USA Carrot Grower Study Tour 2013

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AUSVEG Ltd

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Purpose:

The purpose of this report is to detail the findings resulting from the 2013 Carrot Grower Study Tour to the United States of America (VG12707), in line with the reporting requirements outlined in the project contract.

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Disclaimer:

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1.0 Media Summary

The 2013 USA Carrot Grower Study Tour provided 10 vegetable levy payers with the opportunity to visit leading and innovative carrot operations in the United States, and participate in a four-day International Carrot Convention covering all the elements of commercial carrot production. The tour was funded by HAL using the National Vegetable Levy, voluntary contributions from industry, and matched funds from the Australian Government.

The main focus of the tour was to educate growers about the latest carrot farming methods, technology, equipment and information. To achieve this over the eight-day tour, growers visited Bolthouse and Grimmway operations – America's two largest carrot processors and growers – toured Shiprock Farms in Wisconsin, and attended the 36th International Carrot Conference. Growers received exposure to production and supply chain systems operating in a country recognised as setting many benchmarks in horticulture. From this, participants gained valuable industry knowledge that will be relayed back to other members of the Australian vegetable industry.

In California, growers visited Bakersfield to tour the Bolthouse and Grimmway Farms – both major competitors in the carrot industry – and the producers of more than 80 per cent of the nation's supply. The two companies are striving to find the edge over their opponent, which is encouraging large-scale investment in company R&D. Farm visits began out on the companies' fields, examining both planting and harvesting operations, before following the production line to the packing and processing plants. Growers paid particular focus to the expansion that both companies have made in their businesses to move from being family oriented to multinational operations.

The final destination on the tour of Bolthouse's operations was their machine shop. Closed to the public and members of American vegetable industry, the Australian growers were grateful to be allowed into the grounds. The majority of their farming machinery, from forklifts to planters and harvesters, are designed and custom built in-house to best cater to Bolthouse's specific needs. The tour group took the opportunity to walk freely around the sheds, speaking with mechanics, operators and engineers on their opinions, techniques and pioneering projects.

Closer to the scale of carrot growing operations in Australia, Shiprock Farms provided the group an opportunity to compare their own practices with an American counterpart. Owner and operator, Paul Phillippi, met with the group to show them around his fields. The frosty climate and Wisconsin's marshland soil has played a major role in the alternative techniques implemented at Shiprock's operation. The cold winter restricts growing from May to October, as it can reach -20 ° Celsius for weeks at a time. However, this also has the benefit of producing up to two feet of frost that kills bugs and pests in the fields, giving Paul a fresh start each season.

Also of interest was Shiprock's Muck soil fields, which are created by draining bogs and swamp lands. Due to its dark colour and favourable composition of decomposed plant and organic matter, the Australian growers compared Shiprock's soil to fields of nutrient rich potting mix. The land is ideal for growing root vegetables, but Paul noted there is controversy surrounding Muck Farms, as draining wetlands results in a variety of environmental problems. This has resulted in the fertile land becoming extremely valuable, as it is unlikely that any more will be created in the United States.

The four-day International Carrot Conference tested the tour attendees' technical and practical knowledge of the carrot industry. Speaker sessions and conversations covered topics such as carrot breeding for disease resistance, cultivation methods for increased yield, and innovative harvesting techniques that are being trialled by the University of Wisconsin.

The tour also involved visiting a number of carrot field trials, a visit to a breeding facility, and an on-farm examination of multiple carrot varieties showcasing experiments with carrot colour, texture and taste. As part of this, the tour visited the University of Wisconsin's West Madison Agricultural Experiment Station. The Experiment Station currently has trials underway with an estimated 130 different vegetables. One of the carrot studies, now in its second year of five, was focused on natural nematode resistance between 36 different varieties of carrots in an unaltered environment. The outcomes of the study will influence future carrot breeding activities at the facility. While the results of this test are still undetermined, the growers were able to learn new ways to detect early warning signs of nematodes distinctive to different carrot types.

Written evaluations were undertaken by tour members after each day of activities and debriefing sessions were held regularly throughout the trip to discuss key information and points of interest. These findings were recorded in tour diaries supplied to the participants to ensure there was a written record of each day's events and the information was retained.

2.0 Expected outcomes and how they were achieved

The principal objective of this project was to provide Australian carrot growers with a tour that would be educational and allow them to investigate production improvements that have been made within the carrot industry, while simultaneously identifying any new ideas, techniques, tools or machinery that could be implemented in Australian operations.

The 36th International Carrot Conference provided Australian carrot growers with exposure to international research and development conducted at the University of Wisconsin in areas such as cultivation, disease resistance, plant breeding and genetics. A major benefit achieved from this visit was the direct networking connections made by the tour attendees with leading scientists, growers and agribusiness professionals in the carrot industry through conference participation.

Further to the Carrot Conference, the tour provided attendees the opportunity to converse with their American counterparts and various other industry experts on machinery, irrigation, fertilisation, packing operations and other facets of commercial carrot growing. This knowledge was obtained by visiting a range of farms, machinery shops and processors in California and Wisconsin.

It is expected that the Australian growers who participated in the tour will bring back their acquired knowledge of American carrot production, processing and developments, and share this with their colleagues in the Australian industry.

A range of feedback was received from participants on the tour to aid in gauging outcomes. The below quotes have been extracted from the grower tour evaluation forms:

- “Well worth it for any grower and researcher in our carrot industry just to see the benchmark.”
- “Very insightful visit to an operation of large scale (Bolthouse and Grimmway). Found them very prepared to share information and their knowledge.”
- “The carrot conference was good with aspects of the research presented being very applicable.”
- “Great to see two very large operations and how they operate and manage their business. Also the innovative techniques they have incorporated to make sure they can use the whole carrot.”
- “A broad mix of carrot production information across the US. Outstanding! I would like to encourage growers from Tasmania to attend in the future.”
- “I think the best thing (from the conference) for me was a deeper understanding of the importance of universities to R&D. I hope to build stronger relationships with the academic community and see the next generation of students involved at a deeper level with the industry.”
- “Amazing to see the developments in the fields of breeding carrots. The ability to witness how DNA sequencing and gene mapping makes an impact in the industry was very insightful.“

- “Excellent place to network with academics. Get an idea of what studies are in place.”
- “Very helpful learning about how to look for Alternaia in carrots and at what stages to do so.”
- “Fantastic day (at Bolthouse and Grimmway), we were able to drill down and ask detailed questions in the field and get the information we needed.”
- “The carrot conference was an opportunity to get together with other enthusiastic people in the industry and discuss issues and attempt to solve some ongoing problems that we have not previously been able to nail.”
- “Being able to interact with other leaders in the worldwide carrot industry enables you to feel like you are not fighting alone and view things from an alternative perspective.”

3.0 Tour Report

Day 1 – Australia – Bakersfield, California

(Travel Day)

Day 2 – Bakersfield, California

California produces almost three-quarters of America's carrots due to its favourable climate and good soil. Every day, somewhere in the state, carrots are being planted and harvested. At the epicentre of all this production is Bakersfield, California. Situated in the San Joaquin Valley, Bakersfield is the fourth most productive agricultural region (by value) in the United States and is home to America's largest carrot suppliers, Bolthouse Farms and Grimmway Farms.

The tour began with a visit to the Bolthouse fields located in the southern San Joaquin Valley. Donny Hopkins, an employee of 38 years and Senior Grower Representative Manager at Bolthouse Farms, joined the group beside the field to talk them through the planting process.

Mr Hopkins walked the Australian growers through a field of carrots that were planted three weeks earlier. He explained that Bolthouse plant an average of 800-1000 acres of carrots a week over the year for processing. To keep up with this high rate, they have modified their planters to have the capability of bedding and planting in one pass. The field is cultivated into two forty inch beds (101cm) that sit up to four inches (10cm) high. At the same time the soil is being moulded, the modified spider planter injects the seeds into the finished bed. Tour participants were given the opportunity to ride on the planter, allowing them to study its finer mechanisms in action.

Discussions then turned to soil composition and irrigation. Notably, the San Joaquin Valley represents 25 per cent of the United States food supply, but only equates to 1 per cent of farmland in the entire country. This concentrated production puts an increasing amount of strain on the land. Mr Hopkins, now joined by a Bolthouse agronomist and field manager, explained some of the fertilisation practices implemented to ensure the long term productivity of the land. Mr Hopkins has taken to using cow compost to replace nitrogen in the soil which is removed by plant growth. Cow compost, in its pure form, is considered to be organic and cost efficient as supplies come from local dairy and cattle farms. Similar to Australian growers, the local farms of the San Joaquin Valley have to strictly monitor their use of nitrogen boosting fertiliser, as some nitrogen fertilisers – in particular animal manure – can runoff into rivers and streams. Excessive concentrations of nitrogen runoff can cause river flow to slow by manifesting into blue-green algae.

