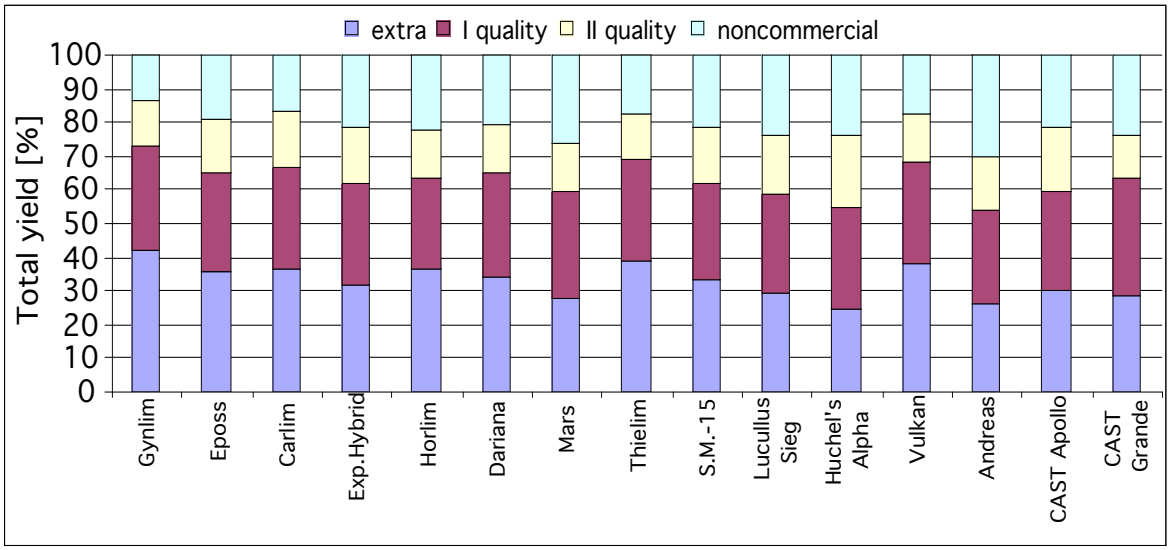

Fig.1. Yield quality structure (2000-2001)

Very high yield of Gynlim in our trial confirms the results announced by several authors: Boonen (1994), Knaflewski et al. (1998), Paschold et al. (1999), Oordt et al. (1999), Bakka et al. (1999), Fadanelli and Meroni (2000).
Falavigna et al. (1999) found that in central and southern Italy American cultivars such as CAST Apollo and CAST Grande gave high yields. In our trial the yields of these cultivars were the lowest because their vigor in a temperate climate is not high. This confirms the earlier results that Californian cultivars are not suitable for cultivation in Poland (Knaflewski and Konys 1993).

Conclusions

The most suitable for white asparagus production in Poland appeared to be the following cultivars: Gynlim, Eposs and Carlim, and the least suitable ones: CAST Grande, CAST Apollo, Andreas and Vulkan

References

Bakka E., Ssonko R., Makumbi V., Singh B.P. 1999. Vegetative growth and spear yield of exotic asparagus cultivars grown in Uganda. Acta Horticulturae 479: 169–175.
Boonen P. 1994. [Development of asparagus breeding in Netherlands.] Rozwoj hodowli szparaga w Holandii. First International Asparagus Conference. Nowy Tomysl: 4.
Fadanelli L., Meroni E. 2000. Evaluation of Asparagus varietes for the production of white spears. Informatore Agrario 54: 51–55.
Falavigna A., Casali P., E. Palumbo D., Materazzo G., Cerbino G., Rosa L. DE. 1999. Varietal innovations for asparagus in Italy. Informatore Agrario 54: 51–55.
Knaflewski M., Konys E. 1993. Suitability of asparagus cultivars for blanched spear production in a temperate climate. Folia Horticulturae V/2: 23–32.
Knaflewski M., Kaluzewicz A., Kaminska B., Spizewski T. 1998. [Yielding and quality green spears fifteenth asparagus cultivars.] Plonowanie i jakosc zielonych wypustek pietnastu odmian szparaga. Zeszyty Naukowe AR im. H. Kollataja w Krakowie 57: 153–157.
Paschold P.J., Hermann G., Arteld B. 1999. [Asparagus varietes tested over 6 year]. Spargelsorten sechs Jahre getestet. Gemuse 35: 261–266.
Oordt E., Vaccari F., Carrillo J.M., Velasquez P., Apaza W. 1999. Preliminary results of the Second International Asparagus Cultivar Trial in Ica. Peru. Acta Horticulturae 479: 149–156.

Effect of Nemaslug®, Salt or Carvone on the Slug Damage in Green Asparagus

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Abstract

Green asparagus (*Asparagus officinalis* L.) crops are frequently damaged by the grey field slug (*Deroceras reticulatum*). Most damage occurs in the soil, although some asparagus spears are attacked above the ground. Damage occurs especially during the first five weeks of harvesting, from the end of April until the end of May and results in loss of quality. Field experiments were conducted at Oudkarspel and Heerhugowaard in the western region of the Netherlands. Nematodes, salt and carvone were added as row applications in asparagus beds. Field experiments were carried out from 1998 until 2000 with the objective of controlling slugs with the slug parasitic nematode (*Phasmarhabditis hermaphrodita)*, salt and carvone. Dosages of 10,000 to 600,000 nematodes per m^2 were used. Salt was applied in doses of 500 to 4000 kg NaCl per ha. Carvone was applied in doses of 0.5 %, 1.0 % and 2.0 % solution Number of applications varied from 1 to 4. Treatments were compared with conventional field application of metaldehyde pellets (448 g a. i. per ha) in an equal number of applications and with untreated plots.

Significant protection of the crop during the harvest period was reached with nematodes in 1999 and 2000, when nematodes were applied three times in the row at a dose of 50,000 per m^2 (2000) or 100,000 or at once 300,000 per m^2 (1999 and 2000). Additionally, salt applied at 2000 kg per ha twice (1998) or at a dose of 1000 kg applied four times (1998, 1999 and 2000) provided successful slug control.

We recommend applying parasitic nematodes (Nemaslug®) once at a dose of 300,000 per m^2 or three times at a dose of 50,000 per m^2 as a row application for The Netherlands.

Introduction

Slug pests are difficult to control in a wide range of horticultural crops (Moens, 1980). Many crops are damaged extensively despite intensive use of molluscicide and no adequate alternative control methods are currently available. In green asparagus, lettuce, Brussels sprouts and strawberries slugs decrease yield or cause loss of quality due to presence of slugs or their faeces in the harvested product (Glen et al., 2000; Huiting and Ester, 2001). The grey field slug (*Deroceras reticulatum*) is the most harmful species in the Netherlands (Ester et al., 1996; Ester and Geelen 1996).

In particular, green asparagus (*Asparagus officinalis* L.) can be damaged extensively by slugs because it is grown for ten years or more on the same field. Green asparagus spears are deformed by tiny feeding marks at the growing tips, resulting in an unmarketable product. Green asparagus was introduced in the Netherlands in the 1980's. Traditionally

white asparagus are grown, mainly on sandy soils. Green asparagus however are mostly grown on clay soils. The soil surface of clay soils is completely closed by a crust in winter. Slugs have restricted capability to pass through this crust so there is no movement from the soil to the surface (Glen et al., 1989). Early in spring, slugs start moving below the soil surface and affect newly developed spears. Increasing temperatures towards the end of March initiates the spears to grow and push the clay clods so the spears will appear above soil level. Here the slugs appear above the ground and affect spears above the soil as well level. From mid April until the end of May, the temperature in the Netherlands is often quite low. Low temperatures results in reduced growth of the spears and in this stage the crop is more vulnerable to slugdamage. These early spears have a high value. In June, temperatures are increasing so the spears are growing fast and are harvested once or twice a day, so damage by slugs is diluted and therefore reduced.

In early spring slugs affect spears below soil level only, before the soil crust is broken. Contrary to the effect of slugs above soil level, molluscicide pellets have no effect on slugs below soil level. During the period of harvesting, mid April until the 24th of June (in practice the final day of harvesting each year) molluscicides are not recommended in asparagus because spears may be consumed the same day, which may result in residue problems.

Registration authorities in the Netherlands are critically reviewing the carbamate molluscicides, such as thiodicarb, so research on alternative methods of control slugs is needed.

□

The nematode, *Phasmarhabditis hermaphrodita,* was discovered as a slug parasite in the UK (Wilson et al., 1993a,b), and has been developed as a biocontrol agent used in small laboratory scale (Wilson et al., 1994) with the trade name Nemaslug®. This parasitic nematode is for sale in the UK, The Netherlands and Switserland as a molluscicide to be used in domestic gardens (Glen et al., 1994). The mechanism of *P. hermaphrodita* killing slugs is described by Wilson et al. (1993).
After penetration of the nematodes into the slug, the slug will stop food intake of Chinese cabbage after four days. Hass et al. (1999) reported a significant reduction of slug damage to winter wheat seedlings six or more days after nematode treatment.

Nemaslug® is available for the home-garden market as a biological agent for the control of slugs with a recommended dose of 300,000 nematodes per m^2 in an overall treatment. This recommendation followed field and mini-plot experiments (Wilson et al. 1994a,b, 1995a).

A major constraint to the extension of the use of this nematode to control slug damage in high – value vegetable crops is one of cost. It is likely that, after the home – garden market, the nematode will also be used in high value vegetables and flowers, such as green asparagus, Brussels sprouts and orchids. In these crops the control of slug damage is unsatisfactory and where there is concern about possible residues of pesticides used for slug control (Glen et al., 1996).

Mature asparagus plants are considered as the most salt-tolerant crop commercially available. Dorsman and Waite (1951) reported that asparagus plants which were inundated by salt sea water for one week survived. Poll (2000) showed that the asparagus crop is insensitive to high concentrations of salt. This characteristic can be useful to investigate the effect of salt on the control of slugs. Dutch growers use salt as a method to control fungus diseases, such as *Fusarium* spp. and *Phytophthora* spp., which results in a higher yield. The recommended dose is twice 1000 kg NaCl per ha, in January and July. The organic farmers organisation in The Netherlands has accepted salt application (Poll, 2000).

Talent® (actieve ingredient: d-carvone 95 %) based on carvone has recently been introduced in The Netherlands as suppresses sprout growth of stored potatoes. Ester & Trul (2000) found a sufficient effect of the product against slugs in the storages. Ester & Nijenstein (1995) found that wheat seeds treated with carvone were protected against damage of slugs.

The aim of this research is to find an alternative for chemical molluscicides, which is effective before the asparagus spears appear and after the spears appear above soil level.

Materials and Methods

Experimental Sites

From April until the beginning of June of 1998, 1999 and 2000, field experiments were carried out at Oudkarspel (soil of 22 % silt) and at Heerhugowaard in 1998 only (soil of 20 % silt) in the western part of the Netherlands. These locations had a high density of *D. reticulatum*. The asparagus variety Gijnlim was used. The asparagus field used in 1998 was planted in 1993 and the asparagus field of Heerhugowaard was planted in 1991. The trial fields of 1999 and 2000 were planted in 1997.

The experimental layout was in randomised blocks with four (1998) or five (1999 and 2000) replicates. Plots consisted of one asparagus bed of 5 m length and 1.5 m width (slugs do not cross this distance during the treatments; the soil is free of any green material as weed) in a conventional field. The experimental row application was 0.3 m wide, this means each plot consisted of 1.5 m^2 treated area.

Treatments

The treatments are summarised in Table 1. Each time the first treatment was carried out when the soil surface crust was breaking as the first asparagus spears emerged (Table 1.). The nematodes (Nemaslug®), salt (NaCl with 1 % Mg O) tradename Aspergezout® , carvone 500 EC and metaldehyde were applied as 0.3 m wide band applications. None of the treatments were corporated into the soil.

The quality of nematodes were tested in a standard bio-assay (MicroBio Ltd. protocol). The nematodes (Nemaslug®) were added as a suspension by watering at the end of the

day. In 1998 for each treatment per plot of 1.5 m^2 25 l (10 mm) water was used and in 1999 and 2000 15 l water (6 mm). In each trial, the recommended treatment of 300,000 nematodes per m^2 at once was used as a standard in an European project (Glen *et al.*, 2000). Salt is already recommended against fungus diseases, applied twice at 1000 kg / ha. Carvone 500 EC was added as a liquid with a watering can. The reference treatment consisted of metaldehyde formulated as bait pellets at a dose of 500 g a.i., tradename: Metarex 5 % granulates 10 kg / ha(1998) or 448 g a.i. tradename: Luxan slakkenkorrels 6.4 % granulates 7 kg / ha (1999 and 2000) per ha. The bait pellets were applied as a row application at the recommended rate.

Assessment of Damage

Asparagus spears were harvested daily, by cutting the spears at 21 cm length above soil level. The harvested spears were counted and divided in to affected and unaffected spears.

The damage caused by slugs was estimated for each asparagus spear separately and was graded into three classes:
Class I, closed tops, undamaged spears, straight and green with a diameter of 10 mm.
Class II, top a little open heads, undamaged spears and straight and green with a diameter of 10 mm.
Class III, unmarketable product, spears affected by slugs and bend spears with open heads.

Data analysis:
Data were analysed using analysis of variance (ANOVA) in Genstat 5. From the ANOVA means, least significant differences (LSD) and F-probabilities are presented. LSD's are calculated with Student's t distribution

Results

In 1998 at the location Oudkarspel the application of nematodes or metaldehyde pellets did not have a significant effect on the percentage of damaged spears (Table 2). Application of salt (four times 1000 kg or two times 2000 kg per ha) to the soil resulted in higher numbers of harvested spears and a lower percentage of affected spears in comparison to the untreated plots. In contrast, 4000 kg salt applied once in one treatment resulted in fewer spears and a significantly higher percentage of affected spears. The average number of harvested asparagus spears at Oudkarspel was about 20 % of the number of Heerhugowaard, which had an average of 152 spears. This is the consequence of the crop quality.

Metaldehyde pellets do not have any effect in protecting the asparagus spears against slugs. At the location Heerhugowaard, application of once 600,000 nematodes per m^2 or carvone 2 % solution to the soil decrease the number of spears in comparison to the untreated plots. Application of nematodes (twice 300,000/ m^2 or once 600,000 / m^2) to

the soil resulted in a lower percentage of affected spears in comparison to the untreated plots. In contrast, 1% and 2 % carvone applied twice in each treatment resulted in significantly fewer spears and the percentage of effected spears on the same level as the untreated plots.

In 1999, the number of harvested spears were higher and the percentage of affected spears were lower than in 1998. There were no significant differences in numbers of harvested spears up to 11 June (Table 3). All plots treated with nematodes had a significantly lower percentage of asparagus spears damaged by slugs than the untreated plots. This covers the critical period of April – May. There were no significant differences in affected spears between the doses of nematode treatments. Salt applied to the soil (treatment four times 1000 kg/ha) and the combination of salt and nematodes resulted in a lower percentage of affected spears in comparison to the untreated plots. In contrast, application of 500 kg salt gave a similar level of affected spears to the untreated plots. All the treatments had a significant lower percentage of unmarketable asparagus spears than the untreated plots. Nematodes applied three times 100,000 or four times 150,000 / m^2 had a lower percentage of the unmarketable spears than the application with metaldehyde pellets.

