Understanding the nuts & bolts of vineyard water use in the MIA

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in a nutshell

- Water use requirements of grapevines are an important issue when planning and scheduling water application
- This paper provides locally derived crop coefficient information for drip irrigated vineyards
- Weather based irrigation scheduling has the potential to provide useful information to vineyard owners at low cost

Understanding the minimum water requirements for grapevines and hence survival of the wine industry in water scarce areas/times requires a clear understanding of total water use. Within the Murrumbidgee Irrigation Area considerable efforts are being undertaken to convert much of the existing 12,000 ha of irrigated vineyards to pressurised drip irrigation systems within the next ten years. To assist planning and design, the potential water savings from these conversions needs to be known and understood, in order to prevent over/under design of systems and to adequately undertake water resources planning and budgeting.

Anecdotal evidence from growers in the area who had switched from flood to drip irrigated systems indicated significant savings in water use on drip irrigated vines compared to flood irrigated vines. Since no previous studies had been undertaken in the MIA to try and quantify water use of vines under drip irrigated conditions, an extensive field trial is being undertaken in a commercial vineyard at Yenda in the MIA.

The methodology advocated by the Food and Agriculture Organisation (FAO) to estimate crop water use (ETc) is to adjust reference crop evapotranspiration (ETo) as measured by weather stations, such as the CSIRO Griffith laboratory station, by a crop coefficient (Kc). Thus, crop water use can be estimated from: ETc = ETo x Kc. Typically, after bud burst Kc values are low and then increase during leaf area development to reach a period of maxima mid season, then decline later in the season.

The FAO suggests adjusting Kc for extremes of understorey management, irrigation method, humidity and wind speed, length of growth periods, stress levels (water and salinity), stomatal control and canopy cover. However, there are very few robust methods growers can use for guidance on these adjustments.

There is substantial variation in crop coefficients published for grapevines ranging from 0.1 to 1.2 that could be attributed to environmental and phenological factors, eg effective canopy cover (determined by leaf area density), foliage extent (vine size and canopy management) and row orientation.

The results from a trial at Yenda will begin to develop some localised crop coefficients for the area and also develop easy techniques for determining crop coefficient information for individual vineyards.

Measurements & equipment

The experimental site is located on a commercial vineyard. A 12 ha Semillon drip irrigated block was instrumented for determining the water balance components over the 2005–06 irrigation season.

Total evapotranspiration was measured using the Bowen ratio energy balance technique which measures key micro meteorological information directly above the transpiring crop to determine the total amount of water being evapotranspirated underneath.

Irrigation volumes were measured using ultrasonic flow meters installed in the vineyard to measure water applied through irrigation to the block and also any surface runoff. A tipping bucket rain gauge was used to log rainfall over the season.

The Semillon vines were 10 years old and on their own roots. The soil consisted of a red-brown earth with a clay loam topsoil. The field was subsurface drained with 1.8 m deep tile drains at 40 m spacing and tile drainage flows were measured with mechanical flow meters installed on the outlet sump.

Results

Total crop water use as measured by the Bowen ratio system in the vineyard at Yenda and reference crop water use as measured at the CSIRO Griffith weather station is shown in Figure 1 for the December 2005 period. The vineyard water use was considerably lower than reference crop evapotranspiration as expected. The daily water use of the vineyard ranged from approximately 1 mm/day to 7 mm/day.

From this information a mid season (peak) crop coefficient could be determined using this data and is shown in Figure 2. The average mid season crop coefficient was found to be 0.52 for the December period and this corresponds to the period of maximum canopy development and therefore maximum water use.

Table 1 shows individual components of the vineyard water balance over the season (defined as 1 September 2005 to 1 April 2006). A total of 7.2 ML/ha of evapotranspiration occurred during the season with 5.2 ML/ha being applied through irrigation water and another 2.2 ML/ha through rainfall during the season. No surface runoff or drainage from the tile drains was recorded during the season. Enviroscan probes were installed in the vineyard and at the start and end of the season soil moisture levels were similar and hence change in soil moisture could be assumed to be small. Therefore total water applied (irrigation + rainfall) was approximately 7.4 ML/ha and total water removed was 7.2 ML/ha. The difference of 0.2 ML/ha is within the measurement error of the instrumentation used.

Considering this breakdown it seems that the drip irrigated vineyard of the study site was maximising the use of all available water from in-season rainfall. Hence it needs to be considered that in total 7.2 ML/ha was used to produce the crop with 30% of ETc being met by in season rainfall. This is an important consideration as in drier years with no in-season rainfall or inadequate soil moisture stores more irrigation water would be required.

The yield was 32.1 t/ha during the 2005–06 irrigation season. The district average was 22.2 t/ha for Semillon which includes crops of all ages grown in the region. As this was a large crop this indicates that the calculated crop water use was most likely at the upper end of vineyard water use for Semillon.