The region's main supply of water comes from the San Joaquin River, which relies on the Sierra Nevada snow melt. Another source of water is the aquifer that lies beneath the valley. However, both water sources are showing signs of increasing depletion, and due to a growing concern, the region's farmers are turning to more conservative means of irrigation. This gave Australian growers the chance to compare their irrigation techniques with the newly implemented methods at Bolthouse, however, there are few similarities. A consensus found that Australian growers use centre pivot irrigation systems on carrot crops due to its high efficiency of water conservation. In contrast, Bolthouse primarily use portable solid set irrigation, running aluminium surface pipes and sprinklers down the length of a field. There were three reasons for these differences that featured prominently in further

discussions. Firstly, while Bolthouse is experiencing a decrease in water supply, they still have access to an abundance of water compared to most agricultural regions in Australia. This means the restrictions applied aren't as harsh and the general water cost is much lower. Secondly, the benefit of having a transferable irrigation system works in favour of large scale operations like Bolthouse. The ability to relocate their pipes from field to field as they are needed allows Bolthouse to keep their irrigation assets working all year round. In contrast, a centre pivot system remains unused for parts of the year, which leads to efficiency issues. The final reason relates to the region's access to cheap labour. In Australia, the cost of labour required to set and rest solid set irrigation systems would offset any profit. In California, where the minimum wage is USD $8 per hour, this is a viable option. Without access to a low cost workforce, the benefits of many of Bolthouse's farming practices would change dramatically, potentially bringing them closer to the methods used by Australian growers.

Weed control proved to be another example of the benefits of access to cheap labour. In a single Bolthouse carrot field, up to 300 labourers can be weeding at one time. In contrast, the highest number of workers used by an Australian grower is 40. Due to low labour cost, Bolthouse has the added advantage of being able to schedule more passes through the field during the carrots' growth cycle, beginning the weeding process much earlier; thus creating less of a weed issue in the longer term.

From the fields, the tour travelled to Bolthouse's processing plant, where carrots are taken when they reach maturity, approximately 160 days after planting. The plant operates 360 days a year at near capacity – an estimated 5,000 to 6,000 units pass through in an hour. Australian growers were given a tour through the factory, from the initial sorting process, all the way to the distribution centre where they were allowed to sample the finished products. The processing plant's operations are autonomous wherever possible. Labour is kept to a minimum, except for the packaging floor where people perform the necessary tasks. Most of the processing floors are set up with an overlooking control room to monitor the production, and when necessary, to make alterations to machinery. Touring growers were able to move over the suspended walk ways that run along the length of the factory, giving them a birds-eye view of the process.

Baby carrots have become Bolthouse's leading product. These are processed from larger carrots; typically three baby carrots can be cut from the harvested carrot. The cut carrot pieces are ground down to a uniform size and the ends are rounded off to present as a naturally shaped baby carrot. Of most interest to the Australian growers, was how the baby carrots are packaged and marketed.

One example provided was Bolthouse's baby carrots which are sold in small snack sized packages and branded as Shake Downs[1], these are targeted at the younger demographic. The name refers to the satchel of flavouring incorporated in the package. This is designed to be opened and shaken through the baby carrots, giving them a ranch or chilli-lime flavour depending on the consumer's choice of product type. The obvious ploy on a health snack has given Bolthouse a unique market. Promoting the product using an advertising campaign similar in style to a junk food commercial, has also proven beneficial in reaching the target market of a younger demographic. In later group discussions, the Australian growers conferred on the potential of a product like this in Australia. It was agreed that

[1] Bolthouse Shakedown Carrots, branded website and TV commercial.

much of their fresh market produce that goes to waste – due it not meeting supermarket display standards – could be processed into a similar product for a controlled market. An idea was raised to develop and trial an Australian version of the Shake Down product, and if successful, it could be processed on a large scale and marketed as a means of creating new income.

The final destination on the tour of Bolthouse's operations was their machine shop. Closed to the public and members of the American vegetable industry, the Australian growers were very grateful to be allowed into the grounds. The machine shop's employees are tasked with the responsibility of maintaining the thousands of vehicles owned by Bolthouse. The plant's main focus is on Bolthouse's fleet of custom harvesters and tractors, however, the 100 plus golf carts used to travel around the carrot processing plant have proven to be the most troublesome and time consuming to maintain.

The majority of farming machinery at Bolthouse, from forklifts to planters, are designed and custom built in-house to best cater to the operation's specific needs. An emphasis is placed on innovation in an effort to maintain an edge over its competitors. The tour group took the opportunity to walk freely around the sheds, speaking with mechanics, operators and engineers on their opinions, techniques and pioneering projects.

After this tour, growers debated the pros and cons of custom built machinery. The benefits of a custom fleet were obvious to the growers who had witnessed Bolthouse's smooth and efficient operation in the morning. The custom machines allowed Bolthouse the flexibility to fine tune its farming and processing operations; a good example being the combination bedder and planter discussed earlier. The other benefit was to the business' bottom line. By keeping construction and maintenance work in-house, the company saves money on outsourcing.

However, the use of custom machinery has created many issues for the company, such as not being able to order parts in, mechanics needing specialised training, extended maintenance time and a resulting high cost of labour. Another factor that weighed into the debate was the risk of machinery breakdowns and the extended down-time required for fixing such a problem, due to the characteristics of a custom machine (e.g. the time needed to build replaceable parts).

Bolthouse has the luxury of being able to afford additional units that remain on standby to replace any breakdowns, guaranteeing a continually flowing operation. The Australian growers did not believe they could justify the expense of stagnant equipment as part of their operation.

All of the touring Australian growers stated they had more than one piece of equipment that had been custom built, however components essential to their operation were primarily store-bought, with modifications made within the stock designed limits. Due to the fact the Australian growers have not yet reached an operation of similar scale, all agreed that they could not afford to invest the additional money and time required.

While having a fully custom built fleet was not deemed practical for Australian growers, tour participants still found value in speaking with the Bolthouse representatives about the reasoning behind some of their designs and believed that some of the ideas could be incorporated into their own future plans.

Tour attendees inspecting a Bolthouse carrot field after a recent irrigation.

Mr Hopkins (left) explaining to Australian growers, Josh Wing and Luke Biocich, how Bolthouse's custom planter and bedder operates.

Tour attendees inspecting the vast machinery used to sort Bolthouse carrots on arrival.

Phillip Gorman, Josh Wing and Ed Windley tasting Bolthouse's Baby Carrot selection in one of the plants control rooms.

Shake Down, the new product line and innovative packaging that has been introduced by Bolthouse as a means to create a new market.

Australian growers watching a presentation on the workings of a custom harvester in Bolthouse's machine shop.

After leaving Bolthouse, the Australian growers arrived at one of Grimmway's carrot fields. Grimmway Farms is currently acknowledged as being the largest carrot operation in the world, with Bakersfield considered to be their epicentre. The group was met by Mark Valpredo, Grower Relations Manager at Grimmway. Founded by the Grimm family in the 1960s, the organisation has grown to now employ 3,500 people in the Bakersfield region and manage the production of 46 different lines of vegetables.

Of the 70,000 acres of carrots grown in California, Grimmway processes 40,000 acres, of which they grow 40 per cent themselves. It is estimated that Grimmway facilities distribute approximately 4,500 tons of carrots every day of the year; a figure almost incomprehensible to the touring growers.

Growing in fields side by side with Bolthouse the two operations share many of the region's issues and benefits. Grimmway is changing aspects of its operations to conserve water and faces similar issues with a growing deficiency of soil nutrients.

Irrigation methods became the first evident difference between Bolthouse and Grimmway. Unlike Bolthouse's aluminium solid set irrigation, Grimmway has adopted a more labour friendly plastic flexible pipe system. Due to the lightweight material, Grimmway's irrigation system requires less labour to initially set and remove than Bolthouse. Grimmway's plastic pipe is also strong enough for tractors to drive over, making it ideal during the cultivation period, as it removes the task of constantly shifting the irrigation – an issue with conventional plastic pipes.

The biggest benefit gained from using the plastic pipe is its flexibility. Mr Valpredo took the growers to a field being planted to illustrate how this flexibility can be used to their advantage. Grimmway has modified its equipment, including the planter on display, to lift the plastic pipe over its frame work while the tractor is moving. This innovation creates a massive saving in labour. Unlike aluminium pipe, the tractor can move freely down the beds without having to shift the pipes in its path. The weight and rigidity of the aluminium pipe would make it impossible to duplicate this in Bolthouse's fields, giving Grimmway an advantage in labour savings.

Another labour saving strategy used by Grimmway, primarily in its organic fields, is to burn weeds using propane gas. Mr Valpredo explained to the tour group that it cost around $50 in propane gas per acre, but if they miss the window of opportunity, it will cost USD $2,000 per acre in labour to hand weed. The burning process can only take place soon after planting, but before the carrots begin shooting. Once the beds are formed, the field is watered a week prior to the crop being planted. This is done to ensure that the weeds have sprouted when the carrots have just been planted. When the propane burner travels over the field it kills the weeds by scorching them and helps the carrot seed to germinate, creating a win-win situation. After the burn, Grimmway still needs to hand weed the field, but not as often or with as many labourers.