In the period 30 April – 9 May 1999, when slug damage was most severe, nematodes applied once at 300,000 / m2 or three times at 100,000 / m2 gave an excellent protection against slug damage (Table 4). Nematodes applied four times at 150,000 / m2 were less effective than the other doses. Application of nematodes and salt showed a significantly lower percentage of affected spears than only the salt applied four times at 500 kg / ha. In the period 20 – 29 May, nematodes applied four times at 150,000 / m2 resulted in a significantly lower numbers of affected spears than the untreated plots. None of the other periods showed any significant differences.

There were no significant differences between the treatments in number of spears harvested in 2000 (Table 5).
Until 6 June, eight weeks after the single treatment (on 11 April) of 300,000 nematodes / m2 , a significant control of slugs was found. Even using three times 50,000 nematodes / m2, plants were less damaged than the untreated plants. However, three times 10,000 nematodes did not show significant crop protection. Treatments with salt showed a decrease in percentage of affected spears and unmarketable spears as well, what means the quality class III only. Four times 1000 kg salt per ha resulted in a lower percentage of affected spears and unmarketable spears in comparison to 500 kg / ha applied four times.

As in 1999, slug damage decreased with time during the harvesting season (Table 6). In the first period, 26 April – 5 May, nematodes applied once at 300,000 / m2 or three times at 100,000 / m2 or three times at 50,000 / m2 gave significant protection against slugs. Nematodes at the dose of 10,000 / m2 applied three times did not sufficiently control slugs in any of the periods. During the first three periods, salt applied four times at 1000 kg / ha decreased the percentage of affected spears compared to salt applied twice at 1000 kg / ha. Metaldehyde pellets strongly decreased the percentage of affected spears especially in the second and third period of harvesting.

Discussion

Wilson et al. (1995a) reported that 300,000 nematodes per m^2 significantly reduced the percentage of lettuce plants damaged by slugs. This corresponds with our results in the green asparagus crop.

Among the treatments, nematodes applied three times at a rate of only 50,000 per m^2 in 2000 or salt at a rate of 1000 kg per ha four times applied proved to be most effective in protecting asparagus spears against slugs. These treatments and nematodes applied once at a rate of 300,000 and three times 100,000 nematodes per m^2 in 1999 and 2000 resulted in the same level of damaged spears as the metaldehyde pellets in the dose of 350 g a.i. per ha, applied four times.

Therefore *Phasmarhabditis hermaphrodita* (Nemaslug®) was shown to be an effective biological molluscicide, that is able to decrease the percentage of asparagus spears damaged by *Deroceras reticulatum*. Slugs usually die 7 to 21 days after infection (Wilson *et al.*, 1993a). Moreover, feeding by *D. reticulatum* is greatly reduced within a few days (Glen *et al.*, 2000 b) and Wilson et al. (1999) showed strong avoidance by slugs to areas of soil treated with *P. hermaphrodita*. They suggested that it may be possible to protect certain crops from slug damage by treating the area immediately around the crop row with a narrow band of nematodes and, thus, reducing numbers of nematodes required for effective control of slug damage. This strategy may be particularly suitable for crops grown in widely spaced rows.

The success of controlling pests with a biological agent such as nematodes often depends the weather conditions in the field. To get maximum efficacy of the biological agent, nematodes as well as salt have been applied more than once. In 1998, the control of slugs with nematodes in doses up to 600,000 per m^2 was insufficient. The lack of effect on slug damage was probably related to soil temperature which, together with soil moisture, is known to affect slug activity (Young and Port, 1989). The nematodes were applied after a dry period and possibly the slugs were not active. The day after the treatments a rainy period started. During this rainy period, the salt got into the soil and the active slugs came into contact with it.

Speiser and Andermatt (1994) reported that 1 million nematodes per m^2 (*P. hermaphrodita*) gave a reduction to slug damage in Tagetes, Chinese cabbage, curly kale, lettuce and kohlrabi. Using the nematodes in combination with salt did not result in decreasing of the slugpopulation. This is in contradiction to use the combination of nematodes with electrical barriers (Glen et al., 2000a). No significant difference between untreated plots and plots treated with metaldehyde pellets were found in 1998, probably because rainfall shortly after treatment rendered the pellets ineffective.

P. hermaphrodita nematodes, applied three times at 50,000 per m^2 as a row application reduced slug damage in asparagus significantly (Table 5).This corresponds with a lower

dose than 300,000 nematodes per m^2 recommended to control slugs in Chinese cabbage (Wilson et al,. 1995b) and recommended on the label for this biocontrol product.

The general use of Nemaslug is restricted by costs of this product. The aim is to reducethe costs. The row application covers 20 % of the soil surface, which is a reduction of 80 % when compared to recommended broadcast application. Row application three times at 50,000 per m^2 results in a reduction of 90% of the recommended dose, whilst protecting the asparagus spears to the same extent as the molluscicide pellets. Nematodes at a lower dose were insufficient (Table 5 and 6). Nemaslug® does not give any reduction in the yield.

In green asparagus as a high value crop especially in the first four weeks of harvesting, *P. hermaphrodita* can be introduced as a new biological agent against slugs (Rozen and Ester, 2000). This nematode resulted in a reduction in the percentage affected asparagus. The rainfall during the autumn and winter was responsible for crusting the soil. Without soil preparation, slugs only found protection under clods in the row, where the soil top layer had been broken. In autumn and winter, hardly any slugs were found, because those slugs cannot migrate into the soil to protect them against low temperatures. Glen et al. (1994) mentioned that, despite the clear effect of nematode application in reducing slug damage, it had little or no impact on the slug population over a period of 27 weeks.

The effect of carvone 500EC in a dose of 2 % solution was insufficient on protecting the asparagus spears against slugs. This product shows a decrease in number of spears as well. The percentage of the unmarketable asparagus spears are often differ from the percentage of affected spears, because the effected spears get a decrease in the quality class but has still a value at the action.

Salt applied four times 1000 kg or twice 2000 kg resulted in a higher number of asparagus shoots than the untreated plots. Francois (1987) and Poll (1999) found that yields increased by adding salt (NaCl) to asparagus. This concurs with our results. Elmer (1992) reported that sodium chloride suppresses *Fusarium* crown and root rot through a fungistatic effect and/ or through manipulation of host resistance. However, the long terms effect of frequently use of salt have to be considered.

Acknowledgements

This study has been carried out with financial support from the Commission of the European Communities, Agriculture and Fisheries (FAIR) specific RTD programme, CT97-3355 “Novel technologies for integrated control of slug damage in key horticultural crops”. We thank Becker Underwood Ltd, for the nematode packages (Nemaslug®).

Literature Cited

Dorsman, S. and C.Waite. 1951. De inundatie gedurende 1944 – 1945 en hun gevolgen voor de landbouw. Ministerie van Landbouw, p. 31.

Elmer, W.H. 1992. Suppression of Fusarium Crown and Root Rot of Asparagus with Sodium Chloride. *Phytopathology* 82: 97 – 104.

Ester, A., A. Darwinkel, H.W.G. Floot and J.H. Nijënstein. 1996. Control of Field slugs (*Deroceras reticulatum*) in winter wheat using seeds treated with pesticides. In: *Slug & Snail Pests in Agriculture, BCPC Symposium Proceedings* 66, pp.165-172.

Ester, A. and P.M.T.M. Geelen. 1996. Integrated control of slugs in a sugar beet crop growing in a rye cover crop. In: *Slug and Snail Pests in Agriculture, BCPC Symposium Proceedings* 66, pp. 445-450 (ed. by I. F. Henderson)

Ester, A. and J.H. Nijënstein. 1995. Control of the field slug *Deroceras reticulatum* (Müller)(*Pulmonata: Limacidae*) by pesticides applied to winter wheat seed. Crop Protection 14: 409-413.

Ester, A. and R. Trul. 2000. Slug damage and control of field slug (*Deroceras reticulatum* (Müller)) by carvone in stored potatoes. Potato Research 43: 253-261

Francois, L.E. 1987. Salinity effects on asparagus yield and vegetative growth. J. Amer. Soc. Hort. Sci. 112: 432–436.

Glen, D. M., N.F.Milson and C.W. Wiltshire. 1989. Effects of seed – bed conditions on slug numbers and damage to winter wheat in a clay soil. Annals of Applied Biology 115: 177 – 190.

Glen, D.M., M.J. Wilson, J.D. Pearce and P.B. Rodgers. 1994. Discovery and investigation of a novel nematode parasite for biological control of slugs. In: *Brighton Crop Protection Conference, Pests and Diseases,* p.617 – 624.

Glen, D.M., M.J. Wilson, L. Hughes, P. Cargeeg and A. Hajjar. 1996. Exploring and exploiting the potential of the rhabditis Nematode *Phasmarhabditis hermaphrodita* as a biocontrol agent for slugs. In: *Slug & Snail Pests in Agriculture*. I.F. Henderson (ed.). *BCPC Monograph No 66:* 271 – 280.

Glen, D. M., C.W. Wiltshire, L. Hughes, A. Ester, K. van Rozen, J. Castillejo, J. Iglesias, B. Speiser, J. Coupland and R. Gwynn. 2000a. The use of slug- parasitic nematodes and other techniques for control of slug and snail damage in horticultural crops. In: The BCPC Conference – Pests and Diseases – 2000. pp. 345-350.

Glen, D.M., M.J. Wilson, P. Brain and G. Stroud. 2000b. Feeding activity and survivel of slugs, *Deroceras reticulatum*, exposed to the rhabditid nematode *Phasmarhabditis hermaphrodita*: a model of dose response. *Biological Control* 17: 73-81

Hass, B., L.A. Hughes and D.M.Glen. 1999. Overall Versus Band Application of the Nematode *Phasmarhabditis hermaphrodita* With and Without Incorporation into Soil, for Biological Control of Slugs in Winter Wheat. Biocontrol Science and Technology, 9: 579-586.

Huiting, H. and A. Ester. 2001. Slakken moeilijk uit spruiten te houden. Groenten & Fruit 30: 34-35.

Moens, R. 1980. Het slakkenprobleem in de plantenbescherming. *Landbouwtijdschrift,* 33: 113 – 128

Poll, J.T.K. 1999. Roest bestrijden met zout. In: *PAV – Bulletin Vollegrondsgroenteteelt*. 20– 22.

Poll, J.T. 2000. Keukenzout helpt asperge tegen Fusarium. Groenten en Fruit/Vollegrondsgroenten, 17: 15.
Rozen van, K. and A. Ester. 2000. Aaltjes lusten naaktslakken rauw. Groenten en Fruit/Vollegrondsgroenten, 45: 4-5.
Speiser, B. and M. Andermatt. 1994. Biokontrolle von Schnecken mit Nematoden. Agrarforschung. 1: 115 – 118.
Wilson, M.J., D.M. Glen and S.K. George. 1993a. The Rhabditid Nematode *Phasmarhabditis hermaphrodita* as a Potential Biological Control Agent for slugs. *Biocontrol Science and Technology*. 3: 503 – 511.
Wilson, M.J., S.K. George, D.M. Glen, J.D. Pearce and P.B. Rodgers. 1993b. Biological control of slug and snail pests with a novel parasitic nematode. A.N.P.P. Third International Conference on Pests in Agriculture, Montpellier, 1, pp. 425 – 432.
Wilson, M.J., D.M. Glen, S.K. George, J.D. Pearce and C.W. Wiltshire. 1994a. Biological control of slugs in winter wheat using the rhabditid nematode *Phasmarhabditis hermaphrodita*. *Annals of Applied Biology*. 125: 377 – 390.
Wilson, M. J., D.M. Glen, C.W. Wiltshire and S.K. George.1994b. Mini-plot Field Experiments Using the Rhabditid Nematode Phasmarhabditis Hermaphrodita for Biocontrol of Slugs. Biocontrol Science and Technology, 4: 103-113.
Wilson, M. J., D.M. Glen, S.K. George and L.A. Hughes. 1995a. Biocontrol of Slugs in Protected Lettuce Using the Rhabditid Nematode *Phasmarhabditis hermaphrodita*. *Biocontrol Science Technology*, 5: 233- 242.
Wilson, M.J., L.A.Hughes and D.M. Glen. 1995b. Developing strategies for the nematode, *Phasmarhabditis hermaphrodita,* as a biological control agent for slugs in integrated crop management systems. In: *Integrated Crop Protection: Towards sustainability?* R.G. McKinlay & D. Atkinson (eds.). *BCPC Monograph No. 63:* 33 – 40.
Wilson, M.J., L.A.Hughes, D. Jefferies and D.M. Glen. 1999. Slugs (*Deroceras reticulatum and Arion ater* agg.) Avoid Soil Treated with the Rhabditis Nematode *Phasmarhabditis hermaphrodita*. *Biological Control,* 16: 170 – 176.
Young, A.G. and G.R. Port. 1989. The effect of micro-climate on slug activity in the field. In: Slugs and Snails in World Agriculture (Henderson, I.F.,ed) BCPC Monograph No. 41.British Crop Protection Council, Thornton Heath, UK. Pp 263 – 270.

Table 1. Nematode rates per m^2, salt in kg per ha, carvone in % and metaldehyde (g / ha) in green asparagus to control slugs.

Treatment	No. of applications	1998	1999	2000
Nematode	3	-	-	10,000
	3	-	-	50,000
	3	-	100,000	100,000
	4	-	150,000	-
	1	300,000	300,000	300,000
	2	300,000	-	-
	1	600,000	-	-
Salt	4	-	500	500
	2	-	-	1,000
	4	1,000	1,000	1,000
	2	2,000	-	2,000
	1	4,000	-	-
Carvone 500 EC	2	0.5 %	-	-
	2	1.0 %	-	-
	2	2.0 %	-	-
Nematode + Salt	4 (2N+2S)	-	150,000(N) + 500 (S)	-
Metaldehyde 6.4%	4	-	448 g a.i. / ha	448 g a.i. / ha
Metaldehyde 5 %	3	500 g a.i. / ha	-	-
Untreated	-	0	0	0
Treatment dates		30 March 8,15,22 April	9,15,22,29 April	11,18,25 April 2 May
Assessment dates		1-29 May	30 April-11 June	26 April-6 June

- = not used

Table 2. Number of harvested spears per m² and percentage spears affected by slug damage up to 29 May, at two locations 1998.

Treatment	Dose	No. of applications	No. of spears		Perc. affected spears	
			Oudkarspel	Heerhugowaard	Oudkarspel	Heerhugowaard
Nematodes	300,000 / m²	1	24 a	143 ab	26 ab	5.9
	300,000 / m²	2	25 a	141 ab	23 abc	3.5
	600,000 / m²	1	20 a	136 a	21 abc	4.3
Salt	1,000 kg / ha	4	37 b	-	18 bc	-
	2,000 kg / ha	2	39 b	-	13 c	-
	4,000 kg / ha	1	25 a	-	29 a	-
Carvone 500 EC	0.5 %	2	-	169 bc	-	5.8
	1.0 %	2	-	146 abc	-	6.6
	2.0 %	2	-	132 a	-	7.7
Metaldehyde	500 g a.i. / ha	3	21 a	175 c	25 ab	4.9
Untreated	0	0	19 a	173 bc	28 ab	8.9
LSD (_ = 0,05)			8.9	31.2	10.0	4.2
F-prob.			< 0.001	0.034	0.042	0.211

*Means followed by the same letter do not differ significantly (_ < 0.05).

