Horticulture Innovation Australia

Final Report

Scoping Study of a disorder that reduces shelf life and consumption of green beans

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Summary

A dilemma facing green bean growers is a post-harvest disorder that affects both the aesthetic of the produce and the shelf life. The objectives of this project were to determine the extent of the problem (i.e. localized, regional or nationwide), capture anecdotal observations related to the onset of the problem and factors contributing to the manifestation of symptoms and, where possible, to collect samples for diagnosis of pathogens/pests that may be associated with the disorder and to make recommendations for further R&D or on how to manage this problem.

Symptoms of this post-harvest disorder of green beans, often referred to as "rust" are, for the most part, consistent with symptoms of 'chilling injury'. This is based on interviews with growers and their staff, pathologist, agronomists and industry representatives from Victoria, Queensland and Tasmania, a farm visit and a review of literature. This disorder appears to be well known throughout the industry. Those growers and companies that have recognized the symptoms as chilling injury have taken steps to mitigate the problem, at least in the part of the supply chain under their control.

Beans are a highly perishable commodity and are particularly sensitive to cold temperatures. The expected shelf life for beans is 8-12 days when stored at 5-7.5ºC. Beans can be stored for 2 days at 1ºC, 4 days at 2.5ºC or 8-10 days at 5ºC before chilling symptoms occur. Descriptions of these symptoms include a general opaque discolouration of the entire bean, pitting of the surface, discrete rusty brown spots and rust-coloured diagonal lines. Exposure of mature bean pods to chilling temperatures before harvest exacerbates the problem.

A good knowledge of the factors that affect bean quality and how best to manage these issues on farm and in the supply chain is essential in ensuring optimum life and quality of beans at the point of sale. Careful handling, quick, thorough post-harvest cooling and storage at optimum temperature throughout the supply chain are considered to be the key to maintaining quality and lengthening shelf life of green beans.

The cause of a bacterial disease in a crop in Victoria was identified as *Pseudomonas syringae*. Based on interviews with growers, bacterial diseases are relatively common in bean production in Australia. There is no doubt that a significant infection of bean pods will, in its own right, reduce the quality of bean pods, a problem experienced by a number of growers. In this instance, however, the bacterium was isolated only from leaves, not from pods.

There is detailed quality information available on chilling injury and on bacterial diseases. Growers would benefit from a precise of this material into a form for easy access and consumption. The diagnosis of chilling injury was based mostly on anecdotal evidence. A follow-up during the peak of the season would ensure a more accurate diagnosis of this and bacterial problems and this exercise could serve to raise industry awareness of how to effectively manage post-harvest disorders.

Keywords

Phaseolus vulgaris, green beans, French beans, dwarf beans, snap beans, bacterial brown spot, *Pseudomonas syringae*, chilling injury, storage disorders, post-harvest disorders

Introduction

Green beans (*Phaseolus vulgaris* L.), which include French, dwarf, runner and climbing beans, are a valuable crop in Australia with annual production of approximately 30,000 tonnes worth $73M (Australian Bureau of Statistics, 2009).

Beans are annuals grown during summer in the temperate regions and during the cool, dry season in the tropics and subtropics. They are grown for the fresh market and for processing (e.g. canned or frozen). Queensland and Tasmania produce 85% of the national crop (51% and 34% of total, respectively). Beans are hand-picked or harvested by machine between 7 to 11 weeks after planting. Machine harvesting only allows a single pick compared with multiple picks with hand harvesting. The harvested pods are sorted in packing sheds to remove trash and culls, washed and packed. Beans are passively chilled in conventional cool rooms or hydro cooled before transport. Plant residues remain in the paddock and are either ploughed in or eaten by stock.

A dilemma facing green bean producers is a disorder that affects both the aesthetics of the product and the shelf-life (Figure 1). Efforts to mitigate the problem have failed as the disorder had been misdiagnosed as "rust". The problem has been observed on produce in the major supermarket chains and there has been concern that, if not resolved, consumers could switch to frozen product from New Zealand.

The objectives of this project were to determine the extent of the problem (i.e. localized, regional or nationwide), capture anecdotal observations related to the onset of the problem and factors contributing to the manifestation of symptoms, identify specific cropping periods when the problem has occurred and examine possible correlations between weather patterns and the disorder. The objective was also, where possible, to collect samples for diagnosis of pathogens/pests that may be associated with the disorder.

The project is a scoping study to determine if this problem requires significant R&D to resolve and if not, and then make some recommendations on how to manage this problem.