Grimmway's crops generally work on a three year rotation program, primarily starting with carrots, followed by potatoes and then one of their rotation specific crops, depending on the field's conditions and requirements. Mr Valpredo is currently favouring Safflower, which the Australian growers viewed in a nearby field. Safflower is a cost effective rotational crop which is commercially harvested for its seed's vegetable oil. This oil can be sold at a profit higher than conventional rotational crops and still has the benefit of being inhospitable to nematodes and other pests. The Australian growers had heard of Safflower before, but none of them have tried it due to a lack of information in Australia regarding the plants viability in local growing conditions.

Growers Josh Wing and Mitchell Moffatt inspecting PVC flexible piping used on Grimmway carrot fields.

Queensland farmer Ed Windley examining the Grimmway carrot planter in action.

A carrot shoot pulled from the Grimmway field.

One of Grimmway's propane burners used as a weed killer in both conventional and organic carrot fields.

Mr Valpredo teaching Australian growers how to inspect a Safflower, while avoiding its notable thorns.

Day 3 – Bakersfield, California – Madison, Wisconsin

(Travel Day)

Day 4 – Madison, Wisconsin

Located in Friendship, Wisconsin, Shiprock Farm offered the visiting group a good opportunity to compare their methods and practices to an American counterpart of similar scale. Owner and operator Paul Phillippi, met with the group to show them around Shiprock's fields. Discussion quickly turned to the cold climate which restricts the growing season from May to October, as it can reach a consistent minus 20° Celsius for weeks at a time in winter. However, this has the benefit of producing up to two feet of frost which kills most pests in the fields.

Mr Phillippi grows on a farm of "muck soil", which is created by draining bogs and swamp lands. The rich soil is made up of decomposed plant and organic matter that was once submerged. Due to its dark colour and favourable composition, the Australian growers compared Shiprocks' soil to fields of nutrient rich potting mix. The land is most favourable to growing root vegetables such as carrots, potatoes and onions. This has resulted in a large concentration of vegetable growers in the region. Mr Phillippi noted there was some controversy surrounding muck farms, as draining wetlands results in a variety of environmental problems. This makes the fertile land extremely valuable as it is unlikely that any more will be created in the United States.

Mr Phillippi also explained that the soil is prone to some unique problems. Muck farms can catch fire and burn underground for months, making the field inhospitable to any crop without major restoration efforts. Also, if the soil dries out, it becomes very light and requires excessive windbreaks to keep it from blowing away. The largest issue facing Mr Phillippi is the oxidation of his muck soil. This is creating sandy patches in the carrot fields and each year the muck soil depth is becoming progressively shallower.

Unlike Bolthouse and Grimmway in California, Shiprock farms had an abundance of water available. Mr Phillippi believes he could pump 1,000 gallons a minute straight from Shiprock's wells for two weeks straight and it still wouldn't run out. He explained the large stores were partly was due to the moist, fertile soil being underlain by clay, making it extremely efficient at holding water. This reduces the need for regional farmers to irrigate, thus creating a sustainable water cycle. However, with the emerging issue of sandy patches, Mr Phillippi has had to modify his previous irrigation practices.

Similar to the Australian growers, Shiprocks' crops are irrigated by a pivot system. To counter the effects of the sandy patches amongst his crop, Mr Phillippi has implemented a variable rate irrigation system that alters the flow of each sprinkler on the pivot. Flow rate out of a sprinkler is controlled by the size of the sprinkler nozzle and the pressure supplied to the sprinkler. Devices attached along the length of the irrigation pipe control the sprinklers flow between each span. Using a computer program to map out the field, Mr Phillippi can target the sandy patches in an effort to lift the area's yield to match the carrots grown in the muck soil. Mr Phillippi said this had not solved the issue of yield deficiency in the sandy areas, however, there were notable improvements since implementing the controlled irrigation system.

Another method implemented by Mr Phillippi was varying his bed heights to help even the field's yield. Higher beds were dug through the muck soil to help the soil warm up faster in the spring, promoting faster emergence. In contrast, beds were lower in the sandy patches to help the carrots capture water in the soil and retain moisture.

Both of these methods were beneficial, and with proven results, the visiting Australian growers expressed interest in trialling variations of these techniques in their own fields.

Australian growers with Shiprock owner Paul Phillippi, talking about irrigation.

Inspecting muck soil and carrot growth in the field.

Shiprock's carrots growing in the muck soil

Later that afternoon, the tour took part in the first event of the International Carrot Conference: an organic field trial. The tour was at the University of Wisconsin's West Madison Agricultural Experiment Station. The experiment station currently has trials underway with an estimated 130 different vegetables. There are eight agricultural research companies based in Madison, Wisconsin. The University of Wisconsin (UW) cooperates with them all on joint projects, as well as running their own R&D at the station and other facilities in the region.

Professor Irwin Goldman and Professor Phil Simon, from the Department of Horticulture at the University of Wisconsin, met the tour group and other convention members, to begin their presentation.

Professor Simon began by covering some background information on the Wisconsin area and industry to outline what drives their studies. To date, Wisconsin has 254 certified organic vegetable growers and is the second highest organic producer in America, behind the state of California. An average grower in Wisconsin targets their local community market, is diverse and usually grows on a small scale between 5-12 acres. There has been a recent increase in the number of growers in the area, mostly through innovative start-ups. One current practice gives community members an opportunity to buy shares in a farm at the start of a season, and in return, they are delivered fresh produce each week near the end of the season.

The Australian growers were intrigued to later find this practice was also used by larger scale growers as a means of offsetting the cost of trial crops. This practice would allow growers to trial different carrot varieties with some financial backing from the local community. If the trials are commercially successful, they can increase the scale to benefit their larger operation. If they are not successful, growers can move on to a new variety. Regardless of the outcome of the trial, the community members that invested at the beginning of the season will still be provided with fresh produce at a fraction of the price they would pay in the supermarket.

In an effort to aid organic growers, the UW experiment station has recently certified 10 acres for organic produce research. The current study underway at the station has thirty-six different carrot varieties in the trial and has been replicated in the states of California and Washington as a comparison. This organic carrot study, now in its second year of five, was focused on assessing nematode resistance, weed control, crop foliage, colour and flavour.

The carrots are grown in an unaltered environment to best assess variations of natural nematode resistance. In conventional crops, nematode control can involve soil fumigation and nematicides as part of an integrated program. However, these aids are unavailable to organic growers, who instead are reliant on their rotation crops and planting bio-fumigant brassicas and mustards to curb nematode populations. The nematode resistance results of this test are still insufficient, but growers were able to learn how to detect early warning signs of nematodes on the crop foliage for different carrot types.

Researchers were also assessing the carrot foliage, seeking fast top growth and quick growing canopies. These attributes are beneficial in carrot crops, as quick growing, thick canopies outcompete weeds, smothering them from the light and stunting their growth. Just as important, the carrots needed to have strong tops for machine harvesting. Another part of the study looked at carrot varieties to ensure these met consumer demands for colour and taste.

The results of this study will influence the university's future breeding program. The breeding will aim to produce a carrot variety with increased nematode tolerance, strong foliage growth and consumer appeal – a promising outcome for both organic and conventional carrot growers.

The university has also begun a study of the benefits of barley as a nurture crop for carrots. Barley is an allopathic plant that releases natural chemicals which restrict germination or growth of other plants. Barley can be planted in the furrows of crops and the carrots planted on the beds. It is proven that the barley in the furrows will counter the growth of weeds but its efficiency and cost benefit needs to be assessed. Once the carrot crop has reached a substantial level of growth, the barley can be slashed and spread around the crop to continue as a natural weed killer without influencing the carrot crop. The outcome of this study is expected to influence organic carrot growing practices internationally. The trial will also be replicated using Sudan grass instead of barley in multiple locations.

Australian growers and convention participants inspecting a carrot plot used in the trial.

Rob Hinrichsen, Josh Wing, Garth Neuendorf and Ed Windley speaking with a university crop manager on nematode detection in the foliage.

Attached to the University of Wisconsin's West Madison Agricultural Experiment Station was the U.S. Department of Agriculture Carrot Improvement Seed Production Nursery. This facility was in use at the time by the Wisconsin University for a current program breeding a longer, thin carrot for processing into baby cuts.

The entire breeding program takes eight to nine years for development. To achieve this quick time frame, the seeds are shipped to California to grow in winter and brought back to Wisconsin in summer, creating a faster turn around between generations. To cross breed the carrots at the experiment station, two different varieties are grown within hessian bags. Inside the bags, flies hop between the plants to cross pollinate. The resulting seeds are then sent to California to grow. Once carrots reach maturity in California, the carrots that show the desired attributes have their seeds collected. These seeds are then brought back to Wisconsin and the process is repeated until the desired attributes are achieved and results are consistent. From this point the seeds need to be multiplied to a commercial scale which can also be a lengthy process.

Australian growers learn of the research facility's breeding techniques

Rows of carrots in the breeding program

Day 5 – Madison, Wisconsin

Attendance at the 36th International Carrot Conference proved to be very valuable tfor the Australian growers on the tour. Hosted every 18 to 24 months at various locations around the world, the conference brings together representatives of the international carrot industry. Attendees included growers, packers, shippers, seed producers, breeders, pathologists, marketers, university and government researchers and extension specialists. Australian growers participated in workshops and speaker sessions that focused on three main categories: production and marketing, diseases and pests, and breeding and genetics.