Table 3. Number of harvested spears per m² and percentage of spears affected by slug damage and unmarketable spears up to 11 June, at Oudkarspel, 1999.

Treatment	Dose	No. of applications	No. of spears	Perc. affected spears Unmarkatable	
Nematodes	100,000 / m²	3	37	5.1 c	2.0 c
	150,000 / m²	4	40	5.7 c	2.0 bc
	300,000 / m²	1	42	6.1 c	2.5 bc
Salt	500 kg / ha	4	45	12.6 ab	4.8 bc
	1,000 kg / ha	4	48	6.2 c	3.0 bc
Nematodes + salt	150,000 / m² + 500 kg	4	43	8.1 bc	3.6 bc
Metaldehyde	350 g a.i. / ha	4	42	8.0 bc	5.5 b
Untreated	0	-	45	14.0 a	9.1 a
LSD (_ = 0,05)			9.8	5.0	3.4
F-prob.			0.421	0.006	0.005

Table 4. Percentage spears affected by slug damage in four harvest periods, at Oudkarspel, 1999.

Treatment	Dose	No.	Percentage affected spears			
			30/4-9/5	10/5-19/5	20/5-29/5	30/5-11/6
Nematodes	100,000 / m²	3	8.8 d	3.8	5.1 ab	1.0 b
	150,000 / m²	4	25.8 b	9.1	2.2 b	0.6 b
	300,000 / m²	1	7.5 d	7.5	3.5 ab	1.8 ab
Salt	500 kg / ha	4	24.9 bc	14.6	6.4 ab	3.8 a
	1,000 kg / ha	4	12.5 cd	3.9	4.3 ab	2.0 ab
Nematodes + salt	150,000 / m2 + 500 kg	4	11.6 d	16.9	7.1 ab	1.0 b
Metaldehyde	350 g a.i. / ha	4	5.8 d	10.8	6.1 ab	1.8 ab
Untreated	0	-	49.4 a	9.8	8.3 a	3.0 ab
LSD (= 0.05)			12.99	13.47	5.81	2.49
F-prob.			< 0.001	0.459	0.456	0.183

Table 5. Number of harvested spears per m², percentage of spears affected by slug damage and percentage of unmarketable spears up to 6 June, at Oudkarspel, 2000.

Treatment	Dose	No.	Number of spears	Perc. affected spears	Perc. unmarketable spears
Nematodes	10,000 / m²	3	40	41.0 cd	26.7 a
	50,000 / m²	3	46	15.6 a	7.5 e
	100,000 / m²	3	42	14.6 a	8.6 cde
	300,000 / m²	1	42	13.7 a	6.9 e
Salt	500 kg / ha	4	42	27.3 b	14.9 bcd
	1,000 kg / ha	4	47	12.8 a	5.6 e
	1,000 kg / ha	2	38	34.1 bc	18.5 b
	2,000 kg / ha	2	52	29.7 b	15.3 bc
Metaldehyde	350 g a.i. / ha	4	47	8.4 a	4.8 e
Untreated	0	-	36	44.9 d	26.5 a
LSD (_ = 0,05)			17.7	10.3	7.2
F-prob.			0.786	< 0.001	< 0.001

Table 6. Percentage spears affected by slug damage in four harvesting periods, at Oudkarspel, 2000.

Treatment	Dose	No.	Percentage affected spears			
			26/4-5/5	6/5-15/5	16/5-25/5	26/5-6/6
Nematodes	10,000 / m^2	3	79.3 a	42.5 ab	22.8 ab	6.5 bc
	50,000 / m^2	3	28.6 bcd	16.3 de	11.3 abcd	5.2 bc
	100,000 / m^2	3	19.5 d	15.8 de	8.9 bcd	5.0 c
	300,000 / m^2	1	16.3 d	14.3 de	7.9 cd	15.0 abc
Salt	500 kg / ha	4	59.0 abc	27.2 cd	11.7 abcd	21.9 a
	1,000 kg / ha	4	20.4 cd	12.8 e	7.9 cd	6.5 bc
	1,000 kg / ha	2	65.5 ab	38.2 abc	22.9 ab	6.5 bc
	2,000 kg / ha	2	46.2 abcd	31.9 bc	20.0 abc	19.8 ab
Metaldehyde	350 g a.i. / ha	4	29.5 bcd	6.5 e	1.1 d	5.0 c
Untreated	0	-	76.0 a	47.1 a	25.9 a	11.4 abc
LSD (α = 0.05)			38.7	13.0	14.7	14.7
F-prob.			0.005	< 0.001	0.021	0.157

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(36 pages)

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Proceeding of the Tenth International Asparagus Symposium
"ISI Web of Knowledge" search engine (www.isiwebofknowledge.com)
Ingenta search engine. (www.ingenta.com)
Many of the publications form the **Ingenta** search engine contain the paper's **Abstracts**.

"Proceedings of the Tenth International Asparagus Symposium" Niigata City, Japan, Aug.30 – Sept. 2, 2001

2002. "Proceedings of the Tenth International Asparagus Symposium", 2002. Ed. Atsuko Uragami. Acta Hort. 589: 392 pp.

Agronomy and Production Systems

Chen, G. 2002. **Production and Development of Asparagus in China**. Acta Hort. 589:21-28.

Nichols, M.A. 2002. **Year-Round Asparagus Production.** Acta Hort. 589:29-32.

Benson, B.L. 2002. **Update of the WORLD'S Asparagus Production Areas, Spear Utilization and Production Periods.** Acta Hort. 589:33-40.

Sato, T. and S Motoki. 2002. **Past and Present Japanese Asparagus Production and Marketing.** Acta Hort. 589:41-50.

Production System and Cultivar Evaluation

Wilson, D. R., C.G. Cloughley and S.M. Sinton. 2002. ***AspireNZ*: A Decision Support System for Managing Root Carbohydrate in Asparagus.** Acta Hort. 589:51-58.

Onggo, T. M. 2002. **Influence of Harvest Method and Schedule on Yield and Spear Size of Green Asparagus in Indonesia.** Acta Hort. 589:59-64.

Paschold, P.-J., B. Artelt and G. Hermann. 2002. **Influence of Harvest Duration on Yield and Quality of Asparagus.** Acta Hort. 589:65-72.

Knaflewski, M. and W. Krzesiski. 2002. **Results of Investigations on Timing Asparagus Production in a Temperate Climate.** Acta Hort. 589: 73-80.

Mullen, R.J. , R.S. Whiteley, T.C. Viss, M.L. Goff and C.A. Cancilla. 2002. **Asparagus Cultivar Evaluation Trials in the Sacramento-San Joaquin Delta Region of California.** Acta Hort. 589: 81--90.

Kohmura, H. 2002. **Asparagus Cultivation in Japan, Focusing on Hiroshima.** Acta Hort. 589: 91-96.

Araki, H. 2002. **Asparagus Production in Drained Paddy with Development of Reduced Layer.** Acta Hort. 589: 97-102.

Stone, N.K. and M.L. Roose. 2002. **Effective Field Evaluation of Asparagus Hybrids Using Reduced Data Collection.** Acta Hort. 589: 103-110.

Nichols, M.A., A.J.R. Godfrey, G.R. Wood, C.G. Qiao and S. Ganesalingam. 2002. **An Improved Imputation Method for Incomplete GxE Trial Data for Asparagus.** Acta Hort. 589: 111-116.

González, M.I. and A. del Pozo. 2002. **Asparagus Cultivar Trials in Bio Bio (VIII) Region of Chile.** Acta Hort. 589: 117-122.

González, M.I. and A. del Pozo. 2002. **Influence of Planting Depth and Plant Population on Yield and Quality of Green Asparagus.** Acta Hort. 589: 123-128.

Matsubara, Y., E. Suzumura and H. Fukui. 2002. **Plug Seedling Growth as Affected by AM Fungus Symbiosis in Asparagus.** Acta Hort. 589:129-132.

Maeda,T., M. Kumagai, N. Inoue, A. Uragami and K. Ito, 2002. **Effective Method for Seed Production of All-male Asparagus Hybrids in a Greenhouse.** Acta Hort. 589: 133- 138.

Krarup, A. and C. Krarup. 2002. **Liming of an Acid Soil and Growth of Asparagus Crowns.** Acta Hort. 589: 139-144.

Krarup, C., A. Krarup and R. Pertierra. 2002. **Growth of Asparagus with Increasing Nitrogen Rates at Three Different Sites.** Acta Hort. 589: 145-150.

Pedreros, A. and M.I. González. 2002. **Herbicide Effects under Sprinkler Line on Production and Quality of Asparagus Crown.** Acta Hort. 589: 151-154.

Pedreros, A., M.I. González and C. Guadamud. 2002. **Weed Control During Asparagus Establishment Year in a Volcanic Soil of Chile**. Acta Hort. 589: 155-158.

Benson, B.L. 2002. **Second International Asparagus Cultivar Trial Final Report.** Acta Hort. 589: 159-166.

Drost, D. 2002. **Asparagus Cultivar Trials in Utah**. Acta Hort. 589:167-172.

Ye, J. 2002. **Primary Report of the Second International Asparagus Varieties Estimate Trials.** Acta Hort. 589: 173-180.

Genetics and Breeding

Ozaki, Y. 2002. **Intra- and Inter-Ploid Cross Compatibility and Trisomic Production in Asparagus (*Asparagus officinalis* L.).** Acta Hort. 589: 181-184.

Falloon, P.G., L.M. Falloon and A.M. Andersen. 2002. **Breeding Asparagus Varieties Resistant to *Phytophthora.*** Acta Hort. 589: 185-192.

González Castañón, M.L. and M.B. Schroeder. 2002. **Rapid Determination of Nuclear DNA Amounts and Ploidy Levels in Germplasms of Asparagus Using Flow Cytometry.** Acta Hort. 589: 193-200.

Falavigna, A. and P.E. Casali. 2002. **Practical Aspects of a Breeding Program of Asparagus Based on in Vitro Anther Culture.** Acta Hort. 589: 201-210.

González Castañón, M.L. 2002. **Asparagus Anther Culture. Influence of Genotype and Growth Environment Conditions of the Donor Plants on the Androgenetic Response.** Acta Hort. 589: 211-216.

Uno, Y., Y. Ii, M. Kanechi and N. Inagaki. 2002. **Haploid Production from Polyembryonic Seeds of *Asparagus officinalis* L.**. Acta Hort. 589: 217-224.

Ochiai,T., A. Kanno, T. Kameya and T. Sonoda. 2002. **Interspecific Hybrids Between *Asparagus schoberioides* Kunth and *A. officinalis* L.**. Acta Hort. 589: 225-232.

Physiology and Biochemistry

Chin, C. K., S.A. Garrison, C.T. Ho, M.T. Huang, Y. Shao, M. Wang and J. Simon. 2002. **Functional Elements from Asparagus for Human Health.** Acta Hort. 589: 233-242.

Woolley, D.J., Karno and M.A. Nichols. 2002. **Effects of Daylength on Dry Matter Partitioning in Asparagus.** Acta Hort. 589: 243-248.

Bhowmik, P.K., T. Matsui, H. Suzuki, Y. Kosugi, F.G. Enriquez, A. Alam and K.M.Shameem. 2002. **Changes in the Amount of Sugars and in the Activities of Acid invertase, Sucrose Synthase and Sucrose Phosphate Synthase in Asparagus Storage Roots on Sprouting.** Acta Hort. 589: 249-256.

Sun,R., Y. Wang, C.-K. Chin and S.A. Garrison. 2002. **Volatile Compounds in *Asparagus officinalis* L.**. Acta Hort. 589: 257-266.

Kanno, A., J.-H. Park, P.-Y. Yun, H.-M. Choi, R. Yoshida and T. Kameya. 2002. **Isolation and Characterization of Floral Organ Identity Genes from *Asparagus officinalis* L.**. Acta Hort. 589: 267-273.

Karno and D.J. Woolley. 2002. **Studies on Remobilization of Fructans from Asparagus Roots during Harvest using Carbon-14 and High Performance Liquid Chromatography.** Acta Hort. 589: 274-280.

Ulrich, D. and E. Hoberg. 2002. **Flavor Analysis in Asparagus Breeding**. Acta Hort. 589: 281-286.

Drost, D. and D. Wilson. 2002. **Estimating Root Length Density and Biomass in Asparagus.** Acta Hort. 589: 287-296.

Wilson, D.R., C.G. Cloughley, P.D. Jamieson and S.M. Sinton. 2002. **A Model of Asparagus Growth Physiology.** Acta Hort. 589: 297-302.

Duangpaeng, A., N. Okuda, H. Suzuki and Y. Fujime. 20002. **Initiation Pattern and Morphological Structures of Asparagus Buds.** Acta Hort. 589: 303-310.

Abe, T., H. Seto and S. Yoshida. 2002. **Effects of Gibberellins on Chemical-Induced Flowering of Asparagus Seedlings.** Acta Hort. 589: 311-314.

Akiyama, M., T. Suzuki, K. Oosawa, I. Maezaki and N. Shiomi. 2002. **Changes in Sugar Level and Related Enzyme Activity of Arbuscular Mycorrhizal Asparagus.** Acta Hort. 589: 315-322.

Suzuki, T., W. Yamamoto, M. Akiyama, N. Kasai and K. Oosawa. 2002. **Reduced Level of Sugars Associated With Destruction of Chloroplasts in Senescent Cladophyll Cells of Asparagus.** Acta Hort. 589: 323-328.

Kakuta, H., T. Maeda, M. Akiyama, R. Hashimoto and Y. Horikawa . 2002 **Transient Gene Expression in Maize and Asparagus Pollen Using Magnetic Particles by Particle Gun.** Acta Hort. 589: 329-334.

Kojima, K. 2002. **Distribution of ABA and IAA in asparagus**. Acta Hort. 589: 335-340.

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Postharvest and Pathology

Lill, R.E. 2002. **Asparagus: life after harvest.** Acta Hort. 589: 349- 352.

Casas , A. and E. Nuñez. 2002. **Mineral composition of asparagus green spears and their relation to their post harvest life.** Acta Hort. 589: 353-356.

Roose M.L., N.K. Stone, D.M. Mathews and J.A. Dodds. 2002. **RT-PCR Detection of Asparagus 2 *Ilarvirus.*** Acta Hort. 589: 357-364.

Davis, R. D. 2002. **Management of Three Newly Recorded Asparagus Diseases in Queensland Will Require Adoption of New Production Strategies.** Acta Hort. 589: 365-372.

Benson, B. L. 2002. **Effect of Autotoxicity on the Growth of Cloned Asparagus Plants.** Acta Hort. 589: 373-376.

Uragami, A., Y. Urashima and M. Morishita. 2002. **Effect of Cultivation of *Asparagus* species on the Survival of Soybean Cyst Nematode (*Heterodera glycines* Ichinohe).** Acta Hort. 589: 377-380.

