# Irrigation Systems – Their Role in Water Requirements and the Performance of Grapevines

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**Irrigation systems were evaluated in three major viticultural areas in South Africa as regards grapevine performance, must and wine quality and the saving of irrigation water. Furrow irrigation saved more than 50% on irrigation water compared to full surface flooding without affecting grape yield, pruning mass and must composition. The irrigation frequency, however, had to be adapted to the volume of soil wetted. Tricklers gave results comparable to that of furrows. In another viticultural region, tricklers saved 25–30% water and the vines yielded a more favourable sugar/acid ratio compared to micro-jets, sprinklers and flood irrigation. In a third trial on a compact silty soil, tricklers gave results similar to that of flooding. Grape yield was not affected by the irrigation system in any one of the trials. Crop factors to be used for irrigation planning and scheduling are presented.**

In many viticultural regions of South Africa, farmers are faced with the problem of achieving high grape yields and good grape quality with limited water supplies. This problem can be addressed by the choice of an irrigation method with a high water application efficiency and by employing an accurate, but preferably simple, method of irrigation scheduling.

Partial wetting of the soil volume can save water, but necessitates an increased irrigation frequency (Moreshet, Cohen & Fuchs, 1983). A reduction in the wetted soil volume can be achieved by either limiting the wetting depth or by irrigating only part of the soil surface. Although trickle irrigation is commonly used for the partial wetting of the potential root zone, various types of micro- and mini-sprinklers as well as furrow irrigation can serve the same purpose. Wetting 40% of the total soil surface with mini-sprayers in comparison with full surface irrigation led to a reduced total water use by orange trees, but fruit yield decreased by 21% in one of the two experimental seasons (Moreshet *et al.*, 1983). Earlier Bielorai (1982) found no yield losses or quality effects in grapefruit when wetting 30%, 40% and 70% of the soil surface with single trickle lines, double trickle lines and sprinklers, respectively. However, yields declined when the tricle irrigation frequency decreased from three to seven days. In both the above-mentioned experiments water use efficiency increased with partial wetting of the root zone. Many other studies on various crops also showed improved water use efficiencies for trickle irrigation compared to conventional irrigation systems (Elfving, 1982; Peacock *et al.*, 1977). Trickle irrigation is, however, no automatic guarantee for improved water use efficiencies, but "must be managed with a high degree of agronomic and technical competence based on fundamental and practical knowledge" (Hillel, 1985).

Large water savings of up to 85% were achieved with daily trickle irrigation of young apple trees compared to sprinkler irrigation every two weeks (Elfving, 1982). The saving of water with tricklers versus sprinklers was largest in a young vineyard but decreased with the age of the vine, viz. 37%, 44% and 22% in the first, second and third years after planting (Peacock *et al.*, 1977).

The Class A-pan provides a simple method to predict evapotranspiration on condition that reliable crop factors are available. Crop factors which have been used in South Africa (Van Zyl, 1981) are only valid for irrigation systems wetting the total surface area. In Australia trickle irrigation applied either daily or on alternate days, based on a crop factor of 0,40, produced grape yields comparable to those of furrow irrigated vines at a crop factor of 0,50 (Smart, Turkington & Evans, 1974). On reducing the crop factor for tricklers to 0,20, yield decreased slightly. In a more recent study McCarthy, Cirami & McCloud (1983) compared Shiraz vines without irrigation to tricle irrigated vines at crop factors of 0,20 and 0,37 in the first season and 0,22 and 0,36 in the second season. The higher crop factors resulted in a significant increase in yield and growth compared to the lower factors, but irrigation scheduled with the higher crop factor had adverse effects on wine quality aspects. The dryland control performed poorer than both irrigation treatments with regard to yield and vegetative growth.

Although localised irrigation holds the promise of water saving, the change from full surface area irrigation to modern-day partial wetting of the soil requires adaptation of irrigation frequencies and necessitates investigations into plant responses. Plant water requirement will probably not change much with partial irrigation which can also limit leaching and evaporation losses from the soil. The experiments reported in this paper were aimed at addressing the above-mentioned aspects with regard to grapevine performance, grape and wine quality and grapevine water requirement. Furthermore, it was attempted to calculate crop factors for both full surface area wetting and localised irrigation for use in practical irrigation scheduling.