The first session covered carrot production, opening with Professor Irwin Goldman who provided an overview of the local industry, similar to his introduction on the previous day at the field trial. Next representatives from the Wisconsin University provided an overview of a range of insect control and integrated pest management (IPM) strategies being trialled by the university and its partners. The session covered a number of studies on key pests in the region, including: aphids, carrot rust fly, black armyworm and aster leaf hopper. Australian growers share these pest issues and were able to relate to the issues caused by them. The rest of the session covered a number of IPM methods being studied by Wisconsin University to combat pests and resulting pathogens. In most cases, the insect is not actually the problem, rather the pathogens that the bugs can carry, that cause issues in the crop. Practical methods and results were compared, providing growers with unparalleled insight into carrot crop protection. Speakers also spoke on a new study into pest migration mapping that could revolutionise how farmers prepare for an incursion and when they distribute their crop protectants.

The second session, still focused on production, covered cultivation methods and focused on how strip tillage, compost and planting density affects carrot quality and yield. Variations of these methods were trialled on three distinctive carrot types; Canadian, Finley and Recoleta carrots. Of the three methods, strip tillage proved to have the most surprising results, with only equivalent or higher yield results in each variety at three locations. However, the long term effects of these practices on weeds still need to be assessed, and it was stressed that implementation should be evaluated on a case by case basis to evaluate economic value.

Speakers in session three and four presented on carrot diseases and breeding. One speaker discussed new carrot trimming technology to control Powdery Mildew (White Mould) in crop foliage. Over the last two years this disease has become recognised as a growing problem in Australia, and while currently manageable, the growers were pleased to learn of organic methods of trimming foliage that reduced Powdery Mildew by 50 per cent without affecting yield.

At the end of the day, the growers split into breakout groups to discuss the day's topics and areas of focus for future research. This gave the Australian growers an ideal opportunity to voice their issues and hear what other industry members knew about the topic, or what studies could potentially be undertaken. From the discussion, it was evident that an underlying problem for Australian growers was the lack of available crop protectants in the country. For example, when Queensland farmers raised their current issue with recurring Pythium outbreaks (a black cavity spot on the carrot), American counterparts questioned why they weren't using Ridomil (Syngenta) and Ranman (FMC) applicants to easily stop the disease. The growers were unsure if either of these crop protectants were available in Australia, despite the evident need for it.

Australian growers participating in the International Carrot Conference speaker session

Touring grower Robert Hinrichsen discussing Australia's current issues in the breakout group

Day 6 – Madison, Wisconsin

The second day of the Carrot Conference speaker sessions focused on breeding. One presentation illustrated the benefits of gene mapping, which was said to provide carrot breeders with a better understanding of the varieties that carry beneficial traits. Gene mapping will allow carrot breeders to shorten the process between initial trials and producing a commercially viable product.

During the afternoon, the Australian growers visited a variety trial, comprised of five different types of carrots sent in by seed companies from all over the world. All of the Australian growers produce fresh market Nantes carrots. There were over 60 different varieties of Nantes carrots on display from 13 different sources, giving the growers an unprecedented opportunity to compare the large amount of varieties on display. Growers assessed core size, length, shape/rounding, root colour, yield and average consistency of specifications based on seed spacing. It was noted that preferred varieties would still need to be grown in Australia to assess now they responded to the local environment. However, the trial was beneficial for assessing disease and pest tolerance in the carrots.

Australian growers and carrot convention participants assess carrot varieties at the trial

A new breed of carrot with an orange core and purple skin on display at the trial

From the carrot trial, the group travelled to a harvesting demonstration by ASA-Lift. Machines on display ranged from single up to six-row harvesters. Growers were given the opportunity to ride on the machines and to learn about the new innovations implemented and the variations between equipment. This allowed them to assess their current and future harvesting requirements against what the market had to offer. Of most interest was the six-row harvester that had advanced capabilities and a harvesting capacity that currently surpasses the requirements of all the touring growers. With the industry trending towards larger farms, machines of this scale and efficiency were noted as viable options for cost cutting ventures.

Touring growers inspecting the leading edge six row harvester.

Leigh Elphinstone and Edward Windley assessing a carrot harvester in action on a Wisconsin carrot fields

Day 11 – Madison, Wisconsin - Chicago, Illinois

Travel day/Rest day

Day 12 – Chicago, Illinois – Australia

Rest day/Travel day

4.0 Implications for Australian horticulture

From this Grower Tour it is clear that there are a range of differences between the United States carrot industry and the Australian carrot industry. The most evident difference between the two countries' industries was scale. Due to the USA's much larger population, its carrot operations have grown to giant scales to match and surpass the country's demands, and now also export large quantities of product. This scale of growth has hastened innovation in the industry in nearly all areas, creating a gap between the Australian and American industries. One driver of this innovation is the increased customisation of carrot farming operations in America as a means to find an edge over rivals. It is evident that the comparative lack of innovation in Australia is a result of the country's small scale of market.

As the Australian carrot industry grows, it will have to produce higher yields using the same resources that are currently available. This growth, along with an increased economic turnover, will result in the creation and adaption of equipment to make better use of current resources and increase efficiency. Tours of this nature, and other projects focused on learning about international innovation, are vital to the Australian carrot industry as a means of keeping it in touch with current advancements, and to ensure the industry is not left behind during this growth period. It was common on the tour for Australian growers to discuss with their American counterparts thoughts on increasing productivity with different types of machinery or harvesting aids. As well as the operational aspects, this tour also provided growers the chance to speak with farmers who had survived the industry's shift from family farms to commercialised and corporate farming – a current trend in Australia.

Another difference evident from the tour is Australia's high cost of labour. The USA has a significantly lower minimum wage ($9.19 USD is the highest minimum wage of the country's states) and access to a large workforce prepared to work for this amount. While processing plants toured in the USA were heavily mechanised and automated, field operations relied on a much larger workforce than Australia but maintained a cost effective operation. It was estimated by the Australian participants that American farmers could have up to three people cultivating a field for the same cost as one in Australia.

The final major implication that arised from the tour is the lack of access in Australia to some of the most effective crop protectants. The group believed that many of the chemicals, such as Ridomil and Ranman mentioned earlier, would pass Australian standards, however, they are not being introduced because the small scale of the Australian industry does not make them commercially viable.

This tour provided the attendees with an unprecedented insight into many facets of the American carrot industry. It is important that tour participants continue investigating the implementation of some of the production methods and technology witnessed on the tour and deemed applicable to the Australian context. Connections need to be maintained with the American industry members and overseas contacts. The continuation of these relationships will prove beneficial, bringing in more valuable information to the Australian industry. The information already gained from this tour has given the attending growers new knowledge that could aid in the successful advancement of the Australian carrot industry.

5.0 How the information gathered will be disseminated

Since the completion of the tour, AUSVEG has encouraged participants to share information on what they learnt and experienced with their local counterparts and through their industry networks across Australia. One way AUSVEG has actively encouraged the participating growers to share their new knowledge with growers is by ensuring they partake in the upcoming AUSVEG National Convention and associated levy funded seminars. The participating grower's attendance will provide an opportunity for them to access a large section of the industry in one place and, in doing so, will provide them with the opportunity to engage in the knowledge transfer process.

AUSVEG will also publish an article in an upcoming edition of *Vegetables Australia* communicating the outcomes of the tour. This will cover key findings and other important information discovered as a result of this tour. The magazine is sent to approximately 6,000 industry members. Additionally, AUSVEG has released several items in its *Weekly Update* e-Newsletter, communicating information from the tour to near 4,000 industry members.

AUSVEG CEO, Richard Mulcahy, and members of staff have discussed, and will continue to discuss, the USA tour in various speeches and at industry meetings. Recently, information has been disseminated to state partners such as Growcom and VGA Vic. The National Levy Payer Meetings will also offer an excellent environment for AUSVEG to convey the benefits of the tour and encourage growers to take advantage of similar educational expeditions in the future.