Motoki, S., T. Ozawa, K. Komatsu and M. Tsukada. 2002. **Allelopathy in Asparagus 1: Reduction of the Allelopathic Effect on Asparagus by the Flowable Agent of Activated Carbon.** Acta Hort. 589: 381-386.

Sonoda, T., A. Uragami and K. Tairako. 2002. **Comparative evaluation of resistance of *Asparagus officinalis* L. Cultivars and Breeding lines to Fusarium Stem and Crown Rot.** Acta Hort. 589: 387-386.

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Yasunaga E, Uchino T, Hu WZ, et al.
Re-examination about the temperature dependence of respiration rate of some vegetables
J FAC AGR KYUSHU U 46 (2): 391-399 FEB 2002

Elmer WH
Influence of formononetin and NaCl on mycorrhizal colonization and fusarium crown and root rot of asparagus
PLANT DIS 86 (12): 1318-1324 DEC 2002

Vujanovic V, Hamel C, Jabaji-Hare S, et al.
Development of a selective myclobutanil agar (MBA) medium for the isolation of Fusarium species from asparagus fields
CAN J MICROBIOL 48 (9): 841-847 SEP 2002

Diaz-Perales A, Tabar AI, Sanchez-Monge R, et al.
Characterization of asparagus allergens: A relevant role of lipid transfer proteins
J ALLERGY CLIN IMMUN 110 (5): 790-796 NOV 2002

Warncke DD, Reid TC, Hausbeck MK
Sodium chloride and lime effects on soil cations and elemental composition of asparagus fern
COMMUN SOIL SCI PLAN 33 (15-18): 3075-3084 2002

Bhowmik PK, Matsui T, Ikeuchi T, et al.
Changes in storage quality and shelf life of green asparagus over an extended harvest season
POSTHARVEST BIOL TEC 26 (3): 323-328 NOV 2002

Perez D, Sanchez MT, Cano G, et al.
Prediction of texture in green asparagus by near infrared spectroscopy (NIRS)
J FOOD QUALITY 25 (4): 277-287 OCT 2002

Bornet FRJ, Brouns F, Tashiro Y, et al.
Nutritional aspects of short-chain fructooligosaccharides: natural occurrence, chemistry, physiology and health implications
DIGEST LIVER DIS 34: S111-S120 Suppl. 2 SEP 2002

Eason JR, Pinkney TT, Johnston JW
DNA fragmentation and nuclear degradation during harvest-induced senescence of asparagus spears
POSTHARVEST BIOL TEC 26 (2): 231-235 SEP 2002

Coupe SA, Sinclair BK, Somerfield SD, et al.
Controlled atmospheres and sugar can delay malate synthase gene expression during asparagus senescence
FUNCT PLANT BIOL 29 (9): 1045-1053 2002

Stajner N, Bohanec B, Jakse M
In vitro propagation of Asparagus maritimus - A rare Mediterranean salt-resistant species
PLANT CELL TISS ORG 70 (3): 269-274 SEP 2002

Yamamori A, Fukushi E, Onodera S, et al.
NMR analysis of mono- and difructosyllactosucrose synthesized by 1(F)-fructosyltransferase purified from roots of asparagus (Asparagus officinalis L.)
MAGN RESON CHEM 40 (8): 541-544 AUG 2002

Feng J, Chen DF, Sun QZ, et al.
Asparosides A and B, two new steroidal saponins from Asparagus meioclados
J ASIAN NAT PROD RES 4 (3): 221-226 SEP 2002

Stajner N, Bohanec B, Javornik B
Genetic variability of economically important Asparagus species as revealed by genome size analysis and rDNA its polymorphisms
PLANT SCI 162 (6): 931-937 JUN 2002

Yamamori A, Onodera S, Kikuchi M, et al.
Two novel oligosaccharides formed by 1(F)-fructosyltransferase purified from roots of asparagus (Asparagus officinalis L.)
BIOSCI BIOTECH BIOCH 66 (6): 1419-1422 JUN 2002

Bussell WT, Robinson C, Bright JD, et al.
Asparagus in tropical Australia - the first fifteen years
AUST J AGR RES 53 (7): 729-736 2002

Guo JM, Jermyn WA, Turnbull MH
Carbon assimilation, partitioning and export in mature cladophylls of two asparagus (Asparagus officinalis) cultivars with contrasting yield
PHYSIOL PLANTARUM 115 (3): 362-369 JUL 2002

Mamiya K, Sakamoto Y
Nitrilo triacetate increases the rate of single somatic embryos in Asparagus officinalis
J PLANT PHYSIOL 159 (5): 553-556 MAY 2002

Guvenc A, Koyuncu M
Studies on the anatomical structure of cladodes of Asparagus L. species (Liliaceae) in Turkey

ISRAEL J PLANT SCI 50 (1): 51-65 2002

Matsubara Y, Hasegawa N, Fukui H
Incidence of Fusarium root rot in asparagus seedlings infected with arbuscular mycorrhizal fungus as affected by several soil amendments
J JPN SOC HORTIC SCI 71 (3): 370-374 MAY 2002

Rodriguez-Arcos RC, Smith AC, Waldron KW
Effect of storage on wall-bound phenolics in green asparagus
J AGR FOOD CHEM 50 (11): 3197-3203 MAY 22 2002

Jitsuyama Y, Suzuki T, Harada T, et al.
Sucrose incubation increases freezing tolerance of asparagus (Asparagus officinalis L.) embryogenic cell suspensions
CRYOLETTERS 23 (2): 103-112 MAR-APR 2002

Suzuki S, Nakatsubo T, Umezawa T, et al.
First in vitro norlignan formation with Asparagus officinalis enzyme preparation
CHEM COMMUN (10): 1088-1089 2002

Seefelder W, Gossmann M, Humpf HU
Analysis of fumonisin B-1 in Fusarium proliferatum-infected asparagus spears and garlic bulbs from Germany by liquid chromatography - Electrospray ionization mass spectrometry
J AGR FOOD CHEM 50 (10): 2778-2781 MAY 8 2002

He CY, Hsiang T, Wolyn DJ
Induction of systemic disease resistance and pathogen defence responses in Asparagus officinalis inoculated with nonpathogenic strains of Fusarium oxysporum
PLANT PATHOL 51 (2): 225-230 APR 2002

Reid TC, Hausbeck MK, Kizilkaya K
Use of Fungicides and biological controls in the suppression of fusarium crown and root rot of asparagus under greenhouse and growth chamber conditions
PLANT DIS 86 (5): 493-498 MAY 2002

Agnelli ME, Mascheroni RH
Quality evaluation of foodstuffs frozen in a cryomechanical freezer
J FOOD ENG 52 (3): 257-263 MAY 2002

Guo JM, Jermyn WA, Turnbull MH
Carbon partitioning and sucrose metabolism in two field-grown asparagus (Asparagus officinalis) cultivars with contrasting yield
FUNCT PLANT BIOL 29 (4): 517-526 2002

Jumberi A, Oka M, Fujiyama H
Response of vegetable crops to salinity and sodicity in relation to ionic balance and ability to absorb microelements
SOIL SCI PLANT NUTR 48 (2): 203-209 APR 2002

van Epenhuijsen CW, Carpenter A, Butler R
Controlled atmospheres for the post-harvest control of Myzus persicae (Sulzer) (Homoptera :Aphididae): effects of carbon dioxide □concentration
J STORED PROD RES 38 (3): 281-291 2002

McKirdy SJ, Murphy P, Mackie AE, et al.
Survey of asparagus in Western Australia for rust and stem blight
AUSTRALAS PLANT PATH 31 (1): 97-98 2002

Lau MH, Tang J
Pasteurization of pickled asparagus using 915 MHz microwaves
J FOOD ENG 51 (4): 283-290 MAR 2002

Tabar A, Diaz-Perales A, Garcia BE, et al.
Lipid-transfer proteins (LTPs) and asparagus allergy
J ALLERGY CLIN IMMUN 109 (1): 949 Suppl. S JAN 2002

Guo JM, Jermyn WA, Turnbull MH
Diurnal and seasonal photosynthesis in two asparagus cultivars with contrasting yield
CROP SCI 42 (2): 399-405 MAR-APR 2002

Gapper NE, Norris GE, Clarke SE, et al.
Novel jasmonate amino acid conjugates in Asparagus officinalis during harvest-induced and natural foliar senescence
PHYSIOL PLANTARUM 114 (1): 116-124 JAN 2002

Mukhopadhyay S, Overney S, Yelle S, et al.
Regeneration of transgenic plants from electroporated protoplasts of Asparagus officinalis L
J PLANT BIOCHEM BIOT 11 (1): 57-60 JAN 2002

Morales-Blancas EF, Chandia VE, Cisneros-Zevallos L
Thermal inactivation kinetics of peroxidase and lipoxygenase from broccoli, green asparagus and carrots
J FOOD SCI 67 (1): 146-154 JAN-FEB 2002

Rodriguez-Arcos RC, Smith AC, Waldron KW
Mechanical properties of green asparagus
J SCI FOOD AGR 82 (3): 293-300 FEB 2002

Garrido A, Sanchez MT, Cano G, et al.

Prediction of neutral and acid detergent fiber content of green asparagus stored under refrigeration and modified atmosphere conditions by near-infrared reflectance spectroscopy
J FOOD QUALITY 24 (6): 539-550 DEC 2001

Williams HA, Bewley JD, Greenwood JS, et al.
The storage cell walls in the endosperm of Asparagus officinalis L. seeds during development and following germination
SEED SCI RES 11 (4): 305-315 DEC 2001

Witt ABR, Edwards PB
Aspects of the biology, distribution, and host range of Crioceris sp (Col.: Chrysomelidae : Criocerinae), a potential biological control agent for Asparagus asparagoides in Australia
BIOL CONTROL 23 (1): 56-63 JAN 2002

Extracted Papers from the "Ingenta" search engine at www.ingenta.com

1. Changes in storage quality and shelf life of green asparagus over an extended harvest season
Bhowmik P.K.; Matsui T.; Ikeuchi T.; Suzuki H.
Postharvest Biology and Technology, November 2002, vol. 26, no. 3, pp. 323-328(6)
Elsevier Science

2. DNA fragmentation and nuclear degradation during harvest-induced senescence of asparagus spears
Eason J.R.; Pinkney T.T.; Johnston J.W.
Postharvest Biology and Technology, 1 September 2002, vol. 26, no. 2, pp. 231-235(5)
Elsevier Science

3. Carbon partitioning and sucrose metabolism in two field-grown asparagus (Asparagus officinalis) cultivars with contrasting yield
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Functional Plant Biology, 19 April 2002, vol. 29, no. 4, pp. 517-526(10)
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Guo J.[1]; Jermyn W.A.[2]; Turnbull M.H.[3]
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[1] Department of Plant and Microbial Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand. [2] New Zealand Institute for Crop and Food Research, PO Box 4704, Christchurch, New Zealand. [3] Department of Plant and Microbial Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand. Corresponding author; m.turnbull@botn.canterbury.ac.nz
☐
Abstract:

The aim of this study was to investigate the roles of carbon partitioning and sucrose metabolism in regulating cultivar differences in spear yield in asparagus (*Asparagus officinalis* L.). In the two

cultivars studied, maximum net photosynthetic rate (*A*max) was positively correlated with sucrose phosphate synthase (SPS) activity (r^2=0.86), which was in turn linked to increases in sucrose content in cladophyll tissue. The high-yielding cultivar ASP-69 exhibited greater SPS activity and sucrose content than the low-yielding cultivar ASP-03, in fully-expanded and mature cladophyll tissue. ASP-69 also displayed a higher percentage of soluble solids in stem cell sap than did ASP-03. Sucrose synthase (SS) activity in storage roots in ASP-69 was significantly greater than in ASP-03 during fern growth season. Total non-structural carbohydrate (TNC) in storage roots did not differ in the two cultivars. Biomass analysis revealed that ASP-69 had a greater root/shoot ratio than ASP-03, suggesting that the total carbohydrate storage pool, rather than carbohydrate concentration, is an important determinant of asparagus yield. The overall results substantiate the conclusion that carbohydrate partitioning in the two asparagus cultivars studied is a property of the entire plant, and is influenced by both source and sink properties. This is highlighted by greater *A*max, SPS activity and sucrose concentrations in cladophyll tissue in ASP-69, and greater SS activity and total carbohydrate content in storage root tissue in ASP-69.

Keywords: acid invertase; Asparagus officinalis; carbon partitioning; sucrose metabolism; sucrose phosphate synthase; sucrose synthase

4. Controlled atmospheres and sugar can delay malate synthase gene expression during asparagus senescence

Functional Plant Biology, 20 July 2002, vol. 29, no. 9, pp. 1045-1053(9)

Coupe S.A.[1]; Sinclair B.K.[2]; Somerfield S.D.[2]; Hurst P.L.[2]

[1] New Zealand Institute for Crop and Food Research Ltd, Private Bag 11 600, Palmerston North, New Zealand. Current address: Department of Animal and Plant Sciences, University of Sheffield, Sheffield S10 2TN, UK. Corresponding author;, Email: s.cou [2] New Zealand Institute for Crop and Food Research Ltd, Private Bag 11 600, Palmerston North, New Zealand.

Abstract:

A cDNA clone encoding malate synthase (MS; EC 4.1.3.2) was isolated from a 48-h postharvest asparagus (*Asparagus officinalis* L.) spear cDNA library using a MS clone from *Brassica napus*. The asparagus MS (*AoMS1*) cDNA hybridized to a 1.9-kb transcript that increased in abundance preferentially in spear-tip tissue during postharvest storage. The *AoMS1* transcript also accumulated during natural foliar senescence of asparagus fern. The cDNA consists of 1960 nucleotides with an open reading frame of 1665 nucleotides or 555 amino acids, and encodes a deduced protein with a predicted *M*r of 63 kDa and a pI of 8.1. The deduced amino acid sequence of AoMS1 showed high identity with the *B. napus* MS clone (77.2%) used to isolate it, and with MS from cucumber (77%). Genomic Southern analysis suggests that a single gene in asparagus encodes AoMS1. Controlled- atmosphere treatments aimed at reducing deterioration of harvested asparagus spears reduced the expression of *AoMS1*. The reduction was correlated with the reduced oxygen level, and reduced MS enzyme activity was also observed. Asparagus cell cultures were used to test the role of sugar status in regulating *AoMS1* gene expression. In cultures without sucrose there was an accumulation of *AoMS1* transcript that was absent in cultures containing sucrose.

