Influence of drip irrigation on onion yield & quality

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IN A NUTSHELL

- Mild onions show very good potential in the southern areas of Australia but effects of irrigation management on yield and quality are not well understood
- A replicated trial on a sand hill at Yanco showed significant differences in marketable yield between different irrigation treatments; highest marketable yield was recorded for plots that were drip irrigated at 2 day intervals
- A trial on heavier soils had highest marketable yield with furrow irrigated treatments, but the block showed a high degree of salinity which may have affected the crop, particularly in the drip irrigated treatment

Mild or sweet onions are now occupying a larger space on supermarket shelves. These large straw coloured onions have traditionally been supplied by Queensland producers but increasingly a larger volume of these milder onion types is grown in the southern states, where growers can supply the fresh market between November and February.

Pungency in onions is largely determined by pyruvic acid – a flavour compound which in high concentrations gives strong flavour. In mild or sweet onions, pyruvic acid levels are very low, and although the natural sugar levels in these varieties are also low, they have a "sweet" taste and very little after burn on the palate.

Growing the right variety is the most important factor for successfully producing mild onions and trials conducted by NSW Department of Primary Industries show very good potential for growing mild onions in the southern areas of Australia (see IREC *Farmer's Newsletter*, No. 167, pp 38–39, 'Evaluation of mild onions'). In addition to variety, growing factors also have a big influence on onion pungency. Soil nutrition, irrigation and timing of harvest can all effect pungency. Some of these factors are well understood while less well known is the effect of irrigation management.

More moisture, more pungency

Pungency can be affected by moisture stress (ie the wetter the soil the higher the pungency), therefore the nature of the irrigation system is of critical importance when producing mild onions.

In Texas, USA, mild onions are commercially grown with drip irrigation systems to give an even supply of moisture during bulb development, to achieve acceptable quality. On the contrary, drip irrigation studies on sweet onion in Georgia, USA, showed no consistent effect on quality in respect to soluble solids and pungency. Deficit drip irrigation studies in Australia reported a consistent increase of pungency in moist soils compared with less frequent irrigation or deficit irrigation. The same study also reported that deficit irrigations could maintain marketable onion yields, even with reduced bulb size but lesser numbers of splitting and doubles. The results of this work are very interesting as significant water savings could be achieved by deficit drip irrigation compared with conventional drip irrigation of onion crops.

In the MIA, onions are primarily grown on furrow irrigation or with centre pivot sprinklers. These irrigation systems not only are less efficient in terms of water use efficiency but may also increase the pungency levels of mild onions, making it difficult to meet market requirements. Drip irrigation has the potential to increase the water use efficiency and also ensure bulb quality of mild onion. Drip irrigation offers the more precise control a grower would need to meet the standards required by the mild onion market. Although drip irrigation is used by only a handful of onion growers at present it is believed that it may be the preferred system of the future.

Taking into consideration anticipated market growth and current farm practice, as well as the need to validate the findings of the effect of irrigation management in Australia and overseas, a trial investigating the yield and pungency of standard mild onion cultivars under different irrigation regimes was conducted.

Comparing irrigation regimes & systems

A trial was conducted on a Yanco sand hill to better understand the feasibility of growing onions on sandy soils using conventional 1.5 m beds, as well to investigate the effects of different irrigation regimes on pungency. To ensure

even watering of the bed, two drip lines (TSX 512) were placed at 8 cm depth and 40 cm apart.

Three recognised mild onion varieties, Mellow Yellow, Predator and Sombrero were planted on 19 May, 2004 (6 rows/bed). Standard cultural management was followed.

Three irrigation regimes, with watering at 2, 4 and 7 day intervals, were considered. EnviroSCAN®, gypsum blocks and tensiometers were installed to monitor soil moisture and flow meters were installed to record the amount of water used in each treatment. Various irrigation treatments started by the end of September at the commencement of bulb initiation (5-leaf stage). Less than 40 mm of rain fell during this period, so rain effects were negligible.