6.0 Carrot Conference Tour Itinerary August 11 – 18 2013

Sunday 11 August	**Sydney – Los Angeles – Bakersfield** Today you will depart Sydney airport for the USA on flight QF11/AA7363 at 1.05pm. After landing in Los Angeles we will drive to the Hollywood Hills. Here you will have two hours to explore the sites strolling over Hollywood's star lined boulevards. We will then meet up at Mel's Drive-In for lunch, a Hollywood institution with classic American cuisine. After lunch we are departing for Bakersfield, which is not only the carrot capital of California, but the entire United States. Bakersfield is just under two hours from Hollywood. Eighty per cent of America's carrots are produced in this region and the industry is currently worth over half a billion dollars. Overnight at: The Padre Hotel 1702 18th St, Bakersfield, CA 93301, United States +1 661 427 4900
Monday 12 August	**Bakersfield** Depart hotel - 7:30am. After an early breakfast we will head off for a tour of Bolthouse Farms, one of the United States' leading growers of fresh and processing carrots. Recently acquired by Campbell's Soup Company, the farm had previously been run by the Bolthouse family for 90 years. This tour will include field walks where we can witness Bolthouse's carrot planting process and carrot germination. Later in the morning we will tour the Bolthouse plant and farm shop where they build their own custom harvesters and equipment. After lunch the group will meet a representative of Grimmway farms to be shown around the fields and factor. Overnight at: The Padre Hotel
Tuesday 13 August	**Bakersfield – Madison** Depart hotel - 7:30am. Today we cross America – driving from Bakersfield to Los Angeles, flying on to Madison, Wisconsin via Denver. From LAX we will fly to Denver on flight UA768. Upon arriving at Denver Airport, you will board your flight for Madison on UA3690 which departs at 3:58pm. Arriving at 7:00pm, our hotel is only a 15 minute drive away. Overnight at: The Madison Concourse Hotel

	1 W Dayton St, Madison, WI 53703, United States Phone: +1 608 257 6000
Wednesday 14 August	**Madison** Depart hotel - 7:30am. After breakfast, the group will travel 90 minutes for a field tour of Shiprock Farms. Shiprock Farms grows carrots for the fresh market. Owner Paul Phillippi will show the group around his operations and provide you with the chance to see and discuss some methods and techniques used in the prosperous region. At 11.00am, we will depart for Madison for lunch and to visit the University of Wisconsin's Agricultural Experiment Station. The tour will lead the group through carrot field trials on organic and conventional plots, and the U.S. Department of Agriculture Carrot Improvement Seed Production Nursery. Overnight at: The Madison Concourse Hotel
Thursday 15 August	**Madison** Depart hotel - 7:30am. Today is Day One of the 36th International Carrot Conference. The International Carrot Conference is designed to bring members from all sectors of the carrot industry together. The conference is an excellent platform for the exchange of ideas and concerns on all aspects of carrot production. Topics such as breeding, production, pest management, and new products will be discussed in formal paper sessions, poster sessions, discussions and field tours. There will also be ample opportunity to interact with others during the social gatherings. Overnight at: The Madison Concourse Hotel
Friday 16 August	**Madison** Depart hotel - 7:30am. Day Two of the 36th International Carrot Conference will involve further presentations and workshops and as well as a tour to Hancock, Wisconsin, to evaluate carrot variety trials. The carrot variety trials represent a significant component of the conference, showcasing the diverse range of carrot varieties grown at the Paul Miller Farm in Hancock, WI. Overnight at: The Madison Concourse Hotel

Saturday 17 August	**Madison - Chicago** Depart hotel - 8:30am. After breakfast, we are heading back to the University of Wisconsin Department of Horticulture's carrot breeding and genetics labs. The carrot breeding and genetics labs investigate the genetics, cytogenetics, taxonomy, gene flow, disease resistance, insect interactions, molecular biology and breeding strategies of carrots and other vegetables. This includes the investigation of chromosome behaviour, phylogeny, pest resistance and suppression, intra-and inter-specific crossing, nutritional quality, flavour, storage quality, and effects of environmental stress and insects on carrots and other vegetables. Research performed at the lab includes the use of exotic germplasm, germplasm enhancement, and development of production technologies where needed. After the tour, you will depart for Chicago at 12.30pm for a two and a half hour drive, including a stop in Rockford for lunch on the way. Following arrival in Chicago, you will have the afternoon off to explore what is the third most populous city in the United States. Head over to the world-famous Wrigley Stadium or take a stroll across the world's largest green roof at Chicago's Millennium Park. Overnight at: Hyatt Regency Chicago 151 E Wacker Dr, Chicago, Illinois 60601, United States Phone: +1 312 565 1234
Sunday 18 August	**Chicago – Australia** Depart hotel – 3:40pm. After breakfast, your morning will be free to explore the city. An exceptionally fun, insightful and exciting eight days has come to an end. With fond memories and new knowledge, you will depart Chicago for your flight home to Australia on AA1617 to LAX and AA7366 to Sydney. **Please note that the bus to Chicago International Airport will depart from the hotel at 3.40pm sharp.** Note: Please check personal flight itineraries for further domestic travel.

7.0 Recommendations

Based on feedback from study tour participants and observations made during the tour, the following list of recommendations has been complied.

- From the evaluation form it is evident that the growers thought the tour was too short. Future tours should take into consideration additional opportunities in surrounding locations and assess whether the tour itinerary could be extended to take advantage of these.
    - "An additional 5 days to see more equipment and possibly to view other operations further north, even Canada, and look at more organics and Cello Carrots".
- The Canadian region was highlighted as of interest in a number of feedback forms. This should be incorporated into future carrot tours as they are perceived to have a similar structure or carrot production/operations.
    - "If this tour goes again, I think a trip to a Canadian grower would top it off, because of similar scale and Nantes (carrot) varieties (grown)".
- It was also mentioned, by participants, who had been on previous tours, that single commodity focused tours proved to be more valuable to them than mixed vegetable tours. Future tours should assess whether greater benefit would be achieved by having a single commodity focus, particularly for the prominent commodities in the Australian market, such as carrots and potatoes.
- The Farm Productivity Design Team should be notified about the research being undertaken in organic Powdery Mildew control methods and the potential for a trial in Australia.
- Pythium crop protectants should be investigated for registration in Australia, particularly Ridomil (Syngenta), which was discussed at the Carrot Conference and already has an Australian permit in place for potatoes.

8.0 Acknowledgements

The 2013 Carrot Grower Study Tour, including farm visits, expo registrations and accommodation, was organised by AUSVEG.

Thanks must go to the many growers and business managers that showed participants through their operations and enlightened them with their business skills and knowledge. A special thanks to Bolthouse, Grimmway and University of Wisconsin for accommodating the group on tours of their facilities.

The tour was funded by HAL using the National Vegetable Levy and voluntary contributions from industry, with matched funding from the Australian Government.

9.0 Tour participants list

Gregory Moffatt	Grower	Queensland
Mitchell Moffatt	Grower	Queensland
Ed Windley	Grower	Queensland
Robert Hinrichsen	Grower	Queensland
Garth Neuendorf	Grower	Queensland
Phillip Gorman	Grower	South Australia
Josh Wing	Grower	Tasmania
Craig Dobson	Grower	Tasmania
Leigh Elphinstone	Grower	Tasmania
Luka Biocich	Grower	Western Australia
Cameron Brown	AUSVEG	Victoria

10.0 Appendices

Appendix 1: 36th International Carrot Conference Program

36th International Carrot Conference Program

Monona Terrace Convention Center
Madison, WI

August 15-16, 2013

Explanation of the Sessions

All oral presentations listed below should fit a 15-minute time slot. Speakers, please leave a few minutes for questions and comments if possible; therefore, plan to speak for about 12 minutes. The moderator will stand up after you've spoken for 12 minutes to give you an indication of how much time you have left. Authors of posters will be available at their posters during two 30-minute periods on Thursday and one on Friday. A breakout session will take place on Thursday afternoon where individuals who would like to participate in more focused discussion on either carrot breeding and pest management, or carrot breeding and genetics, will have a chance to do so. Finally, we will have a brief business meeting at 12:00 on Friday to discuss several items, including the location of the next International Carrot Conference. Thank you all for your participation.

Thank you to our sponsors for their generosity and support: Bejo Zaden, Nunhems USA, Seminis-Monsanto, ASA-Lift, the Wisconsin Potato and Vegetable Grower's Association, Paul Miller Farms, Sumika Agrotech Co. Ltd., and Sakata Seed America.

Thursday, August 15, 2013

8:00-8:30 ***Continental breakfast sponsored by Nunhems USA***

8:30 – 10:00 Session 1 Carrot Production

1. Introduction to the Conference- Irwin Goldman and Phil Simon
2. Groves, R. University of Wisconsin-Madison, USA. *Overview of insect control and integrated pest management in Wisconsin carrot production*
3. Buishand, Jan. Carosem B.V., The Netherlands. *Experiences with hybrid carrot seed production in China*
4. Ali, A. *Carrot production in Pakistan*