Figure 3 shows historical in-season (1 September to 1 April) rainfall over the past 20 years. Average rainfall was 2.3 ML/ha during this time period. In low rainfall seasons such the 2006–07 season, drip irrigators who traditionally rely on using in-season rainfall will need to be aware that extra water will be needed when budgeting to maintain crop yields.

Future work

Future work is currently being planned to investigate the individual components of vineyard water use and to separate the evapotranspiration into what is actually transpired through the vine and what is lost through inter-row transpiration of weeds and soil evaporation. This is being undertaken with sap flow sensors which are currently being calibrated in large weighing lysimeters being instrumented at CSIRO Griffith, Figure 4.

Table 1: Individual components of the vineyard water balance over the growing season (1 September 2005 to 1 April 2006)

Total vineyard evapotranspiration	7.2 ML/ha
Irrigation applied	5.2 ML/ha
Surface runoff	0 ML/ha
Subsurface (tile) drainage	0 ML/ha
Rainfall	2.2 ML/ha

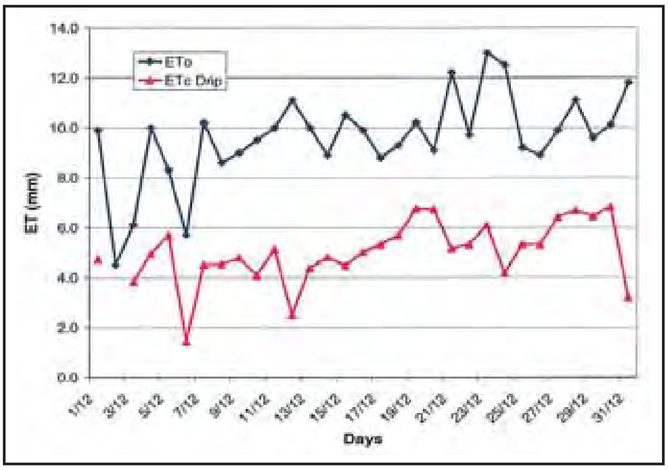

Figure 1: Actual vineyard crop water use (ETc Drip) compared with reference crop water use (ETo)

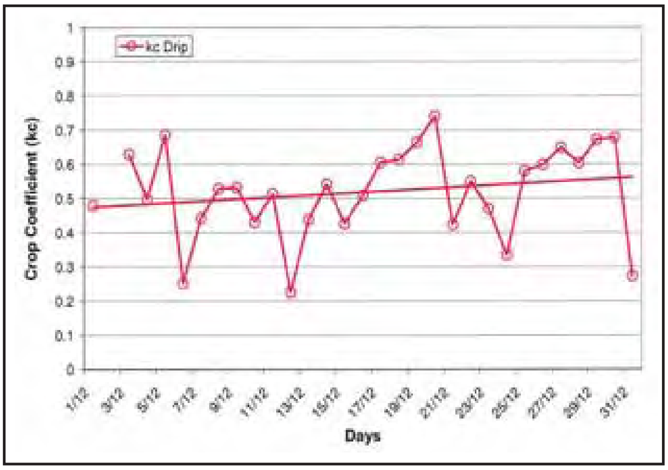

Figure 2: Crop coefficient for December in the drip irrigated vineyard, canopy is mature

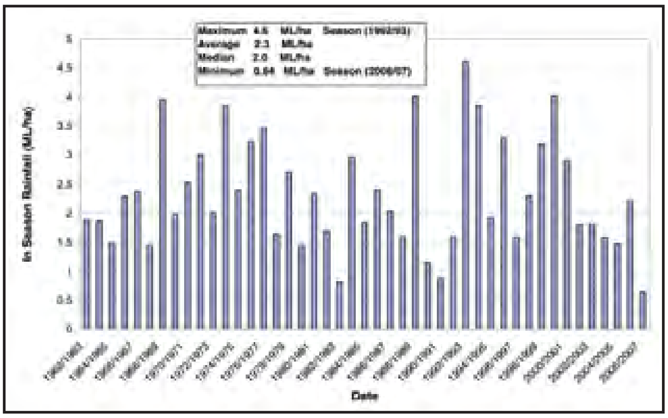

Figure 3: Historical in season (1 September to 1 April) rainfall taken from the CSIRO Hanwood weather station

Methods and tools for determining crop coefficients for individual irrigators, that are low cost and easily available, are also being investigated. This will allow low cost scheduling information to be collected by the irrigator using information from publically accessible local weather stations. At present the ability to determine crop coefficients based on canopy size measurements taken from satellite images is being investigated and relationships are being established at the Yenda site between canopy cover and crop coefficients. This information along with local weather station information is then being combined to provide automated SMS delivery of irrigation scheduling information.

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Further information

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Figure 4: CRC for Irrigation Futures PhD Student Belinda Kerridge standing next to one of the twelve 1500 kg weighing lysimeters currently being constructed at CSIRO Griffith to calibrate grape vine sap flow sensors