Onion bulb yield and quality were recorded at harvest when 80% tops were down (30 November – 6 December, 2004). Pungency was assessed by laboratory analysis of pyruvic acid. All data were subjected to statistical analysis.

Post harvest storage studies were also conducted as part of the trial at the NSW DPI Post Harvest Laboratory of the Gosford Horticultural Institute, to measure how well each variety from the different irrigation treatments maintained quality during 1–3 months storage.

In order to demonstrate the feasibility of using drip irrigation for commercial onion production, a trial was conducted at Pat Demarco's Griffith property, to compare drip irrigation against furrow irrigation, which is the most common form of irrigation by onion growers.

Three mild onion varieties (Predator, Mellow Yellow and Sombrero) and the surrounding grower's crop (Centurion) were evaluated in two separate blocks (100 m apart) of furrow and drip irrigation (drip tapes were laid 35 cm from the edge of the bed) on 1.8 m beds.

The crop and trial was planted on 13 May, 2004. The trial area was managed as part of the entire crop, by the cooperating grower. Furrow irrigation was managed as determined by the grower's experience. Drip irrigation began in later September on the basis of tensiometer readings.

Bulb yield was recorded at harvest on 29 November (when 80% tops were down).

Findings

Research station trial

The bulb yield and quality as influenced by the irrigation treatments and varieties are presented in Table 1. Significant differences were observed for the irrigation treatments on the production of marketable yield (Table 1). Highest marketable yield was recorded for the plots that were drip irrigated at 2 day intervals. This treatment also produced yield with an average of two third of the marketable bulbs larger than 75 mm diameter. Non-marketable double and spilt bulbs were consistently lower Predator (less than 2%), with little variation between irrigation treatments. No apparent significant differences for the total marketable yield were observed between the varieties or their interaction with different irrigation treatments (Table 1). However Mellow Yellow at 2 day treatments excelled all others producing the highest marketable yield of 61.6 t/ha. Higher yield contributed by the higher number of larger grade bulbs with frequent irrigation were also reported by earlier workers.

Table 1
Influence of drip irrigation on bulb quality of mild onion varieties and on productivity of water used

Irrigation interval	Varieties	Large bulb yield (75mm+diam) t/ha	Total marketable yield t/ha	Non marketable yield t/ha	Pyruvic acid µmol/g fresh wt.	Productivity t/ML
2 days	Predator	39.16	52.05	1.01	3.70	9.63
	Mellow Yellow	38.72	61.59	5.07	3.82	11.40
	Sombrero	35.28	54.31	8.17	4.00	10.05
4 days	Predator	35.62	50.62	1.31	3.86	11.77
	Mellow Yellow	25.99	47.75	4.89	3.96	11.10
	Sombrero	31.27	51.84	3.94	3.96	12.06
7 days	Predator	20.36	43.67	1.78	3.48	10.44
	Mellow Yellow	17.95	41.52	5.05	3.82	9.88
	Sombrero	24.89	47.76	4.32	3.60	11.37
LSD .05		NS	NS	NS	NS	
Average						
2 days		37.72	55.98	4.75	3.84	10.37
4 days		30.96	50.07	3.38	3.93	11.64
7 days		21.06	44.32	3.72	3.63	10.55
LSD .05		6.19	6.08	NS	0.21	
	Average					
	Predator	31.71	48.78	1.36	3.68	10.61
	Mellow Yellow	27.55	50.29	5.00	3.87	10.79
	Sombrero	30.48	51.30	5.48	3.85	11.16
	LSD .05	NS	NS	0.41	0.16	

LSD- Least Significant Difference; NS - Not significant

Pungency levels (pyruvic acid) were consistently low across all three irrigation treatments (Table 1). While the 7 day treatment averaged significantly lowest at 3.63 µmol/g, compared to the average for the 2 day and 4 days at 3.84 and 3.93 µmol/g respectively, all variety and treatment combinations were less than 4 µmol/g, well within the acceptable range for mild onions. The variety Predator showed significantly lowest pyruvic acid at 3.68 µmol/g compared with other varieties.