5. Rahim, A. *Carrot production in Bangladesh*

10:00 – 10:30 Break and Poster Session – *Sponsored by Sakata Seed America*

POSTERS

1	Development of a high throughput SNP resource to advance genomic, genetic and breeding research in carrot (Daucus carota L.)	Massimo Iorizzo, Douglas Senalik, Shelby Ellison, Dariusz Grzebelus, Pablo Cavagnaro, David Spooner, Allen Van Deynze and Philipp Simon	Department of Horticulture, USDA-Agricultural Research Service, Vegetable Crops Research Unit, University of Wisconsin, Department of Genetics, Plant Breeding and Seed Science, University of Agriculture in Karakow, CONICET, Fac. Ciencias Agrarias -Universidad Nacional de Cuyo, and INTA EEA LA Consulta, CC8 La Consulta (5567), Mendoza, Argentina, Seed Biotechnology Center, University of California
2	Screening for resistance to Xanthomonas hortorum pv. carota in Daucus carota	Charles E. Christianson, Stephen S. Jones, and Lindsey J. du Toit	Washington State University Mount Vernon NWREC, Mount Vernon, WA 98273
3	Class II transposon insertion profiling differentiates cultivated carrots of various origin	Anna Nowicka, Alicja Macko-Podgórni, Ewa Grzebelus, Dariusz Grzebelus	Department of Genetics, Plant Breeding and Seed Science, University o f Agriculture in Krakow, Poland
4	Exploration of plant-microbe interactions influencing crop perfomance in organic soils	Gregory Heller, Lori Hoagland	Department of Horticulture and Landscape Architecture, Purdue University
5	Daucus Germplasm Collection at the North Central Regional Plant Introduction Station	Kathlee R. Reitsma an dLucinda D. Clarck	Agronomy Department/North Central Regional Plant Introduction Station (NCRPIS), Iowa State University Ames, IA 50011 USA
6	Can insecticide seed treatments protect carrots from damage by carrot veevil and carrot rust fly?	Mary Ruth McDonald, Kevin Vander Kooi and Alan Taylor	Department of Plant Agriculture, University of Guelph, Muck Crops Reasearch Station, King Ontario, L7B 0E9, Canada, Cornell University, Department of Horticultural Science, New York Stte Agriculture Experiment Station, Geneva New York, USA
7	Elucidating the genetic basis underlying anthocyanin pigmentation in carrot	Pablo F. Cavagnaro, Massimo Iorizzo, Mehtap Yildiz, Douglas Senalik, Joshua Parsons, David K. Willis, Allen Van Daynze, Philipp W. Simon	Department of Horticulture, Univeristy of Wisonsin-Madison, 1575 Linden Drive, Madison, WI 53706, USA, CONICET, Facultad de Ciencias Agrarias - Universidad Nacional de Cuyo, And INTA EEA La Consulta, Ex Ruta 40.km 96, La Consulta CC 8, Mendoza (5567), Argentina. Department of AGricultural Biotechnology,. Faculty of Agriculture, Yunzuncu Yil University, 65080, Van, Turkey, USDA-Agricultural Research Service, Vegetable Crops Unit,

			University of Wisconsin-Madison, 1575 Linden Drive, Madison, WI 53706, USA. Department of Plant Pathology, University of Wisconsin-Madison, 1575 Linden Drive, Madison, WI 53706, USA. Seed Biotechnology Center, university of California, Davis, CA, 95616. corresponding author: Philipp.Simon@ars.usda.gov
8	Evaluation of the environmental and genotypic control of canopy growth in carrot under organic and conventional management systems	Sarah Turner, Philipp Simon	University of Wisconsin-Madison, USDA-ARS
9	Potential for regional level forecasting of Sclerotinia rot of carrot based on distribution or aerial ascospores	M. Parker, M.R. McDonald and G.J. Boland	Department of Plant Agriculture, University of Guelph, 50 Stone Road East, Guelph, ON N1G 2WI, Canada.
10	Influence of pigmentation and management practices on the antioxidant content of carrots.	Mary Ruth McDonanld, Chanli Hu, Rong Cao, and Al Sullivan	Department of Plant Agriculture, University of Guelph, Guelph, On, N1G 2WI Canada. Agriculture and Agri-Food Canada, Guelph, ON, Canada
11	Do pigments influence the susceptibility of carrots to cavity spot?	M.R. McDonald, L.Riches, K. Vander Kooi and P.W. Simon	Department of Plant Agriculture, University of Guelph, Guelph, On, N1G 2WI Canada, USDA-ARS
12	Impact of N fertilizer timing and placement of carrots and weeds in Michigan	C. Noyes, D.C. Brainard and Kurt Steinke	Michigan State University, USA
13	Investigating performance of reduced risk funicides fo foliar disease ocntrol in carrot	Stephen A. Jordant, Kenneth Frost, Amanda J. Gevens	Department of Plant Pathology, 693 Russell Laboratories, Univresity of Wisconsin, Madison, WI 53706 sjordan3@wisc.edu 608-219-6811; Department of Plant Pathology, 574 Russell Labroatories, University of Wisconsin, Madison, WI 53706 kfrost@wisc.edu 608-262-9914; Department of Plant Pathology, 689 Russell Laboratories, University of WIsconsin, MAdison, WI 53706 gevens@wisc.edu 608-575-3029
14	Breeding coloured carrots for organic production	Thomas Nothnagel, Reiner Kramer and Detlef Ulrich	Institute forBreeding Research on Horticultural and Fruit Crops. Institute for Ecological Chemistry, Pland Analysis and Stored Product Protection, Federal Research Centre for Cultivated Plants, Julius Kühn-Institute (JKI), Erwin-Baur-Str. 27, D-06484 Quedlinburg, Germany
15	The development of a web-based tool for carrot disease	Kenneth E. Frost, Russell L. Groves and Amanda	Department of Plant Pathology, 574 Russell Laboratories, Univresity of Wisconsin, Madison, WI 53706 kfrost@wisc.edu 608-262-9914;

	forecasting	Gevens	Department of Plant Pathology, 537 Russell Labroatories, University of Wisconsin, Madison, WI 53706 groves@entomology.wisc.edu 608-262-3229 Department of Plant Pathology, 689 Russell Laboratories, University of WIsconsin, MAdison, WI 53706 gevens@wisc.edu 608-575-3029;
16	Taxonomy, distribution, and germplasm collection needs of Daucus	David Spooner and Philipp Simon	Both at USDA Vegetable Crops Research Unit Madison, WI
17	Reassessment of practical species identification of the USDA Daucus carota germplasm collection: morphological data	David M. Spooner, Mark P. Widrlechner, Kathleen R. Reitsma, Debra E. Palmquist, Philipp W. Simon	Spooner and Simon- USDA Vegetable Crops Research Unit Madison, WI. Widrlechner- Iowa State University, Ames IA. Reitsma-North Central Regional Plant Introduction Station Ames IA. Palmquist-USDA Midwest Area Office Peoria IL
18	Multiple nuclear ortholog next generation sequencing phylogeny of Daucus	Carlos Arbizu, Holly Ruess, Douglas Senalik, Philipp Simon, David Spooner	Arbizu-University of Wisconsin-Madison. Ruess, Senalik, Simon, Spooner all at USDA Vegetable Crops Research Unit Madison WI
19	Exploration of plant-microbe interactions influencing crop performance in organic soils	Gregory Heller, Lori Hoagland	Purdue University, USA.
20	Variation in tocochromanol concentration in processed carrot food products	Rachael Vernon, Claire Luby, Irwin Goldman	University of Wisconsin-Madison, USA

10:30 -12:00 Session 2 Carrot Production and Diseases

1. Brainard, D., C. Noyes and R. Oomen. Michigan State University, USA. *Strip tillage, compost, and planting density effects on carrot quality and yield*
2. Navazio, J.P., and N. Huber. Washington State University, Organic Seed Alliance, and Nash's Organic Produce, Washington, USA *Weed control in organic carrot production: a case study in Western Washington.*
3. Ojo, O.D., and E.A. Akinrinde. NIHORT, Nigeria. *Residual Effects of Phosphorus Sources on Carrot Production.*
4. Navez, B., V. Cottet, M. Jost ,F. Latour, F. Villeneuve, S. Huet, E. Geoffriau INRA, France. *Variation factors involved in carrot sensory appreciation*
5. Nogales, A., L. Munoz-Sanhuel., L. Hansen, B. Arnholdt-Schmitt. ICAAM, Portugal. *Calorespirometry: a new tool for phenotyping carrot genotypes for cold tolerences and fuctioonal marker development*

6. Kramer, R. T. Nothnagel, and D. Ulrich. Julius Kuhn Institute, Germany. Black rot caused by *Alternaria radicina* in coloured carrots

12:00-1:30 Lunch

1:30-3:00 Session 3 Carrot Diseases and Pest Management

1. Gevens, A. University of Wisconsin-Madison, USA. *Overview of disease management in Wisconsin carrot production.*
2. Roberts, H, M.R. McDonald, and D. Van Dyk. University of Guelph, Canada. *Carrot Trimming Technology for Control of White Mould*
3. Roberts, P, P. Simon, W. Matthews, and J. Nunez. University of California-Riverside and University of Wisconsin-Madison, USA. *Root-Knot Nematode Resistance in Carrot: a Focus for Breeding*
4. Villeneuve, F., F. Latour, F. Pascaud, and E. Geoffriau. Angers, France. *Interest of a semi-controlled test for screening carrot resistance to Rhizoctonia solani*
5. Frost, K., A. Gevens, and R.L. Groves. University of Wisconsin-Madison, USA. *Toward an adaptive management strategy for the control of aster yellows in Wisconsin carrot*
6. Vandeer Kooi, K., M.R. McDonald, and P.W. Simon. Univ. Guelph, Canada, and Univ. Wisconsin. Carrot cavity spot incidence and severity as affected by pigmentation.