5. *In vitro* propagation of *Asparagus maritimus* – A rare Mediterranean salt-resistant species

Plant Cell, Tissue and Organ Culture, September 2002, vol. 70, no. 3, pp. 269-274(6)

tajner N.[1]; Bohanec B.[1]; Jake M.[2]

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Abstract:

Asparagus maritimus L. Miller is a rare species growing of the Mediterranean region and is morphologically similar to *A. officinalis*. In order to establish an efficient *in vitro* propagation protocol, explants were excised from spear segments and cultured on Murashige and Skoog (1962) medium containing 3% sucrose and various concentrations of growth regulators. The best shoot initiation (3–4 per explant) was achieved on a medium containing 0.88 M N6-benzyladenine (BA), 0.93 M kinetin, 1.07 M -naphthaleneacetic acid (NAA) and 3.90 M ancymidol. Shoot initiation could also be achieved without ancymidol but the shoots were thinner and longer. A very high shoot multiplication rate was achieved on media supplemented with 3% sucrose, 1.07 M NAA, 0.93 M kinetin, 0.44 M BA and various concentrations of ancymidol. The lowest concentration of ancymidol (0.39 M) significantly promoted the highest shoot multiplication rate (11.9 shoots/crown). For root formation, media were supplemented with 6% sucrose, 1.07 M NAA and various concentrations of ancymidol. Rooting frequency increased with higher ancymidol concentration up to 5.07 M (82.0% rooting). The number of *ex vitro* shoots formed was strongly correlated (r=0.66) with the length of roots formed *in vitro*, which was the highest at a 1.95 M ancymidol.

Keywords: ancymidol; *Asparagus scaber*; micropropagation; morphogenic response; rooting

6. DISEASE NOTES OR NEW RECORDS: Survey of asparagus in Western Australia for rust and stem blight

Australasian Plant Pathology, 12 March 2002, vol. 31, no. 1, pp. 97-98(2)

McKirdy S.J.[1]; Murphy P.[1]; Mackie A.E.[1]; Kumar S.[1]

[1] Department of Agriculture Western Australia, Locked Bag 4, Bentley, WA 6983 Australia.

Abstract:

Asparagus (*Asparagus officinalis*) crops in Western Australia were surveyed for the presence of asparagus rust (caused by *Puccinia asparagi*) and asparagus stem blight (caused by *Phomopsis asparagi*). Neither disease was detected during a physical survey of 48% of the properties growing asparagus in the state.

7. Carbon assimilation, partitioning and export in mature cladophylls of two asparagus (*Asparagus officinalis*) cultivars with contrasting yield

Physiologia Plantarum, July 2002, vol. 115, no. 3, pp. 362-369(8)

Guo J.[1]; Jermyn W.A.[2]; Turnbull M.H.[1]

[1]Department of Plant and Microbial Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand [2]New Zealand Institute of Crop and Food Research, PO Box 4704, Christchurch, New Zealand

Abstract:

To assess the physiological aspects underpinning cultivar difference in asparagus (*Asparagus officinalis* L.) yield, diel carbon exchange, carbon partitioning and export and sucrose phosphate synthase (SPS) activity were examined in mature cladophyll tissue of two asparagus cultivars (ASP-69 and ASP-03) under field conditions. Both cultivars exhibited similar diel patterns in carbon exchange rate (CER) and carbohydrate partitioning. Rates of carbon export estimated from CER and dry mass changes were the highest at midday and coincided with maximum assimilation rate. Carbon export accounted for about 74% of carbon fixation during the photoperiod. No diel fluctuations were observed in SPS activity in either cultivar. A positive correlation between day CER and carbon export rate ($r^2 = 0.87$) was found and this relationship did not differ between the two cultivars studied. The greater carbon export rate measured in the high-yielding cultivar (ASP-69) was associated with significantly higher CER in comparison to the low-yielding cultivar (ASP-03). However, a correlation between sucrose concentration and carbon export rate did not exist. Biochemical evidence indicated that the greater CER in ASP-69 was associated with a significantly greater SPS activity (P 0.05). Phloem ^{14}C exudate analysis revealed that ^{14}C flux out of cladophyll tissue in ASP-69 was significantly greater than in ASP-03. These results indicate a feed-forward effect of rate of photosynthesis on assimilate export in the two cultivars studied.

8. Nitrilo triacetate increases the rate of single somatic embryos in *Asparagus officinalis*

Journal of Plant Physiology, May 2002, vol. 159, no. 5, pp. 553-556(4)

Mamiya K.[1]; Sakamoto Y.[2]

[1]Plant Laboratory, Kirin Brewery Co., Ltd., 3377 Kitsuregawa, Shioya-gun, Tochigi, 329-1491, Japan [2]Applied Research Center, Kirin Brewery Co., Ltd., 3 Miyaharacho, Takasaki 370-1202, Japan

Abstract:

A method for the production of single somatic embryos with uniform shape is described in *Asparagus officinalis* L. Two types of somatic embryos, namely, single embryos and multiple embryos are usually produced. The multiple embryos are aggregations of embryos that did not separate from each other, and these multiple embryos show irregular sizes and shapes. Different concentrations of nitrilo triacetate and application times were studied to increase the number of

single embryos. When 100 mol/L nitrilo triacetate was added to the medium for the production of mature embryos 2 weeks after inoculation of suspension cell clusters, the number of single embryos significantly increased. The somatic embryos produced in the media with nitrilo triacetate successfully developed into normal plants, and there was no significant difference in their conversion frequencies.

Keywords: Asparagus officinalis L.; nitrilo triacetate; somatic embryo; secondary embryogenesis

9. Novel jasmonate amino acid conjugates in *Asparagus officinalis* during harvest-induced and natural foliar senescence

Gapper N.E.; Norris G.E.; Clarke S.F.; Lill R.E.; Jameson P.E.
Physiologia Plantarum, January 2002, vol. 114, no. 1, pp. 116-124(9)
Munksgaard International Publishers, Oxford, UK

10. Mechanical properties of green asparagus

Journal of the Science of Food and Agriculture, February 2002, vol. 82, no. 3, pp. 293-300(8)

Rodriguez-Arcos R.C.[1]; Smith A.C.[1]*; Waldron K.W.[1]

[1][*]Institute of Food Research, Norwich Research Park, Colney, Norwich NR4 7UA, UK

Abstract:

The mechanical properties of three sections (upper, middle and lower) of the spears of green asparagus (*Asparagus officinalis*) were investigated as affected by storage and cooking. A range of methods based on cutting, compression and puncture was employed to measure mechanical properties of spear sections. A transverse puncture test was the most suitable for measuring mechanical properties of fresh and cooked spear sections, and it was observed that strength increased along the spear from the upper to the lower section of fresh asparagus. Postharvest storage resulted in strengthening, mainly located in the last portion of the stem. A softening phenomenon was detected in every section as a consequence of cooking. The results of a tensile test on two different tissue types separated from the middle and lower portions of the stem showed that the external tissues were stronger and stiffer than the internal tissues, and both increased in strength and stiffness after 3 days of storage. However, the effect of cooking was different: while the external tissues decreased in stiffness and strength, as expected, a significant increase was observed for the internal tissues of the stem.

Keywords: asparagus tissues; texture; toughening; storage; cooking

11. Xyloglucan endotransglycosylase: a role after growth cessation in harvested asparagus

Functional Plant Biology, 30 May 2001, vol. 28, no. 5, pp. 349-361(13)

O'Donoghue E.M.[1]; Somerfield S.D.[2]; Sinclair B.K.[2]; Coupe S.A.[2]

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Abstract:

Little is known about the mode of xyloglucan endotransglycosylase (XET) activity in cell walls once the turgor, which drives expansion, is reduced. Such a situation exists when growing shoots are excised from the parent plant, and is the case for many commercially valuable vegetable crops, e.g. asparagus, *Asparagus officinalis* L. XET activity was present in all zones of rapidly growing, immature asparagus spears, but with highest levels at the spear base where elongation growth had ceased. Activity increased in all parts of the spear for up to 72 h after harvest. Two members of the XET-related gene family in asparagus (AoXET1 and AoXET2) were isolated and mRNA corresponding to these clones accumulated at low levels, particularly in the basal zone during spear growth. Transcript levels increased in all parts of the asparagus spear after harvest, but this increase did not coincide with the increase in XET activity. The harvest-related changes to xyloglucan molecular weight were restricted to slight, segment-specific, up- or down-shifts. However, this may hide strategic alterations to linkages leading to a more rigid wall without major changes in overall molecular weight. The initial postharvest surge in XET activity could be related to harvest stresses such as water deficit, but we propose that the later induction of AoXET1 and AoXET2 is linked to the development of lignified secondary cell walls.

12. Carbon metabolism in developing spears of two asparagus (Asparagus officinalis) cultivars with contrasting yield

Functional Plant Biology, 9 October 2001, vol. 28, no. 10, pp. 1013-1021(9)

Guo J.[1]; Jermyn W.A.[2]; Turnbull M.H.[1]

[1] Department of Plant and Microbial Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand. [2] New Zealand Institute of Crop and Food Research, PO Box 4704, Christchurch, New Zealand.

Abstract:

To assess the relative importance of sucrose-cleaving enzymes in the regulation of carbon accumulation in developing asparagus spears (growing shoots), we investigated spear elongation, carbohydrate accumulation and enzyme activities of acid invertase (AI), neutral invertase (NI) and sucrose synthase (SS) in two asparagus (*Asparagus officinalis* L.) cultivars with contrasting yield. The greater elongation rate measured in the high-yielding cultivar ASP-69 was associated with a significantly higher hexose accumulation ($P < 0.05$) in spear tissue in comparison with the low-yielding cultivar ASP-03. However, sucrose content was similar in the two cultivars, suggesting a more efficient machinery for transport and catalysis of carbohydrate in spears of ASP-69. Biochemical evidence indicated that the greater elongation rate in ASP-69 was associated with a significantly higher AI activity ($P < 0.05$) in the elongation zone, whereas SS activity was not significantly different between the two cultivars. There was little NI activity detected in either cultivar. These results strongly suggest that it is AI, and not SS or NI, that is an

important determinant of the difference in sucrose metabolism between the two asparagus cultivars in metabolising imported sucrose in the elongation region, which in turn plays a part in regulating the import of sucrose into spear tissue. The profile of sucrose-cleaving enzyme activities along spear sections indicated that SS was the dominant enzyme in both the tip and base of spears, whereas AI was the dominant enzyme in the elongation zone. Apart from sucrose-cleaving enzymes, the associated biochemical processes for structure and component synthesis in spear tissues also contributed to the regulation of carbohydrate accumulation. It is most likely that carbohydrate metabolism in the developing spears is a whole spear property influenced by sucrose degradation (AI and SS activity) and its utilisation in building spear structure and storage materials. The overall data substantiate the conclusion that changes in the activity of sucrose-cleaving enzymes are correlated with sink functions in developing spears.

Keywords: acid invertase; asparagus; carbohydrate; growth rate; neutral invertase; spear; sucrose metabolism; sucrose synthase

13. DISEASE NOTES OR NEW RECORDS: Asparagus stem blight recorded in Australia

Australasian Plant Pathology, 20 June 2001, vol. 30, no. 2, pp. 181-182(2)

Davis R.D.[1]

[1] Agency for Food and Fibre Sciences, Queensland Horticulture Institute, Department of Primary Industries, Gatton Research Station, LMB 7, Mail Service 437, Gatton, Queensland 4343, Australia. davisr@dpi.qld.gov.au

Abstract:
Stem blight caused by *Phomopsis asparagi* Sacc. has been detected for the first time in Australia in asparagus (*Asparagus officinalis* L.) growing in south-eastern Queensland.

14. DISEASE NOTES OR NEW RECORDS: Asparagus rust recorded in Australia

Australasian Plant Pathology, 20 June 2001, vol. 30, no. 2, pp. 183-184(2)

Davis R.D.[1]

[1] Agency for Food and Fibre Sciences, Queensland Horticulture Institute, Department of Primary Industries, Gatton Research Station, LMB 7, Mail Service 437, Gatton, Queensland 4343, Australia. davisr@dpi.qld.gov.au

Abstract:

Asparagus rust caused by *Puccinia asparagi* DC. in Lam & DC. has been detected for the first time in Australia in asparagus (*Asparagus officinalis* L.) growing in south-eastern Queensland.

15. Seeds as Vehicles for Pathogen Importation

Biological Invasions, 2001, vol. 3, no. 3, pp. 263-271(9)

Elmer W.H.[1]

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Abstract:

Since the 1900s, consumer demand for new plant products gave opportunity for many plant pathogens to disseminate to new areas on imported seeds. New markets for plant commodities encouraged plant breeders to begin collecting seed stocks from abroad. The birth of new seed companies extend their markets to new area. These events began the global dissemination of many seedborne pathogens. Many seedborne pathogens gained entry and escaped detection by specific traits that favored their dissemination. Three recent case scenarios are presented that illustrate how plant pathogens that passively employ the seed coats of their host achieved global dissemination and permanence in each patho-system. Evidence is presented to show that asparagus (Asparagus officinalis) seed produced in the US acted as a vehicle for disseminating one vegetatively compatible group (VCG) of a pathogenic fungus on asparagus called Fusarium proliferatum throughout new plantings in Australia. Similarly, public demand for Mediterranean cuisine in the US and abroad during the last 20 years led to an increase in the importation of basil (Ocimum basilicum) seed along with an inconspicuous fungus called Fusarium oxysporum. The fungus caused a destructive disease called Fusarium wilt of basil that appeared in over 25 separate locals spanning three continents. The third example demonstrated how new developments in lupine (Lupinus spp.) cultivars and increased public demand led to the global dispersal of a seedborne pathogen called Colletotrichum gloeosporioides. Each case highlights how these pathogens use seeds, humans, and particular traits to disperse globally in short period of time.

Keywords: anthracnose of lupin; Asparagus officinalis; Colletotrichum gloeosporioides; Fusarium crown and root rot of asparagus; Fusarium oxysporum; Fusarium proliferatum; Fusarium wilt of basil; Lupinus spp.; Ocimum basilicum; plant disease epidemiology

16. Asparagus-based amperometric sensor for fluoride determination

Liawruangrath S.; Oungpipat W.; Watanesk S.; Liawruangrath B.; Dongduen C.; Purachat P.

Analytica Chimica Acta, 3 December 2001, vol. 448, no. 1, pp. 37-46(10)
Elsevier Science

17. Taxonomy of the western European endemic Asparagus prostratus (A. officinalis subsp.prostratus) (Asparagaceae)

Botanical Journal of the Linnean Society, October 2001, vol. 137, no. 2, pp. 127-137(11)

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☐
Abstract:

Asparagus prostratus Dumort(wild asparagus) and **A. officinalis** L. (cultivated asparagus), often regarded as subspecies or varieties of a single species, have been confused for historical and nomenclatural reasons. A taxonomic review was carried out, and they were found to be distinct species which differ in morphology (characters retained in cultivation), cytology, distribution and ecology, and they are reproductively isolated. The tetraploid **A. prostratus** is unlikely to be the taxon from which the diploid **A. officinalis** evolved. Morphological descriptions are presented, and **A. prostratus** is lectotypified. **A. prostratus** is a western European endemic of coasts of Belgium, Britain, the Channel Islands, France, Germany, Ireland, Spain and The Netherlands.

☐
Keywords: cytology – infraspecific variation – lectotype – wild asparagus.