While irrigation intervals remained constant through the trial, the duration varied according to soil moisture levels (recorded using tensiometers, EnviroSCAN and GBug systems). Water applied was higher than expected, with 5.4 ML/ha, 4.3ML/ha and 4.2 ML/ha applied to the 2, 4 and 7 day treatments respectively. In terms of water use efficiency, the 4 day treatment was best at producing marketable bulb yield of 11.6 t/ML compared to 2 and 7 day treatments producing 10.4 and 10.6 t/ML, respectively (Table 1). From a varietal point of view Sombrero was superior to Mellow Yellow and Predator. Most water efficient treatment combination was for Sombrero with 4 days treatment producing 12.1 t/ML.

Post harvest assessment indicated that weight loss was not affected by irrigation frequency or variety during curing or subsequent storage. Firmness was also unaffected by irrigation. However, Mellow Yellow retained firmness during storage better than other varieties trialled. Similarly, pungency was unaffected by irrigation, but varied between varieties and increased significantly during storage.

Although irrigating at 2 day intervals increased marketable yield it also increased the incidence of disease. In the case of Mellow Yellow and Sombrero, increases in yield appeared to compensate for increased incidence of rots, even when the bulbs were stored for up to three months. However, the Predator variety was more susceptible to disease, and this susceptibility greatly increased with frequency of irrigation. In this case total returns may be maximized using less frequent irrigation.

Griffith field trial

For the trial at grower's field the total marketable yield was higher for the furrow irrigated crop compared to the drip irrigated ones in respect to most varieties and also for the average of the varieties (Figure 2). Predator had the highest yield of 70 t/ha in furrows with Centurion producing the lowest yield of 45 t/ha also in furrows. However both varieties performed superiorly in furrows compared to drip. Mellow Yellow and Sombrero had similar yield performance in both the irrigation types. Centurion performed a little better in drip plots as compared to the furrow crops. The trial results therefore suggest no major yield advantage of mild onion varieties grown in drip irrigated plots over the furrow ones. It is not out of place to mention that soil samples collected from the block showed a high degree of salinity which might have affected the crop stand and the subsequent bulb yield. Further commercial level trials are needed in this regard.

Conclusion

Findings from this work will help strengthen an emerging sector of the onion industry. One of the main advantages with drip irrigation is the ability to meet crop water requirements. This is particularly important as the crop matures, as over watering an onion crop near harvest can damage the bulbs and reduce shelf life. This sometimes occurs with furrow irrigation, the most common form of irrigating onions in NSW. Use of drip adds to the cost, but it could be that if in future there is a reliable premium in the market for mild onions, then the extra cost would be justified. The findings also demonstrate the potential of using deficit drip irrigation treatments in sandy soil for production of quality mild onions.

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Further information

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Figure 1 *The results of the irrigation trial were discussed at a field day at Yanco Research Station*

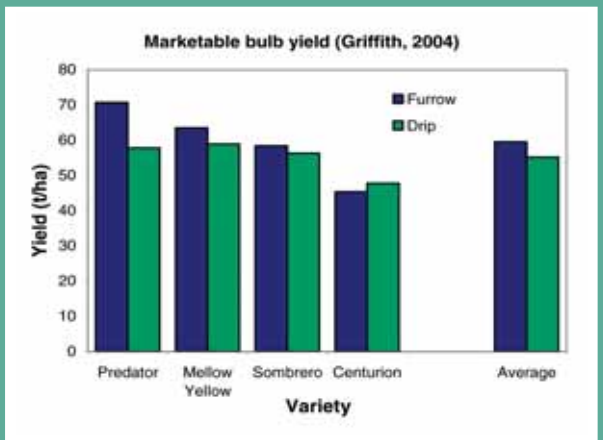

Figure 2 *Marketable bulb yield of onion as influenced by irriagtion type and variety*