3:00-3:30 Break and Poster Session – *Sponsored by Monsanto and Seminis*

3:30-5:00 Session 4 Carrot Diseases and Carrot Breeding

1. Macdonald, M, R.D. Peters, L. Hale, J. Kemp, T. Barasubiye, J. Driscoll, G. Dykerman, S. Adams, A. Ryan, C. Banks, A. Macphail, D. Gregory, and K. Drake. University of Prince Edward Island, Agriculture and Agri-Food Canada, Prince Edward Island Horticultural Association, Brookfield Gardens, Prince Edward Island Department of Agriculture and Forestry, Canada. *Pathogenicity, chemical sensitivity and management of Fusarium spp. infecting carrots*
2. Van Dyk, D., K. Jordan, and M.R. Macdonald. University of Guelph, Canada. *Evaluating nematicides for the control of soil-borne nematode pests on vegetable crops in Ontario*
3. Postma-Haarsma, Dorien. BejoZaden, The Netherlands. *Carrots and Genomics: An Introduction to the application of Molecular Markers*
4. Allender,C.J., and M. de Cesare. University of Warwick, United Kingdom. *Diversity in carrot: variation in a structured collection of genetic resources.*
5. Cardoso, H., A. Ferreira, M.D. Campos, A.M. Frederico, and B. Arnholdt-Schmitt. Universidade de Evora, Portugal. *β-tubulin intron-length-polymorphism*

marker (cTBP) – a useful tool to assist species/subspecies discrimination and genetic diversity analysis in carrot

5:00 – 5:00 Break - *Sponsored by the Wisconsin Potato and Vegetable Grower's Association*

5:30-6:40 Breakout Sessions

1. Carrot Production and Pest Management
2. Carrot Breeding and Genetics

6:30-8:30 Dinner – *Sponsored by Bejo Zaden B.V.*

Friday, August 16, 2013

8:00-8:30 *Continental breakfast sponsored by ASA Lift*

8:30 – 10:00 Session 1 Carrot Breeding

1. M. Jourdan, S. Gagné, C. Dubois-Laurent, M. Maghraoui, S. Huet, M. Briard, D. Peltier, E. Geoffriau· INRA, France. *Association mapping in carrot: application to root carotenoid content and colour*
2. M. Iorizzo, D. Senalik, S. Ellison, P. Cavagnaro, A. Van Deynze and P. Simon· University of Wisconsin-Madison, USA. *The building of the first Apiaceae Genome*
3. P. Simon, M. Iorizzo, D. Senalik, S. Ellison, P. Cavagnaro, and A. Van Deynze. University of Wisconsin-Madison and University of California-Davis. USA. *Status of mapping carrot traits.*
4. Fei-Yun Zhuang, Cheng-Gang Ou, Jin-Rong Li, Zhi-Wei Zhao. Chinese Academy of Agricultural Science. China. *Isolated Microspore Culture in Carrot*
5. Spooner, D. and P. Simon. University of Wisconsin-Madison, USA. *Taxonomy, distribution, and germplasm collection needs of Daucus*

10:00 – 10:30 Break and Poster Session – *Sponsored by Monsanto and Seminis*

10:30 -12:00 Session 2 Carrot Breeding

1. T. Nothnagel, B. Linke, R. Barański, D. Grzebelus, A. Kielkowska, P. Straka, K. Metge and H. Budahn. Julius Kühn-Institute, Germany, University of Agriculture,

Poland, and Humboldt University, Germany. *Mapping genes important for flower architecture and pollen development in carrot (Daucus carota L.)*

2. Van Etten, M.L., and J. Brunet. Massey University, New Zealand, and USDA-ARS, University of Wisconsin. *The potetnail impact of gene flow from cultivated carrots on the weediness of wild carrot populations.*
3. C. Luby, H. Maeda, and I. Goldman. University of Wisconsin-Madison, USA. *Assessment of tocochromanol (vitamin E) content and concentration in wild and domesticated carrot during crop production, postharvest storage, and reproductive growth*
4. Ellison, S., M. Iorizzo, P. Simon, D. Senalik. USDA-ARS University of Wisconsin. *Utilizing genotyping by sequencing to identify candidate genes underlying domestication traits in carrot*

12:15 Board Buses for Field Tour

Lunch on the bus

2:15 Arrive at Paul Miller Farms

3:30 Depart Paul Miller Farms for Madison

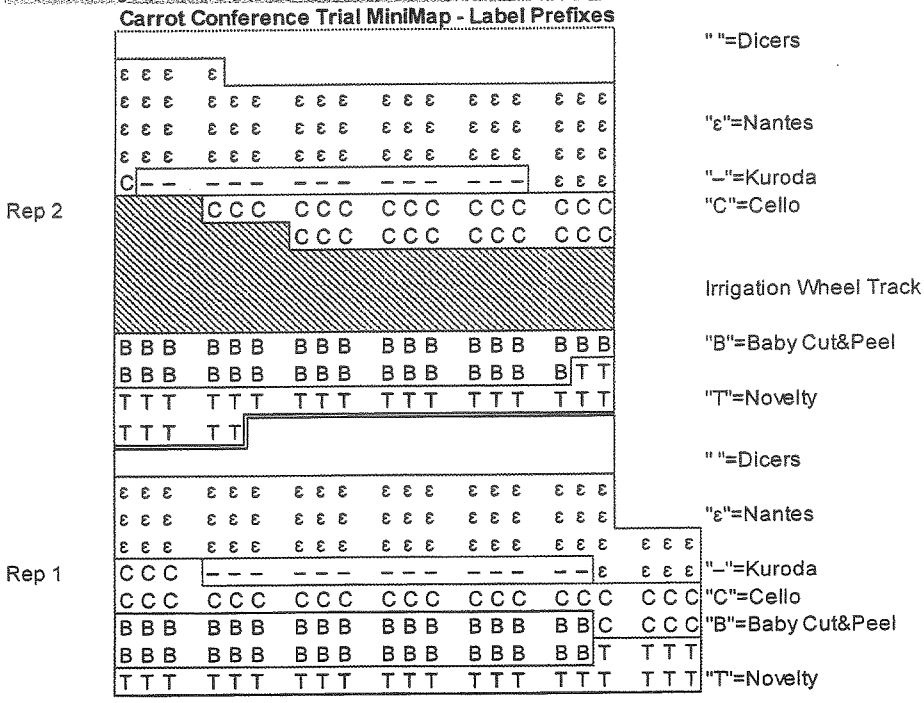
5:30 Arrive at Monona Terrace

Appendix 2: 36th International Carrot Conference Trial

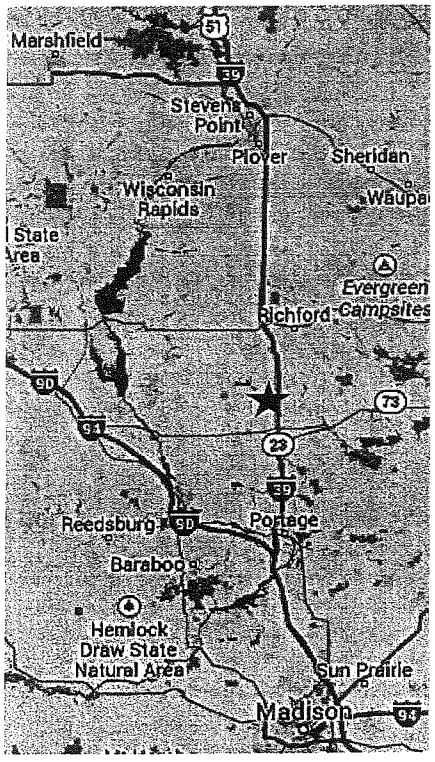
36th International Carrot Conference Trial — August 16, 2013
Paul Miller Farms, Hancock, Wisconsin — Planted May 6

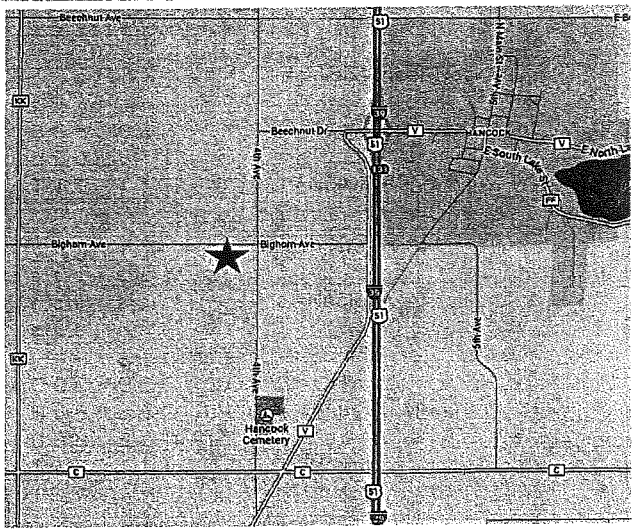
Field No. Entry | Seed Source | Remarks

Field Layout



Location





36th International Carrot Conference Trial — August 16, 2013
Paul Miller Farms, Hancock, Wisconsin — Planted May 6