18. The storage cell walls in the endosperm of *Asparagus officinalis* L. seeds during development and following germination

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Seed Science Research, December 2001, vol. 11, no. 4, pp. 305-316(12)
☐
Williams H.A.[1]; Derek Bewley J.[1]*; Greenwood J.S.[1]; Bourgault R.[1]; Mo B.[1]
☐
[1]Department of Botany, University of Guelph, Guelph, Ontario, N1G 2W1, Canada [*]
☐
Abstract:

The thickened cell walls of endosperm cells of asparagus (*Asparagus officinalis*) seeds are composed of glucomannans. During development, the extensive thickening of the cell wall is specific to the lateral region of the endosperm and not to the micropylar region. The micropylar endosperm may thus be predisposed to facilitate germination. Following germination there is a progressive mobilization of the reserves in the cells of the lateral endosperm in a wave-like manner away from the haustorial cotyledon, accompanied by the loss of cytoplasm and the crushing of the lateral endosperm cells. Although the internal reserves are mobilized from the micropylar endosperm cells, the cells themselves remain intact throughout the period of lateral endosperm mobilization and may form a living barrier to prevent the loss of soluble hydrolysis products of the lateral endosperm to the surrounding environment. The location and timing of endo--mannanase production and the increase in activity of -mannoside mannohydrolase in seeds of germinated asparagus were followed. Endo--mannanase activity increases greatly in the endosperm until the mid-point of mobilization, and is about 45 times higher than in the embryo on a per seed part basis. Unlike endo--mannanase, which is extractable in low-salt buffer, -mannoside mannohydrolase requires high salt (0.5 M NaCl) for extraction. This enzyme continually increases in activity in both the endosperm and embryo following germination, with

the majority of the activity being concentrated in the embryo when considered on a per seed part basis.

Keywords: endo--mannanase; -mannoside mannohydrolase; endosperm cell walls; Asparagus officinalis L.; storage reserves; reserve mobilization

19. Color development in harvested white asparagus spears in relation to carbon dioxide and oxygen concentration

Siomos A.S.; Dogras C.C.; Sfakiotakis E.M.

Postharvest Biology and Technology, December 2001, vol. 23, no. 3, pp. 209-214(6)
Elsevier Science

20. Isolation of a Novel Deoxyribonuclease with Antifungal Activity from Asparagus officinalis Seeds

Biochemical and Biophysical Research Communications, November 2001, vol. 289, no. 1, pp. 120-124(5)

Wang H. [1]; Ng T.B. [2]

[1] College of Biological Science, China Agricultural University, Beijing, China [2] Faculty of Medicine, Chinese University of Hong Kong, Shatin, New Territories, Hong Kong, China

Abstract:

A deoxyribonuclease distinct from the previously isolated asparagus ribosome-inactivating proteins, possessing a molecular weight of 30 kDa and requiring a pH of 7.5 for optimum hydrolytic activity toward herring sperm DNA, was isolated from **Asparagus officinalis** seeds. The isolation procedure involved extraction with saline, (NH4)2SO4 precipitation, ion-exchange chromatography on DEAE–cellulose, affinity chromatography on Affi-gel blue gel, ion-exchange chromatography on CM-Sepharose, and FPLC gel filtration on Superdex 75. The doxyribonuclease was unadsorbed onto DEAE–cellulose and Affi-gel blue gel and adsorbed onto CM-Sepharose. It exhibited the novel N-terminal sequence, GIEVIKIREL. The deoxyribonuclease was purified to a specific activity of 1584 units/mg. It was devoid of ribonuclease, protease, and HIV-1 reverse transcriptase-inhibitory activities. However, it inhibited cell-free translation in a rabbit reticulocyte lysate system with an IC50 of 20 M. It exhibited antifungal activity toward **Botrytis cinerea** but not toward **Fusarium oxysporum** and **Mycosphaerella arachidicola. Copyright 2001 Academic Press.**

21. Activation of Defense Responses to Fusarium Infection in Asparagus densiflorus

European Journal of Plant Pathology, June 2001, vol. 107, no. 5, pp. 473-483(11)

He C.[1]; Hsiang T.[2]; Wolyn D.J.[3]

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Abstract:

Defense responses to Fusarium oxysporum f. sp. asparagi and F. proliferatum were compared after root inoculation of the asparagus fern, Asparagus densiflorus vars. Myersii and Sprengeri, and cultivated asparagus, A. officinalis cv. Guelph Millennium. Both varieties of A. densiflorus exhibited a hypersensitive response with rapid death of epidermal cells within 8–24 h and restricted the fungal growth. In A. officinalis roots, rapid cell death was not found, and necrotic lesions were observed 8–14 d after fungal inoculation. Peroxidase and phenylalanine ammonia-lyase activities increased significantly in inoculated A. densiflorus but not A. officinalis plants. Local and systemic induction of peroxidase activity was detected after pathogen inoculation in root and spear tissues, respectively, of A. densiflorus. POX activity decreased in roots of inoculated A. officinalis by 8 d post-inoculation. Germination and germ tube growth were inhibited when spores of F. oxysporum f. sp. asparagi were incubated in root exudates and on root segment surfaces of inoculated A. densiflorus plants exhibiting hypersensitive cell death. Spore germination of F. proliferatum and three fungi non-pathogenic to cultivated asparagus was inhibited as well. Rapid induction of hypersensitive cell death in A. densiflorus was associated with restriction of fungal growth, and activation of peroxidase and phenylalanine ammonia-lyase, two defense enzymes thought to be important for plant disease resistance.

Keywords: antifungal property; asparagus; Fusarium oxysporum f. sp. asparagi; F. proliferatum; hypersensitive response; peroxidase; phenylalanine ammonia-lyase

22. Agrobacterium-mediated transformation of Asparagus officinalis L.: molecular and genetic analysis of transgenic plants

Molecular Breeding, 2001, vol. 7, no. 2, pp. 141-150(10)

Limanton-Grevet A.[1]; Jullien M.[2]

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Abstract:

Four long-term embryogenic lines of Asparagus officinalis were co-cultured with the hypervirulent Agrobacterium tumefaciens strain AGL1Gin carrying a uidA gene and an nptII gene. 233 embryogenic lines showing kanamycin resistance and -glucuronidase (GUS) activity were obtained. Transformation frequencies ranged from 0.8 to 12.8 transformants per gram of inoculated somatic embryos, depending on the line. Southern analysis showed that usually 1 to 4 T-DNA copies were integrated. Regenerated plants generally exhibited the same insertion pattern as the corresponding transformed embryogenic line. T_1 progeny were obtained from crosses between 6 transformed plants containing 3 or 4 T-DNA copies and untransformed plants. They

were analysed for GUS activity and kanamycin resistance. In three progenies, Mendelian 1:1 segregations were observed, corresponding to one functional locus in the parent transgenic plants. Southern analysis confirmed that T-DNA copies were inserted at the same locus. Non-Mendelian segregations were observed in the other three progenies. T_2 progeny also exhibited non-Mendelian segregations. Southern analysis showed that GUS-negative and kanamycin-sensitive plants did not contain any T-DNA, and therefore inactivation of transgene expression could not be responsible for the abnormal segregations.

Keywords: Asparagus officinalis L.; Agrobacterium tumefaciens; Embryogenic lines; Genetic transformation; Inheritance of transgenes

23. A method to produce encapsulatable units for synthetic seeds in Asparagus officinalis

Plant Cell, Tissue and Organ Culture, 2001, vol. 64, no. 1, pp. 27-32(6)

Mamiya K.[1]; Sakamoto Y.[2]

[1]Central Laboratories for Key Technology, Kirin Brewery Co., Ltd., 3377 Kitsuregawa, Shioya-gun, Tochigi 329-1491, Japan; requests for offprints) [2]Applied Research Center, Kirin Brewery Co., Ltd., 3 Miyaharacho, Takasaki 370-1202, Japan

Abstract:

A method to produce encapsulatable units for synthetic seeds was developed in Asparagus officinalis L. Encapsulatable units with high conversion ability in non-sterile soil were produced from somatic embryos by a pre-encapsulation culture. The synthetic seeds containing somatic embryos without the pre-encapsulation culture did not germinate in soil. When the pre-encapsulation culture medium did not contain growth regulators, the roots elongated too much to accomplish encapsulation. Several growth regulators were studied and indole-3-acetic acid was considered to be optimum at 28.5 M. The pre-encapsulation culture medium with indole-3-acetic acid inhibited the growth of roots during the pre-encapsulation culture and produced compact encapsulatable units. The growth of roots was promoted when plants were produced from the encapsulatable units. The percent conversion of the synthetic seeds with these encapsulatable units was 72% in non-sterile soil. This is the first report on synthetic seeds in Asparagus officinalis L.

Keywords: conversion; indole-3-acetic acid; non-sterile; pre-encapsulation culture; somatic embryo

24. Assessment of somaclonal variation in asparagus by RAPD fingerprinting and cytogenetic analyses

Raimondi J.P.; Masuelli R.W.; Camadro E.L.

Scientia Horticulturae, 29 October 2001, vol. 90, no. 1, pp. 19-29(11)
Elsevier Science

25. Characterization of the interaction between the dark septate fungus *Phialocephala fortinii* and *Asparagus officinalis* roots

Canadian Journal of Microbiology, August 2001, vol. 47, no. 8, pp. 741-753(13)

Yu T.; Nassuth A.; Peterson R.L.

Abstract:

Phialocephala fortinii Wang & Wilcox is a member of root-inhabiting fungi known collectively as dark septate endophytes (DSE). Although very common and distributed worldwide, few studies have documented their interaction with roots on a structural basis. The objective of this study was to determine the early colonization events and formation of microsclerotia of *P. fortinii* in roots of *Asparagus officinalis* L., a species known to have DSE. A loose network of hyphae accumulated at the root surface, and coils formed around root hairs and external to epidermal cells overlying short cells of the dimorphic, suberized exodermis. Root penetration occurred via swollen, appressorium-like structures into epidermal cells where coiling of hyphae occurred along the periphery of the cells. Hyphae penetrated from the epidermis into short exodermal cells and from these into cortical cells. Hyphae colonized the cortex up to the endodermis and sometimes entered the vascular cylinder. Some root tips were colonized as well. Microsclerotia in epidermal and exodermal short cells accumulated glycogen, protein, and polyphosphate. Energy-dispersive X-ray spectroscopy on distinct bodies visible in microsclerotial hyphae revealed high levels of phosphorus.*Key words*: *Mycelium radicis atrovirens, Phialocephala fortinii*, microsclerotia, DSE.

Phialocephala fortinii Wang & Wilcox est un membre des champignons vivant dans des racines connus sous la dénomination d'endophytes septés foncés (ESF). Bien que communs et distribués mondialement, peu d'études se sont intéressées à leur interaction avec les racines sur une base structurelle. L'objectif de cette étude était de déterminer les événements de colonisation précoces et la formation de la microsclérote de *P. fortinii* dans les racines de *Asparagus officinalis* L., une espèce possédant des ESF. Un réseau lâche d'hyphes s'est accumulé à la surface des racines et des enroulements se sont formés autour des poils radiculaires et à l'extérieur des cellules épidermiques recouvrant les cellules courtes de l'exoderme dimorphique subérifié. La pénétration dans les racines se produisit au travers de structures gonflées ressemblant à des hyphes aplatis, vers l'intérieur de cellules épidermidiques, endroit où les hyphes se sont enroulées le long de la périphérie des cellules. Les hyphes ont passé de l'épiderme vers l'intérieur des cellules exodermermiques courtes et de celles-ci dans les cellules corticales. Les hyphes ont colonisé le cortex jusqu'à l'endoderme et se sont parfois introduits dans le cylindre vasculaire. Certaines terminaisons de racines ont également été colonisées. La microsclérote dans les cellules épidermiques et exodermiques courtes a accumulé du glycogène, de la protéine et du polyphosphate. Un examen par spectroscopie à dispersion d'énergie des rayons X de corps distincts visibles sur des hyphes microsclérotiques a permis de détecter des niveaux de phosphore élevés.*Mots clés* : *Mycelium radicis atrovirens, Phialocephala fortinii*, microsclérote, ESF.[Traduit par la Rédaction]

Keywords: *Mycelium radicis atrovirens; Phialocephala fortinii*; microsclerotia; DSE; *Mycelium radicis atrovirens; Phialocephala fortinii*; microsclérote; ESF

26. Metabolism of etiolated and green asparagus before and after harvest

The Journal of Horticultural Science and Biotechnology, July 2001, vol. 76, no. 4, pp. 497-500(4)

PAPADOPOULOU P.P.; SIOMOS A.S.; DOGRAS C.C.

Abstract:

Pre- and post-harvest respiratory activity and ethylene production of etiolated and green asparagus (Asparagus officinalis L.) were measured at 15°C in whole spears. The growing asparagus spears had an extremely high CO2 production (5.0-8.0 mmol kg-1 h-1) but a quite low ethylene production (46-85.nmol kg-1 h-1). Higher respiratory activity (by a factor of 1.58) as well as higher ethylene production (by a factor of 1.84) was found in green spears compared with etiolated ones. Apparently, as a result of wounding stress from harvesting, the respiration and ethylene production increased immediately after harvest in both green and etiolated spears. The effect of wounding induced by cutting of spears was greater in the green than in the etiolated spears. Subsequently, respiration rate declined before reaching an equilibrium level of around 3.4 and 2.3 mmol CO2 kg-1 h-1 in the green and the etiolated spears, respectively, while ethylene production, after a decline until 6 h after harvest, almost doubled by the 24th h and later decreased to a level of about 21 nmol kg-1 h-1 in both green and etiolated spears.

27. Expression of asparagine synthetase in response to carbohydrate supply in model callus cultures and shoot tips of asparagus (*Asparagus officinalis* L.)

Journal of Plant Physiology, May 2001, vol. 158, no. 5, pp. 561-568(8)

Irving D.E.[1]; Shingleton G.J.[2]; Hurst P.L.[2]

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Abstract:

Sugar uptake and metabolism were studied in callus cultures and shoot tips of asparagus. Asparagus callus cultures were used to model senescence in shoot tips. Callus cultures absorbed glucose from a nutrient medium, and accumulated sucrose, glucose and fructose. This uptake of glucose by the callus cultures down-regulated expression of asparagine synthetase and -galactosidase transcripts that otherwise accumulated when sugar was withheld. When 80 mm-long asparagus shoots were excised from growing plants and placed in 2 % and 8 % sucrose solutions, endogenous concentrations of sucrose, glucose, fructose, UDPglucose, and glucose-6-phosphate declined in the 30 mm-long meristematic tip regions. At the same time, asparagine and asparagine synthetase gene transcripts began to accumulate in these tips. When 10 mm-long asparagus shoot tips were placed on glucose- or fructose-containing agar, the tips accumulated sucrose, glucose and fructose, and asparagine accumulation and expression of asparagine synthetase were marginally reduced. We concluded that in callus cultures, asparagine synthetase expression was sugar regulated, but that sugar regulation was not as pronounced in asparagus

shoot tips. This may be due in part to slower rates of sugar uptake into shoot tips and in part to compartmentation of sugars in the tips. We suggest that callus cultures are not a suitable model for metabolic studies in asparagus shoot tips.

Keywords: Asparagus officinalis L.; asparagine synthetase; gene regulation; phosphorylated metabolites; senescence

28. Numerical model for the combined simulation of heat transfer and enzyme inactivation kinetics in cylindrical vegetables

Martens M.; Scheerlinck N.; De Belie N.; De Baerdemaeker J.