Figure 1 Post-harvest symptoms of rust-coloured flecks and lesions (left) and 5 mm diameter water-soaked lesions (right) on beans

Methodology

This investigation involved a number of different activities. They included:

- Capturing anecdotal evidence through email and discussions with researchers, growers, company staff responsible for production and produce quality and agronomists involved with green bean production;
- A visit to a key production area in Lindenow, Victoria, to examine the problem first-hand and interview an affected grower and a local agronomist;
- Laboratory diagnoses of possible disorders on samples of plants and bean pods collected on farm, provided by growers and agronomists and from green grocers;
- Literature search on post-harvest disorders of green beans

Outputs

A report in the prescribed HIA format that described the activities undertaken and information clearly outlining areas of research or knowledge gaps for potential further investigation.

Outcomes

Based on conversations, phone interviews and emails from key bean pathologists, agronomists, growers and industry representatives in Queensland, Tasmania, New South Wales and Victoria, the so called "rust" disorder of beans is known throughout the industry but appears to be of particular concern to Victorian growers.

Although a tentative diagnosis at this stage, this study has identified two possible causes of the symptoms that can affect the quality of fresh green beans post-harvest. These are:

- Chilling injury of bean pods post-harvest; and
- A bacterial disease of leaves and pods.

This was based on interviews with more than a dozen persons, including growers, agronomists, researchers and plant diagnosticians, a farm visit in the vegetable production area of near Lindenow, Victoria, and laboratory testing of leaf and bean pod samples from the field, from cold storage and from a greengrocer for presence of pathogens. However, since the study was conducted late in the season, there was no opportunity to observe the 'rust' disorder first hand.

The disorder that was the focus of this study was generally reported back to growers by the supermarket distribution centres, wholesalers and retailers after produce had left the farm. Some of the complaints were made when beans were well past their life expectancy, which indicates a lack of knowledge of best-practice post-harvest handling of the produce in some instances.

The symptoms in photographs provided by a grower (Figure 1) and symptoms described by growers and others are consistent with those of chilling injury such as those shown in Figure 2 and Figure 3. Descriptions of chilling injury symptoms include a general opaque discoloration of the entire bean,

pitting of the surface, discrete rusty brown spots and rust-coloured diagonal lines on the surface. The symptoms can be exacerbated by the presence of free moisture on beans in boxes or prepacks. Rough handling of the beans causing water soaked patches on the skin can add to these problems.

Beans are a highly perishable crop with a relatively short shelf life. They consist primarily of fast-growing, immature tissue that is easily damaged by rough handling, cold temperatures, dehydration and attack by decay organisms.

The expected shelf life for beans is 8 to 12 days when stored at 5-7.5ºC (Cantwell and Suslow 2013). However, beans are very prone to chilling damage, even at 5-7.5ºC. Beans can be stored for 2 days at 1ºC, 4 days at 2.5ºC, or 8-10 days at 5ºC before chilling symptoms occur. The effects will be cumulative when pods are exposed to cold temperatures in the field followed by the farm cool rooms (<5 ºC). These symptoms may not be apparent until beans have been returned to ambient temperature on the retail shelves. Cultivars differ significantly in their susceptibility to chilling injury.

Anecdotally, this problem at Lindenow appeared to be exacerbated by periods of heavy rain in December 2014 and April 2015. On one farm, heavy rain affected bean quality on the bush resulting in a suspension of harvest. Symptoms in this case included opaque blemishes and opaque 'spotting' of the bean skin.

Some growers interviewed were familiar with post-harvest disorders and had learnt how to manage the problem both on farm and in the supply chain. They tended to be the larger operations with the advantage of close relationships with contracted clients.

At Lindenow, the bacterium *Pseudomonas syringae* was isolated from leaf spots in a sample collected from the field, but not from bean pods. The disease was suspected to be Bacterial brown spot (*Pseudomonas syringae* pv. *syringae*), which has been previously reported from this region, but conclusive testing for pathovar was not undertaken. The symptom was reported to be most prevalent during the hottest month of the year in crops under overhead irrigation. There was no evidence that bacterial brown spot was responsible for the chilling injury symptoms observed on the bean pods, although this disease will no doubt reduce bean quality in its own right under high disease pressure.