Field No.	Entry	Seed Source	Remarks
Cut and Peel			
B301	FCR 12033	Sakata	
B302	FCR 11747	Sakata	
B303	FCR 9496	Sakata	
B304	FCR 12040	Sakata	
B305	FCR 12039	Sakata	
B306	H1030	Chinese Academy of Agricultural Sciences	
B307	H1040	Chinese Academy of Agricultural Sciences	
B308	H1063	Chinese Academy of Agricultural Sciences	
B309	VILM1	Vilmorin	
B310	VILM2	Vilmorin	
B311	HoneySnax	Nunhems	
B312	CrispyCut	Nunhems	
B313	CandySnax	Nunhems	
B314	NUN 85931	Nunhems	
B315	KXPC-516	Integra	
B316	KXPC-306	Integra	
B317	KXPC-060	Integra	
B318	KXPC-222	Integra	
B319	KXPC-506	Integra	
B320	Ibiza	Bejo	
B321	PROPEEL	Seminis	
B322	PS 07101441	Seminis	
B323	CR1640	Seminis	
B324	CR1706	Seminis	
B325	Triton	Sakata/Rispens	
B326	(9256 × 7551) × 2301	USDA 245–4	
B327	(9253 × 9788) × 2301	USDA 245–5	
B328	(2144 × 6253) × 2575	USDA 157–3	
B329	(9253 × 9788) × 9758	USDA 286–7	
B330	(6253 × 2144) × 1397	USDA 039–3	
B331	(9253 × 9788) × 2574	USDA 156–6	
B332	S.C. × 2301	USDA 245–2	
B333	(9253 × 7551) × 2301	USDA 245–3	
B334	(9253 × 7551) × 1397	USDA 039–5	

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Field No.	Entry	Seed Source	Remarks
· Cello			
C301	Bj 2951	Bejo	
C302	CA98-966	Carosema	
C303	CA11173	Carosema	
C304	VILM3	Vilmorin	
C305	VILM4	Vilmorin	
C306	Maverick	Nunhems	
C307	Rebel	Nunhems	
C308	Trooper	Nunhems	
C309	KXPC-020	Integra	
C310	KXPC-403	Integra	
C311	KXPC-404	Integra	
C312	CR2289	Seminis	
C313	SV2384DL	Seminis/Rispens	
C314	FCR 12069	Sakata	
C315	FCR 12073	Sakata	
C316	FCR 12077	Sakata	
C317	FCR 12070	Sakata	
C318	OLYMPUS	Sakata/Rispens	
C319	(5280 × 6366) × 7254	USDA 752-3	
C320	(7241 × 2126) × 0186	USDA 135-2 '01	
C321	(5280 × 7808) × 8503	USDA 246-6 '02	
C322	(2566 × 5238) × 2205	USDA 012-6 '00	
C323	(7241 × 2126) × 8524	USDA 248-5 '00	
C324	(3035 × 3999) × 1175	USDA 256-2	
C325	(S.C. × 3999) × 1175	USDA 256-3	
C326	(7254 × 9788) × 3999	USDA 058-5	
C327	(6366 × 2226) × 5280	USDA 154-7	
C328	(8542 × 8524) × 4002	USDA 117-3	
· Nantes			
ε301	Nayarit	Bejo	
ε302	Naval	Bejo	
ε303	Besmuda	Bejo	
ε304	Newhall	Bejo	
ε305	NAPA	Bejo	
ε306	Newhall	Bejo	
ε307	Bermuda	Bejo	
ε308	Necoras	Bejo	
ε309	Niland	Bejo	
ε310	Naval	Bejo	
ε311	H1210	Chinese Academy of Agricultural Sciences	
ε312	H1212	Chinese Academy of Agricultural Sciences	
ε313	H1233	Chinese Academy of Agricultural Sciences	
ε314	H1267	Chinese Academy of Agricultural Sciences	
ε315	H1278	Chinese Academy of Agricultural Sciences	
ε316	Atlantis	Carosema	
ε317	CA9546	Carosema	

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Field No.	Entry	Seed Source	Remarks
ε318	Cestas	Carosema	
ε319	CA1564	Carosema	
ε320	CA6572	Carosema	
ε321	FCR 12140	Sakata	
ε322	FCR 12116	Sakata	
ε323	FCR 12121	Sakata	
ε324	FCR 12108	Sakata	
ε325	FCR 12112	Sakata	
ε326	VILM5	Vilmorin	
ε327	VILM6	Vilmorin	
ε328	VILM7	Vilmorin	
ε329	VILM8	Vilmorin	
ε330	VILM9	Vilmorin	
ε331	VILM10	Vilmorin	
ε332	VILM11	Vilmorin	
ε333	VILM13	Vilmorin	
ε334	CARVEJO	Seminis	
ε335	CARVORA	Seminis	
ε336	CARBOLI	Seminis	
ε337	NEBULA	Seminis	
ε338	CARRAZZO	Seminis	
ε339	CAROTELLA	Integra	
ε340	KXPC-044	Integra	
ε341	Maxi	Integra	
ε342	KXPC-081	Integra	
ε343	KXPC-425	Integra	
ε344	Coltan	Nunhems	
ε345	Elegance	Nunhems	
ε346	Romance	Nunhems	
ε347	Sirkana	Nunhems	
ε348	NUN 13076	Nunhems	
ε349	Fidra	Rijk Zwaan/Rispens	
ε350	Jerada	Rijk Zwaan/Rispens	
ε351	Morelia	Rijk Zwaan/Rispens	
ε352	Crofton	Rijk Zwaan/Rispens	
ε353	Grivola	Rijk Zwaan/Rispens	
ε354	Joshi	Rijk Zwaan/Rispens	
ε355	SV5300DN	Seminis/Rispens	
ε356	Samantha	Alf. Christianson/Rispens	
ε357	Magnum	Harris Moran/Rispens	
ε358	Gold finger	Harris Moran	
ε359	Triton	Clause	
ε360	Phoenix	Clause	
ε361	Stromboli	Clause	

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Field No.	Entry	Seed Source	Remarks
Kuroda			
–301	KXCP- 510	Integra	
–302	KXCP- 552	Integra	
–303	RANGU	Seminis	
–304	SV5300DN	Seminis	
–305	SV5102DN	Seminis	
–306	Bj 2956	Bejo	
–307	SNZHC 001	Sumika	
–308	SNZHC 002	Sumika	
–309	SNZHC 003	Sumika	
–310	SNZHC 004	Sumika	
–311	SNZHC 005	Sumika	
–312	VILM14	Vilmorin	
–313	VILM15	Vilmorin	
–314	VILM16	Vilmorin	
Dicers			
301	Napa	Bejo	Slicer
302	Finley	Bejo	Dicer
303	Bastia	Bejo	Dicer
304	Bj 2909	Bejo	Dicer
305	Belgrado	Bejo	Dicer
306	CARDIFF	Bejo	Dicer
307	BEIJING	Bejo	Dicer
308	CUPAR	Bejo	Dicer
309	BERN	Bejo	Dicer
310	CORDOBA	Bejo	Dicer
311	BERLIN	Bejo	Dicer
312	VILM17	Vilmorin	Dicer
313	VILM18	Vilmorin	Dicer
314	PX07107318	Seminis	Dicer
315	PX07107315	Seminis	Dicer
316	ABACO	Seminis	Dicer
317	SANTA CRUZ	Seminis	Dicer
318	SV3118DH	Seminis	Dicer
319	NUN 85222	Nunhems	Dicer
320	NUN 85180	Nunhems	Dicer
321	NUN 85190	Nunhems	Dicer
322	MAXIMA	Carosema	Dicer
323	PANAMA	Carosema	Dicer
324	CA8295	Carosema	Dicer
325	CA723	Carosema	Dicer
326	CA12403	Carosema	Dicer
327	Warmia	Rijk Zwaan/Rispens	Dicer
328	Esperanza	Seminis/Rispens	Jumbo Nar
329	WI Dicer #2	University of Wisconsin	Dicer
330	WI DIcer #1	University of Wisconsin	Dicer
331	Moon raker	Harris Moran	Dicer

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Field No.	Entry	Seed Source	Remarks
Novelty			
T301	White Satin	Bejo	
T302	NUN 89141	Nunhems	
T303	Seed Movement White Population	USDA 885–1	
T304	CreamPak	Nunhems	
T305	Mello Yello	Bejo	
T306	PS 07100015	Seminis	
T307	YellowBunch	Nunhems	
T308	(2566 × 6253) × dY	USDA 310-2	
T309	JOD × W.Belgium	USDA 207–1	
T310	Daucus carota Z020	USDA 691-1	
T311	Deep Purple	Bejo	
T312	Purple Sun	Bejo	
T313	PurpleElite	Nunhems	
T314	NUN 89682	Nunhems	
T315	(6139 × 6245) × 6360	USDA 125–5	
T316	6523 × 8438	USDA 277–2	
T317	(S.C. × 0148) × 8197	USDA 273–5	
T318	Red S.C. × (0148 Cg 6220)	USDA 252–2	
T319	8201 × 8197	USDA 273–2	
T320	(S.C. × 0148) × 8201	USDA 274–4	
T321	(S.C. × 6220) × 8201	USDA 275–2	
T322	Red S.C. × (0148 Cg 6220)	USDA 252–4	
T323	((8197 × (P.I. × P.I.)) × 82012)	USDA 131–3	
T324	(Red × 6259) × 8201	USDA 131–2	
T325	Rainbow	Bejo	