Journal of Food Engineering, February 2001, vol. 47, no. 3, pp. 185-193(9)
Elsevier Science

29. Use of allozyme variation for evaluating genetic purity in asparagus (Asparagus officinalis L.) cultivars

The Journal of Horticultural Science and Biotechnology, January 2000, vol. 75, no. 1, pp. 105-110(6)

OZAKI Y.; TASHIRO T.; OKUBO H.

Abstract:

The study demonstrates the usefulness and applicability of allozyme variation as genetic markers in asparagus. Thirteen cultivars and one supermale strain were surveyed for allozyme polymorphism by starch gel electrophoresis. Five enzyme systems showed polymorphism, and eight loci with 19 alleles were determined by the segregation patterns of offspring obtained from artificial crosses. Allozyme variation within cultivars was found to provide a practical and rapid estimation of genetic purity or seed contamination in commercial seed lots in clonal hybrid cultivars.

30. In Vitro Preservation of Asparagus Officinalis

Biologia Plantarum, August 2000, vol. 43, no. 2, pp. 179-183(5)

Bekheet S.A.[1]

[1]Plant Cell and Tissue Culture Department, Genetic Engineering and Biotechnology Division, National Research Centre, El-Tahrir Str., Dokki, 12622 Cairo, Egypt

Abstract:

A simple systems for in vitro storage of health asparagus germplasm was developed. High percent (90 %) of shoots cultured in a standard multiplication medium were maintained viable in vitro at 5 °C in darkness for 12 months. This percent was decreased to 60 % when cultures were stored for 18 months. At normal temperature, shoots and callus cultures also survived for 1 year under osmotic stress on medium containing 40 g dm^-3 mannitol.

Keywords: cryopreservation; mannitol; osmotic stress

31. Fusarium Redolens f.sp asparagi, Causal Agent of Asparagus Root Rot, Crown Rot and Spear Rot

European Journal of Plant Pathology, November 2000, vol. 106, no. 9, pp. 907-912(6)

Baayen R.P.[1]; van den Boogert P.H.J.F.[2]; Bonants P.J.M.[2]; Poll J.T.K.[3]; Blok W.J.[4]; Waalwijk C.[1]

[1]Plant Protection Service, Mycology Section, P.O. Box 9102, 6700 HC Wageningen, The Netherlands (Phone: 31 317 496830; Fax: + 31 317 421701; E-mail: r.p.baayen@pd.agro.nl) [2]Plant Research International, Wageningen University and Research, P.O. Box 16, 6700 AA Wageningen, The Netherlands [3]Applied Research for Arable Farming and Field Production of Vegetables, P.O. Box 430, 8200 AK Lelystad, The Netherlands [4]Biological Farming Systems Group, Wageningen University and Research, Marijkeweg 22, 6709 PG Wageningen, The Netherlands

Abstract:

Two Fusarium species, F. oxysporum f.sp. asparagi and F. proliferatum, are known to be involved in the root and crown rot complex of asparagus. We have investigated reports on the involvement of F. redolens, a third species, which until recently was considered conspecific with F. oxysporum because of morphological similarities. RFLP analysis of the rDNA internal transcribed spacer region and AFLP fingerprinting identified eight strains from asparagus unambiguously as F. redolens. Four of these were tested and found to be pathogenic to asparagus either in this study (two strains) or in a previous one in which they were classified as F. oxysporum (three strains). Disease symptoms and disease development were the same as with F. oxysporum f.sp. asparagi and F. proliferatum. Present data and literature reports identify F. redolens as a host-specific pathogen involved in root, crown and spear rot of asparagus. The pathogen is formally classified as F. redolens Wollenw. f.sp. asparagi Baayen.

Keywords: Asparagus officinalis; Fusarium oxysporum; Fusarium proliferatum; Fusarium redolens

32. A thaumatin-like gene from *Asparagus officinalis* (AoPRT-L) exhibits slow activation following tissue maceration or salicylic acid treatment, suggesting convergent defence-related signalling in monocots

Molecular Plant Pathology, November 2000, vol. 1, no. 6, pp. 357-366(10)

Darby R.M.; Firek S.; Mur L.A.J.; Draper J.

Abstract:
Summary

Messenger RNA derived from mechanically separated cells of asparagus has proved to be an enriched source of defence-related transcripts. We describe the characterization of a novel PR-5 gene coding for a secreted protein of neutral pI (AoPRT-L) that is strongly up-regulated following cell isolation or following accelerated tissue ageing caused by tissue maceration, but which is also responsive to salicylic acid, a defence-related signal not normally associated with wound responses. Infection with the necrotizing fungal pathogen *Stemphylium vesicarium* confirmed the responsiveness of AoPRT-L to pathogen challenge in intact plants. An upstream region of the AoPRT-L gene of less than 500□p was sufficient to confer SA-inducibility in transgenic tobacco. The expression profile of AoPRT-L in both macerated and pathogen challenged tissue suggested there were complex, convergent signalling mechanisms operating during responses to these different stresses.

33. A PR-5 gene promoter from *Asparagus officinalis* (AoPRT-L) is not induced by abiotic stress, but is activated around sites of pathogen challenge and by salicylate in transgenic tobacco

Molecular Plant Pathology, November 2000, vol. 1, no. 6, pp. 367-378(12)

Kenton P.; Darby R.M.; Shelley G.; Draper J.

Abstract:
Summary

Using a promoter-*uid*A (AoPRT-L-GUS) construct, we have characterized heterologous expression controlled by an *Asparagus officinalis* acidic PR-5 gene promoter. The construct was found to be up-regulated following a variety of treatments with the defence signal salicylate. Similarly, AoPRT-L-GUS was induced by the SA mimic benzothiodiazole, however, unlike salicylate, this compound does not appear to be transported through the vasculature. The construct was insensitive to wounding and to the wound signal jasmonate. Pathogen challenge resulted in a restricted zone of expression at and around the infection site. High levels of NaCl or PEG 8000 failed to induce foliar expression, however, mannitol proved to be an effective inducer when applied as a root drench. The oxidants H2O2 and *t*-butyl hydroperoxide also failed to induce AoPRT-L-GUS expression. Developmental expression of the construct appeared to be limited to leaf axils, sepal tips, a proportion of anthers and a small segment of tissue just below the stigma. Thus, the AoPRT-L promoter exhibits a limited expression profile responding principally to salicylate-related defence signals, and shows very little developmental expression. This suggests that the AoPRT-L promoter may be an ideal choice for contained gene expression.

34. Contact dermatitis to *Asparagus officinalis*

Australasian Journal of Dermatology, November 2000, vol. 41, no. 4, pp. 262-263(2)

Rademaker M.; Yung A.

Abstract:
SUMMARY

A 53-year-old farm worker presented with a 3-year history of an occupational allergic contact dermatitis to asparagus. The dermatitis cleared quickly with courses of systemic corticosteroids but relapsed within days of further exposure to asparagus. The genera Asparagus is made up of some 300 species. It belongs to the family Liliaceae which includes tulips, onions and garlic. Asparagus contains asparagin, coniferin and the glucoside vanillin. The allergen may be a plant growth inhibitor, 1,2,3-Trithiane-5-carboxylic acid, which is present in young shoots.

Keywords: allergic contact dermatitis; occupational contact dermatitis; *Liliaceae*; vegetables

35. Analysis of habituated embryogenic lines in Asparagus officinalis L.: growth characteristics, hormone content and ploidy level of calli and regenerated plants

Limanton-Grevet A.; Sotta B.; Brown S.; Jullien M.
Plant Science, 7 December 2000, vol. 160, no. 1, pp. 15-26(12)
Elsevier Science

36. Somatic embryogenesis in Asparagus officinalis can be an in vitro selection process leading to habituated and 2,4-D dependent embryogenic lines

Limanton-Grevet A.; Jullien M.
Plant Physiology and Biochemistry, 8 July 2000, vol. 38, no. 7, pp. 567-576(10)
Elsevier Science

38. A new FISH protocol with increased sensitivity for physical mapping with short probes in plants

Journal of Experimental Botany, May 2000, vol. 51, no. 346, pp. 965-970(6)

Guzzo F.; Campagnari E.; Levi M.

University of Verona, Dipartimento Scientifico e Tecnologico, Strada le Grazie 15, Cà Vignal 1, 37134 Verona, Italy

Abstract:

Fluorescence *in situ* hybridization (FISH) is a well-established technique used for the detection of specific DNA regions, that has been applied to interphase nuclei, pachytene and metaphase chromosomes as well as to extended DNA fibres. This technique allows the physical mapping of specific DNA sequences both on individual chromosomes and extended fibres. A new FISH protocol is described here that enhances the sensitivity of the method. Probes for small unique

DNA sequences of less than 2 kb give high signal-to-noise ratio with this method, and can be visualized easily by means of conventional fluores cence microscopy.
□
Keywords: FISH; *Asparagus officinalis*; physical mapping.

39. Farmer participatory research to minimize soil erosion on steepland vegetable systems in the Philippines

Poudel D.D.; Midmore D.J.; West L.T.
Agriculture, Ecosystems and Environment, July 2000, vol. 79, no. 2, pp. 113-127(15)
Elsevier Science

40. Responses of Asparagus officinalis pollen to the culture filtrate of Fusarium oxysporum f. sp. asparagi

Pontaroli A.C.; Camadro E.L.; Babinec F.J.; Ridao A.
Scientia Horticulturae, 5 June 2000, vol. 84, no. 3, pp. 349-356(8)
Elsevier Science

41. Tillage alters root distribution in a mature asparagus planting

Drost D.; Wilcox-Lee D.
Scientia Horticulturae, 31 March 2000, vol. 83, no. 3, pp. 187-204(18)
Elsevier Science

42. Modified atmosphere packaging of white asparagus spears: composition, color and textural quality responses to temperature and light

Siomos A.S.; Sfakiotakis E.M.; Dogras C.C.
Scientia Horticulturae, 28 April 2000, vol. 84, no. 1, pp. 1-13(13)
Elsevier Science

43. Effects of sugar concentration and strength of basal medium on conversion of somatic embryos in Asparagus officinalis L.

Mamiya K.; Sakamoto Y.
Scientia Horticulturae, 28 April 2000, vol. 84, no. 1, pp. 15-26(12)
Elsevier Science

44. AFLPs Represent Highly Repetitive Sequences in Asparagus Officinalis L.

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Chromosome Research, June 1999, vol. 7, no. 4, pp. 297-304(8)
□
Reamon-Büttner S.M.[1]; Schmidt T.[1]; Jung C.[2]
□
[1]Institute of Crop Science and Plant Breeding, Christian- Albrechts-University of Kiel, Olshausenstrasse 40, D-24118 Kiel, Germany [2]Institute of Crop Science and Plant Breeding, Christian- Albrechts-University of Kiel, Olshausenstrasse 40, D-24118 Kiel, Germanycjung@plantbreeding.uni-kiel.de

Abstract:

The chromosomal and genomic organization of 5 cloned AFLP fragments in asparagus (Asparagus officinalis L.) were investigated. Two of the 5 AFLP loci were sex-linked. The fragments, amplified with EcoRI/MseI primers, ranged from 107 to 267 bp and were AT-rich. Southern hybridization gave interspersed, middle repetitive to high copy sequence signals. Fluorescence in-situ hybridization (FISH) exhibited hybridization signals on all chromosomes with dispersed distribution pattern and varying signal intensities. Repetitive signals in the form of clusters were observed on all chromosomes. In addition, the 5S rRNA gene was physically mapped on one pair of chromosomes and the 18S-5.8S-25S rRNA genes on three pairs. The results of the FISH and Southern analyses showed that the AFLP marker technology relies on repetitive sequences. Since repetitive DNA sequences represent a fraction of the plant genome undergoing rapid changes during the course of evolution, the question of whether such molecular markers originating from repetitive DNA sequences remain stable is discussed.

Keywords: Asparagus officinalis L.; FISH with AFLP sequences; sex-linked markers

45. Carbamate-induced flowering in asparagus (Asparagus officinalis L.) seedlings: optimization of treatment and cultivar variation in flowering response and pollen germination

Euphytica, 1999, vol. 110, no. 2, pp. 77-83(7)

Ozaki Y.[1]; Kurahashi T.[1]; Tashiro T.[1]; Okubo H.[1]

[1]Laboratory of Horticultural Science, Faculty of Agriculture, Kyushu University 46-01, Fukuoka 812-8581, Japan

Abstract:

Optimal carbamate treatment conditions were studied for flower induction in seedlings of an asparagus cultivar `Mary Washington 500 W'. Flower induction was most accelerated by soaking seeds in 50 mg l^-1 carbamate solution for 12 days at 25 ^°C under the fluorescent light. Longer exposure to carbamate over a 12 day period induced a higher percentage of seedlings to flower. A higher percentage of flowering seedlings were male. Flower induction frequency among seven cultivars through carbamate treatment widely ranged from 13 to 67%. `Geynlim', `Mary Washington 500 W' and `Welcome' exhibited a high percentage of flowering seedlings, while `Larac' and `Vulkan' showed low values. Only male flowers were induced in all-male cultivars. Variation in pollen germination was found within all cultivars. `Geynlim', `Cito' and `Mary Washington 500 W' showed high values of average pollen germination. Application of carbamate compound to induce flower production can rapidly produce homogenic cultivars which include both sexes. This is necessary for genetic studies and breeding purposes.

Keywords: Asparagus officinalis L.; breeding; carbamatetreatment; flower induction; homogenic cultivar; pollen germination

46. Changes in Texture and Nutritional Quality of Green Asparagus Spears (*Asparagus officinalis* L.) during Microwave Blanching and Cryogenic Freezing

Acta Agriculturae Scandinavica, B, 26 November 1999, vol. 49, no. 2, pp. 110-116(7)

Kidmose U.; Kaack K.

Abstract:
Green asparagus spears were blanched for a short or long period by steam, water or microwave in two different systems, and spears were frozen by blast or liquid nitrogen under different conditions. The influence of the process conditions on shear force values (toughness), vitamin C, dietary fibre, chlorophyll and drip loss was investigated. Spears with similar or higher shear force values and lower vitamin C were obtained by microwave blanching than by steam and water. No differences were found in shear force values, vitamin C, chlorophyll and dietary fibre between cryogenic and blast freezing, whereas cryogenic freezing reduced the drip loss significantly. Shear force values increased and vitamin C decreased slightly, whereas dietary fibre and chlorophyll did not change during frozen storage.

47. Nutritional changes in the essential trace elements content of asparagus during industrial processing - a closer look at the IUPAC definition

Lopez M.A.A.; Rojas R.M.; Cosano G.Z.; Segarra P.J.S.
Food Research International, August 1999, vol. 32, no. 7, pp. 479-486(8)
Elsevier Science

48. Formation and development of embryo and endosperm in intra- and inter-specific crosses of Asparagus officinalis and A. densiflorus cv. Sprengeri

Ziam H.; Pandey V.S.; Darwiche J.; Losson B.; Kumar V.; Marcellan O.N.; Camadro E.L.
Scientia Horticulturae, 29 April 1999, vol. 81, no. 1, pp. 1-11(11)
Elsevier Science

49. Heat treatment prevents postharvest geotropic curvature of asparagus spears (Asparagus officinalis L.)

Paull R.E.; Jung Chen N.
Postharvest Biology and Technology, 1 May 1999, vol. 16, no. 1, pp. 37-41(5)
Elsevier Science

50. Histological and 2-D protein patterns comparisons between a wild type and a somatic embryogenic mutant of Asparagus officinalis L.