Green beans were described by one grower as being a very specialist crop. Beans are a highly perishable product and yield and quality can be compromised during the production phase (adverse weather conditions, diseases), during harvest and sorting (physical damage from handling) and post-harvest (handling and chilling injury) in the supply chain. Beans have a shelf-life of 5 to 10 days (Boyette et al.), although this can be extended to 8-12 days under optimum conditions. There is little room for error and rejection of product at the wholesale and retail end of the market can be very costly. There is good quality published material available from North America that provides clear guidelines for good post-harvest management of beans throughout the supply chain (e.g. Boyette et al., Cantwell and Suslow 2013). The focus is on careful handling, quick thorough post-harvest cooling (hydro cooling is a preferred method) and storage throughout the supply chain at 5-7.5ºC.

Guidelines for the effective management of bacterial diseases in the crop include a range of cultural practices and regular foliar applications of copper based compounds (e.g. Dillard and Legard 1991).

Figure 2 Two examples of symptoms of 'chilling injury' on green bean pods (Photo Marita Cantwell, University of California Davis Post-harvest Technology Centre)

Figure 3 Rust coloured diagonal strips on bean pods attributed to chilling injury

Evaluation and Discussion

A more detailed report of the activities undertaken in this study, including summaries of interviews with growers, researchers, agronomists and industry representatives, can be found in Appendix 1.

Based on phone interviews with key representatives in Victoria, Tasmania, New South Wales and Queensland, the post-harvest 'rust' issue would appear to be widely known but of particular concern to Victorian growers.

A number of producers that were interviewed were familiar with 'chilling injury' and believe that they have procedures in place to manage bean quality in the production, harvest and the post-harvest supply chain. This included hydro cooling of beans after harvest, cool storage at 5-7ºC before transport. These producers also had in common close relationships with their retailers, ensuring that the whole supply chain was familiar with appropriate post-harvest management of the produce for optimum shelf-life.

There are a number of references, including extension material and research papers from North America, that provide practical information on post-harvest cooling and handling of beans to maintain post-harvest quality (e.g. Boyette et al., Cantwell and Suslow 2013, Proulx et al. 2010). Consolidating this material for ready access would be of benefit to the industry including wholesalers and retailers.

Bacterial diseases in the crop and on the bean pod were of concern to most growers that were interviewed. Bacterial diseases of beans and their control are well documented in a number of publications (Dillard and Legard 1991, Hagedorn and Inglis 1986, Persley et al. 2010).

Because this study was conducted late in the season, there was little opportunity to examine first-hand the produce that had been rejected at the market due to blemish disorders. Our diagnosis was based mainly on anecdotal and photographic evidence from affected growers. A single bean sample from a greengrocer and several samples of beans taken from the field and from cold storage at Lindenow were submitted to Crop Health Services but no pathogens were isolated, except for *Pseudomonas syringae* from bean leaves collected from the field (as mentioned above). Further examination of material during peak season is recommended.

Recommendations

Green beans are essentially a specialist crop. Once harvested, beans are highly perishable with a shelf life of 5 to 12 days, depending on how they are managed post-harvest and in the supply chain. A clear understanding of best-practice processes that ensure that optimum quality is maintained throughout the supply chain is the key to minimizing losses. Growers would benefit from ready access to information that allows them to make key decisions in the effective management of their bean crop, such as a website and fact sheets that summarise best practice post-harvest management of beans.

Because this study has taken place outside of the peak bean season, the diagnosis of chilling injury as the cause of the 'rust' has been based mostly on anecdotal evidence. A follow-up of the problem during the peak of the season will help confirm the diagnosis and could serve and an extension exercise for growers affected by this problem.

Bacterial diseases also appear to be a problem in bean crops and infection of pods can no doubt reduce quality. Growers would also benefit from accessible information on how to diagnose and control these diseases.

Scientific Refereed Publications

None to report.

Intellectual Property/Commercialisation

Intellectual property will be created in the form of copyright material. These materials will be made

available to all stakeholders of the project. Publications from the project will be made available publically as hard copies or online. No permission requirements are anticipated.

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Appendices

Appendix 1 – Detailed report of a scoping study of a disorder that reduces the shelf-life and consumption of green beans

NB. Confidentiality - The participants of the activities and discussions detailed below have not been asked if they would prefer to remain anonymous. Therefore, this section of the report has remained confidential.

This Appendix provides details of activities and observations undertaken. The approach was to gather anecdotal information from growers and their representatives, agronomists and scientists; visit a field site to look at bean production first hand; collect specimens where possible for diagnosis of potential disease problems and conduct a literature search.

Outcomes of different activities, including details of interviews with growers and others are detailed.