Incidence and sites of visible infection of *Aspergillus niger* on bulbs of two onion (*Allium cepa*) cultivars

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Abstract

The incidence of visible black mould caused by *Aspergillus niger* on the neck, middle and base of onion bulbs was evaluated in the brown-skinned fresh market cultivar Creamgold, and the white-skinned dehydrating cultivar Southport White Globe. Black mould occurred all over the bulbs, but the incidence was lower in the neck region. Infection levels were consistently higher in Creamgold (77.5%) than in Southport White Globe (46.6%). Infection levels increased with increasing bulb size. Nitrogen topdressing was also evaluated, but in a situation where nitrogen levels were already high. Rates up to 150 kg N/ha had no clear effects on black mould incidence and no significant influence on bulb yield or soluble solids concentration.

Introduction

Black mould caused by *Aspergillus niger* v. Tiegh. causes significant economic losses in onions (*Allium cepa* L.) produced in inland New South Wales, because of surface blemish and rotting in storage. The development of *A. niger*, a common saprophyte, is favoured by warm conditions (28–33°C), which are usual during the harvest period in the onion growing areas of south western New South Wales. In these areas, onions are sown from May to August and harvested from November to March.

Black mould is known to develop anywhere on the bulb surface, as well as on interior leaf scale surfaces to which it gains entry via the neck and roots (Burchill 1984). Fungicide applications in the field may reduce the severity of black mould infection in stored onions (Maheshwari et al. 1988), provided fungicides can reach areas of the plant where infection occurs. There is little information available on the relative importance of sites of bulb infection in the field. Fertiliser regimes may also affect disease development in the field. Onion growers in New South Wales often apply in excess of 100 kg N/ha after bulb initiation, in addition to a preplanting application, but the effect of such high nitrogen rates on the incidence of black mould has not been studied.

An experiment was conducted to determine where bulb infection occurred, and to study the influence of nitrogen fertiliser management on the incidence of the disease. Two cultivars were compared, the predominant local brown-skinned table cultivar, Creamgold (syn. Pukekohe Longkeeper), and a major white-skinned dehydrating cultivar, Southport White Globe.

Methods

The trial was sown by Stanhay precision seeder on 25 June 1984 at Leeton Field Station (Lat. 34.6°S) on a grey, semi-self-mulching soil (Gogeldrie clay-loam: van Dijk 1961). Beds (1.5 m centre to centre) had been formed in fallow ground, previously under ryegrass/clover pasture. In May, a dressing of 100 kg N, 39 kg P and 62 kg K/ha as mixed fertiliser (Multigro) was applied about 15 cm deep in four bands per bed. The experiment was laid out in four replicates of a split-plot design, with cultivar as main plots and nitrogen topdressing treatments as sub-plots. Sub-plot size was 10 m of bed, with four plant rows per bed, from which 2 m from each outside row were sampled at harvest.

The onion cultivars used were Creamgold (Excello Seeds) and Southport White Globe (Dessert Seeds). Nitrogen was applied as urea at 0, 50,
100 and 150 kg N/ha on 19 November, when plants had about eight green leaves and were just commencing to bulb (maximum diameter of base approximately double that of neck). The urea was applied by hand directly over each plant row and incorporated by spray irrigation the following morning.

Pre-emergent herbicides were applied immediately after sowing (3.9 kg propachlor plus 7.5 kg chlorthal dimethyl/ha) and a post-emergent grass herbicide was sprayed over the beds in September (1.05 kg aloxydim/ha). Chlorpyrifos was applied on a few occasions to control seedbed pests and thrips. No fungicides were applied. The crop was irrigated by spray irrigation during winter and subsequently by furrow irrigation, except for incorporating the urea application.

Bulbs were harvested on 11 February 1985, after the foliage (tops) had collapsed and dried. Tops and roots were cut off close to the bulb using hand shears and the bulbs placed into storage in a cellar under ambient conditions until they were assessed in mid-May (mean daily temperatures at Yanco weather station were 24.2°C in February, 23.1°C in March, 17.1°C in April and 13.4°C in May). Bulbs were categorised according to quality and size, as marketable bulbs in 1 cm diameter increments, or as non-marketable bulbs (mis-shapen or 'double' bulbs, arising because of excessive growth of subsidiary shoots within the bulb). The number and weight of bulbs was determined for each category. Bulbs were then visually inspected closely for signs of black mould. Dry skins were peeled back where necessary to confirm the presence of black mould. For each category, counts were recorded for bulbs with no visible black mould or with visible black mould infection in the neck (N) region only (upper third of bulb surrounding the neck), base (B) region only (lower third surrounding the root plate), remaining bulb surface only (M), or various combinations of those areas (NM, NB, MB, NMB).

Five bulbs were taken randomly from the marketable bulbs in each sub-plot and processed individually through a domestic juice extractor. Soluble solids concentration (per cent sucrose w/w) of bulb juice was determined with a refractometer.

**Results**

Both Creamgold and Southport White Globe reached maturity (50% of plants with collapsed tops) during late January. The mean number of bulbs per plot for Creamgold (70.6 bulbs/4 m row) was significantly ($P<0.05$) less than that of Southport White Globe (80.9 bulbs/4 m row). Creamgold (11.8 kg total and 10.0 kg marketable bulbs/4 m row) significantly ($P<0.05$) outyielded Southport White Globe (9.5 kg total and 7.6 kg marketable bulbs/4 m row), and also produced significantly ($P<0.05$) larger bulbs, with an average weight of 161 g/marketable bulb, compared with 113 g/marketable bulb for Southport White Globe. The soluble solids content of Southport White Globe was significantly ($P<0.05$) higher, with a level of 19.2% w/w, compared with 11.0% w/w for Creamgold. There were no significant ($P>0.05$) nitrogen or nitrogen:cultivar effects on yield or juice soluble solids concentration.

Black mould incidence was analysed using generalised linear modelling with Poisson errors and log link. The counts of cultivar by nitrogen rate by size class were considered fixed and the response variable was infection class. To facilitate analysis of data according to bulb diameter, the data were grouped into four size classes: < 5 cm, 5–7 cm and > 7 cm diameter and mis-shapen. To provide sufficient bulbs in each category for analysis under the model of interactions with size class, infection classes were rationalised to no visible infection, infection on neck, middle or base alone (N/M/B), infection on neck and middle or neck and base (NM/NB), infection on middle and base (MB), and infection on neck, middle and base (NMB). These groupings were selected because initial inspection of the data showed relatively little difference within each cultivar in the incidence of disease on N, M or B alone (respectively, 6.9%, 3.6% and 3.2% for Creamgold and 9.1%, 7.4% and 2.6% for Southport White Globe), nor between that on NM and NB (2.0% and 2.2% for Creamgold and 1.5% and 0.8% for Southport White Globe).

The interactions between infection class, cultivar, nitrogen rate and size class were tested in a series of nested models (Table 1). The highest order interaction (Cv:N:Scl:1cl) was found not to be significant ($P>0.05$) and was dropped from the model. The interaction of infection class by nitrogen rate was significant (Table 1), but the pattern of counts for nitrogen rate (Table 2) was difficult