Dupire L.; Decout E.; Vasseur J.; Delbreil B.
Plant Science, 10 September 1999, vol. 147, no. 1, pp. 9-17(9)
Elsevier Science

51. AFLP markers tightly linked to the sex locus in Asparagus officinalis L.

Reamon-Büttner S.M.; Schondelmaier J.; Jung C.
Molecular Breeding, April 1998, vol. 4, no. 2, pp. 91-98(8)
Kluwer Academic Publishers, Dordrecht, The Netherlands

52. Somaclonal and chromosomal effects of genotype, ploidy and culture duration in Asparagus officinalis L.

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Euphytica, 1998, vol. 102, no. 3, pp. 309-316(8)

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Kunitake H.[1][2]; Nakashima T.[1]; Mori K.[1]; Tanaka M.[1]

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□

Abstract:

Chromosome and morphological variations of embryogenic calli-derived plants of gynogenic haploid, diploid, triploid and tetraploid asparagus (Asparagus officinalis L.) were investigated. Artificial tetraploids were produced using colchicine treatment of seeds of diploid cultivar, `Poultom'. `Haidel' (2X) was crossed with the artificial tetraploids, from which one gynogenic haploid, one diploid, 6 triploid, 3 mixoploids were obtained. Embryogenic calli were first obtained from crown buds, subsequently induced to form somatic embryos, and after 30 days, induced to germinate. Chromosome variation in embryogenic calli-derived plants increased with increasing duration of subculture, particularly when low ploidy levels of plants such as haploid and diploid were used as explants. Approximately 80% of haploid-derived plants showed morphological variations such as dwarfness and abnormal morphological characteristics, although no differences were observed in cladodes and stem characteristics between other polyploid-derived plants and their parents. The data presented here would supply important fundamental information for commercial mass-propagation using somatic embryogenesis.

□

Keywords: Asparagus officinalis L.; somatic embryogenesis; polyploid; gynogenesis; haploid; chromosome variation

53. Characterization of the harvest-induced expression of -galactosidase in Asparagus officinalis

O'Donoghue E.M.; Somerfield S.D.; Sinclair B.K.; King G.A.
Plant Physiology and Biochemistry, October 1998, vol. 36, no. 10, pp. 721-729(9)
Elsevier Science

54. Towards a freshness test for asparagus: spear tip asparagine content is strongly related to post-harvest accumulated heat-units

Hurst P.L.; Boulton G.; Lill R.E.
Food Chemistry, 31 March 1998, vol. 61, no. 3, pp. 381-384(4)
Elsevier Science

55. Enhanced Formation of Roots and Subsequent Promotion of Growth of Shoots on Cryopreserved Nodal Segments of Asparagus officinalis L

Cryobiology, May 1998, vol. 36, no. 3, pp. 194-205(12)

Suzuki T.; Kaneko M.; Harada T.; Yakuwa T.

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Abstract:

This study was designed to investigate the effects of cryopreservation on the survival, organogenesis, and growth of plants regenerated from nodal segments of asparagus (**Asparagus officinalis** L.) that had been cut from cultures **in vitro.** The addition of dimethylsulfoxide (Me2SO) to the freezing solution at 8–16% (v/v) with or without a sugar (glucose, sorbitol, or sucrose) was effective for successful cryopreservation by a slow prefreezing method. Frequencies of root formation (average, 59.3%) from cryopreserved and surviving nodal segments were significantly higher (**P** < 0.005) than those (average, 13.9%) from nodal segments that had only been treated with freezing solution supplemented with 12% (v/v) Me2SO and various sugars without freeze–thawing. The increased frequency of root formation from cryopreserved nodal segments appears to have been induced by the freeze–thaw step of the cryopreservation procedure. Numbers and lengths of shoots derived from cryopreserved nodal segments were initially lower but were subsequently higher, after 60–90 days of culture, than those of shoots derived from nodal segments without freeze–thawing. The promotion of growth of shoots from cryopreserved nodal segments seemed to have been due to the increased percentage of root formation. Histological observations revealed that only dome-shaped meristematic tissue and a few cells of cladophyll primordia survived in cryopreserved nodal segments that had been cultured for 5 days after thawing. Many mitochondria and well developed rER were observed in these cells. Disorganization and/or physiological changes might have occurred in the surviving tissues and/or cells of the cryopreserved nodal segments that were responsible for the subsequent increased formation of roots.

56. A synopsis of the occurrence and pathogenicity of Phytophthora species in mainland China

Mycopathologia, 1997, vol. 138, no. 3, pp. 143-161(19)

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Abstract:

To date, 26 species of Phytophthora have been reported in mainland China but only 23 are accepted as good taxa. Phytophthora nicotianae (P. parasitica) is the single most important species causing over 40 different plant diseases; P. boehmeriae is widespread attacking Gossypium, Boehmeria, Citrus, Broussonetia papyrifera and Pterocarya stenoptera; P. ``fragariae

var. oryzo-bladis" is unique to mainland China causing blight of Oryza sativa seedlings; P. megasperma sensu lato has been isolated from Glycine max, Asparagus officinalis and Spinacia oleracea. In Hainan Province, P. heveae is present in the soil without causing apparent diseases to Hevea brasiliensis there.

57. Variations of chromium and nickel content during industrial processing of white asparagus
Amaro-Lopez M.A.; Zurera-Cosano G.; Moreno-Rojas R.; Sanchez-Segarra P.J.
Food Chemistry, June 1997, vol. 59, no. 2, pp. 261-267(7)
Elsevier Science

58. Genomic characterization of members of the Bet v 1 family: genes coding for allergens and pathogenesis-related proteins share intron positions
Hoffmann-Sommergruber K.; Vanek-Krebitz M.; Radauer C.; Wen J.; Ferreira F.; Scheiner O.; Breiteneder H.
Gene, 15 September 1997, vol. 197, no. 1, pp. 91-100(10)
Elsevier Science

59. Recovery of transgenic asparagus plants by particle gun bombardment of somatic cells
Li B.; Wolyn D.J.
Plant Science, 15 July 1997, vol. 126, no. 1, pp. 59-68(10)
Elsevier Science

60. Soil water deficits and asparagus: I. Shoot, root, and bud growth during two seasons
Labarthe N.; Reis Ferreira A.M.; Guerrero J.; Newcomb K.; Paes-de-Almeida E.; Drost D.; Wilcox-Lee D.
Scientia Horticulturae, July 1997, vol. 70, no. 2, pp. 131-143(13)
Elsevier Science

61. Soil water deficits and asparagus: II. Bud size and subsequent spear growth
Drost D.; Wilcox-Lee D.
Scientia Horticulturae, July 1997, vol. 70, no. 2, pp. 145-153(9)
Elsevier Science

62. Effect of industrial processing on the mineral content of white asparagus
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International Journal of Food Science & Technology, October 1997, vol. 32, no. 5, pp. 401-406(6)
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Abstract:

Concentrations of calcium, magnesium, sodium, potassium and phosphorus were determined in white asparagus (Asparagus officinalis, L.) by atomic absorption spectrophotometry to investigate and estimate if the influence of industrial processing on mineral content and mineral nutritional value of different varieties, diameters and portions of white asparagus spears. Four-factor anova (processing, variety, diameter and portion) and a Scheffe test ($P < 0.05$) established statistically significant differences and different homogeneous groups for the four factors. All the elements studied showed significant ($P < 0.001$) changes in their levels throughout the processing stages with a decrease of the calcium and sodium content and an increase in magnesium, potassium and phosphorus concentrations. These variations are especially related to peeling since the loss of the spear peel may produce changes in the mineral content. Concentrations of the majority of the mineral elements analysed were higher in the SUR variety asparagus, the largest diameter spear (14-19 and > 19 mm) and the tip and middle portions of the spear. Nutrient density was well over 100% for all the elements, except for sodium, and the processing has no consequences for the mineral nutritional value.

Keywords: Asparagus officinalis; L.; atomic absorption; blanching; nutrient density; nutritional valuation; peeling; washing

63. Increase in Freezing Resistance of Excised Shoot Tips of Asparagus officinalis L. by Preculture on Sugar-Rich Media

Cryobiology, May 1997, vol. 34, no. 3, pp. 264-275(12)

Suzuki T.; Kaneko M.; Harada T.

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Abstract:

The effects of preculture on freezing resistance, sugar and water content, and the cell structure of asparagus shoot tips (Asparagus officinalis L.) were examined. Freezing resistance of tips was increased by a 48-h preculture on a medium supplemented with a high concentration of sugar. The optimal concentration of sugar in the preculture medium was 0.5 M, regardless of the sugar. The results of analysis of sugar and water contents suggested that dehydration of cells in the shoot tips and absorption of sugar from the medium occurred during preculture. Exogenous fructose, glucose, and sucrose taken up by the precultured shoot tips were metabolized into other kinds of sugar, but sorbitol was not. Estimated concentrations of sugar in the precultured shoot tips were similar to those in the preculture medium, except in the case of added sucrose. In shoot tips that had been precultured on a medium supplemented with 0.5 M glucose, only a few of several dome-shaped meristematic protrusions and leaf premordia survived. The dead cells, in which the organelles had been entirely destroyed, seemed to have been plasmolyzed to a very considerable extent in the hypertonic media. Severe plasmolysis may be a consequence of possible dehydration damage. In surviving cells, many developed plastids that contained starch grains were observed,

and extensive rER developed in the cytosol. It is suggested that the uptake of sugars and dehydration occurred in cells during preculture, with consequent increase of freezing resistance of precultured shoot tips.

64. DETECTION OF METAL CONTAMINATION IN WILD ASPARAGUS NEAR A WASTE DISPOSAL SITE

Environmental Monitoring and Assessment, 1996, vol. 43, no. 3, pp. 201-216(16)

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Abstract:

Estimating contaminant distributions in environmental media is necesary to evaluate human and ecological hazards. Because of uncertainties in release histories and transport, traditional sampling and statistical techniques applicable to the experimental sciences may not be suitable for exploratory studies at hazardous waste sites. An approach that relies on cluster analysis of principal components (PCA) was used to identify contaminated wild asparagus (Asparagus officinalis) growing in the vicinity of waste disposal sites along the Columbia River at the U.S. Department of Energy's Hanford Site in southeast Washington state. Metals in soil samples taken from the sites contained elevated levels of Ag, Al, Ba, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Zn, and V. Samples of asparagus tissue were collected from the river near the waste site, from Hanford old fields abandoned 52 years ago, and from commercial fields in the neighboring communities. Dried tissues were analyzed for metals content by ICP-mass spectrometry, furnace AA, and cold vapor AA. Tissue concentrations of elements varied over 5 orders of magnitude, from K at 46 900 ppm to As and Ag at maximum concentrations below 1 ppm. PCA produced four components that accounted for 66.2\% of the metals variance. Subsequent cluster analysis using Ward's minimum variance separated the data into Columbia River and old-field groups, with the River group further divided into three clusters: plants primarily upriver from the waste sites, plants primarily downriver, and plants growing in or near the waste sites. The clustering showed that the more soluble components of the discharges (Ba and Ca) showed a pattern of distribution in the asparagus plants consistent with the ground water flow pattern, in that these elements were found far downriver of the disposal sites themselves. In contrast, the less mobile elements Al, Cd, Cr, Fe, Mn, Tl, and Zn were elevated only near the most-recently used waste disposal area. Asparagus from agricultural fields, including fields abandoned 50 years ago, contained higher concentrations of Fe, Cu, Pb, K, and Ni than did the wild riverine plants.

65. Tiprot in asparagus: effect of temperature during spear growth

Aguilar M.; Carrascosa M.; Agullo-Lopez F.; Lill R.E.; Borst W.M.; Irving D.E.

Postharvest Biology and Technology, April 1996, vol. 8, no. 1, pp. 37-43(7)
Elsevier Science

66. The viability of asparagus pollen after storage at low temperatures
Marcellan O.N.; Camadro E.L.
Scientia Horticulturae, November 1996, vol. 67, no. 1, pp. 101-104(4)
Elsevier Science

67. Efficient plant regeneration of asparagus by inducing normal roots from in vitro multiplied shoot explants using gellan gum and glucose
Shigeta J.-i.; Sato K.; Tanaka S.; Nakayama M.; Mii M.
Plant Science, 5 January 1996, vol. 113, no. 1, pp. 99-104(6)
Elsevier Science

68. Production of interspecific somatic hybrid plants between Asparagus officinalis and A. macowanii through electrofusion
Kunitake H.; Nakashima T.; Mori K.; Tanaka M.; Saito A.; Mii M.
Plant Science, 3 May 1996, vol. 116, no. 2, pp. 213-222(10)
Elsevier Science

69. Genotype and auxin influence direct somatic embryogenesis from protoplasts derived from embryogenic cell suspensions of Asparagus officinalis L.
May R.A.; Sink K.C.
Plant Science, 16 June 1995, vol. 108, no. 1, pp. 71-84(14)
Elsevier Science

70. Uptake and Redistribution of 15N Within an Established Asparagus Crop after Application of 15N-labelled Nitrogen Fertilizer

Annals of Botany, February 1994, vol. 73, no. 2, pp. 169-173(5)

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Abstract:

The uptake and redistribution of 15N within a 6-year-old asparagus (*Asparagus officinalis* L.) crop were examined for applications of 15N-enriched ammonium sulphate (5 g N m-2) either prior to growth of foliage (commonly called 'fern'), prior to harvest, or early-harvest prior to the main period of spear (newly-emerged, edible, unexpanded shoot) production. During the harvest in spring, 38 kg N ha-1 was removed in harvested spears, but this was small compared to the 710 kg N ha-1 present in crowns and roots. Limited uptake of 15 N occurred during harvest from the pre-harvest and early-harvest applications (11 and 4% of the 15N applied, respectively) and the lack of plant uptake of N from soil was also evident from an accumulation of inorganic N in unfertilized soil during spring. These results indicate that N in spears was derived largely from remobilisation of N stored in the crowns and roots.

Most plant uptake of added ^{15}N occurred during the first 8 weeks of foliage growth in summer, when 282 kg N ha^{-1} had accumulated in the above-ground foliage. After this 8 week period, foliage from the early-harvest treatment contained 24% of the ^{15}N applied. Fifteen weeks later (late autumn), foliage was senescing and the ^{15}N content of senesced foliage in all treatments had declined by 90% due to remobilisation and translocation into the crown and root tissue. Similarly, foliage N had declined from 282 to 24 kg N ha^{-1} and this remobilised N was equivalent to approximately 40% of the total plant N present prior to foliage growth.

During the subsequent spring period, the ^{15}N enrichment of spears was about twice that of the crowns and roots. Thus, there was preferential remobilisation of recently-absorbed, stored N for new spear growth.
□
Keywords: Asparagus; Asparagus officinalis; nitrogen; 15N; redistribution; remobilisation; uptake