## MATERIALS AND METHODS

The response of wine grapes to irrigation systems was investigated at three localities, viz. Oudtshoorn in the

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Little Karoo, Robertson in the Breede River Valley and Lutzville in the Olifants River Valley. All three localities receive less than 250 mm of rain per annum (mostly in winter) and consequently viticulture is not feasible without irrigation. Class A-pan evaporation, rainfall and other climatic data were monitored at each site. The planting distance in all experiments was 3,0 x 1,5 m. Field water capacity was determined in situ at Robertson and coincided with a tensiometer reading of 5 kPa. This value was also considered to represent field water capacity for the other two localities. The water content at 1 500 kPa, as determined in the laboratory, was taken as permanent wilting point and the available soil water viz., the quantity of water retained in the soil between field capacity and permanent wilting point, calculated.

**Oudtshoorn:** The irrigation trial at Oudtshoorn was conducted over 10 years in a Colombar/Rupestris du Lot vineyard trained on a 1,5 m slanting trellis. The 1,5 m deep alluvial soil, classified as an Oakleaf Vaal River according to MacVicar *et al.,* (1977) has a high potential for grape production. Root penetration extended to a depth of 1,2 m and the available soil moisture of the fine sandy loam soil totalled 175 mm over the rooting depth.

The flood irrigation treatments comprised border irrigation, *i.e.* wetting the total soil surface, and irrigation under the vine rows in furrouws of 1 m width. Each treatment plot (12 m x 12 m) was replicated five times. During the last four years of the trial, 4 *l*/h tricklers at a spacing of 3,0 x 0,5 m were also incorporated in the experiment. Irrigations were scheduled with the aid of Class A-pan evaporation and a crop factor of 0,40 during months of peak water consumption, *i.e.* between flowering (November) and harvest (March). An irrigation frequency of three water applications per week was used for tricklers while the soil water replenishment in the case of the two flood irrigation treatments was based on a 50% depletion level. The middle row areas outside the furrows were irrigated during winter in order to grow a cover crop. The soil water status was monitored weekly by gravimetric soil water determinations with 250 mm increments down to a depth of 1,2 m. Sampling was done on three replicate plots of each treatment. Following irrigations, a three day interval was allowed for drainage to stop and for the soil to reach field capacity before soil sampling commenced. Evapotranspiration for all irrigation systems was determined by calculating the decrease in soil water content based on the total soil surface area. Using this data, new crop factors were calculated for periods without rain according to the formula:

Crop factor = Et/Eo
where, Et = evapotranspiration (mm)
Eo = A-pan evaporation (mm)

Irrigation quantities were measured and the grapevine response monitored by determining pruning mass, grape yield and trunk circumference. Must analyses for sugar concentration, total titratable acidity and pH were carried out at harvest according to standard VORI methods.

**Robertson:** In this trial, micro-jet, trickle, sprinkler and flood irrigation were compared in a Colombar/99 Richter vineyard over a period of ten years (for a more detailed description see Van Zyl, 1984). Micro-jets with an application rate of 8,6 mm/h, installed upright 300 mm above ground level at a spacing of 3,0 x 3,0 m, wetted the total surface area. Trickle irrigation was applied at a rate of 4 *l*/h and the spacing between tricklers was 1 m on the lines on the 3 m rows. Sprinkler irrigation was carried out using under-vine sprinklers while flood irrigation took place in 2 m wide furrows under the vine rows. In all cases irrigation scheduling was done with the aid of tensiometers. Micro-jet and trickle treatments were irrigated when the available soil moisture decreased to a 90% level while sprinkler and flood irrigation treatments received water applications at a 50% level of available water. These 90% and 50% soil water levels corresponded to mean matrix potential values for four measurement depths of -11,8 kPa and -43,7 kPa respectively.

Based on a pedological survey and soil physical properties the experimental vineyard was divided into two parts with regard to irrigation scheduling. Treatment plots (15 m x 36 m) of three replications (blocks) were laid out on a sandy loam soil (Hutton) and those of the other three replications on a sandy clay loam soil (Oakleaf). The monitoring of soil water status, soil sampling and the application of irrigation treatments were carried out separately on both soils. As in the case of Oudtshoorn, crop factors were calculated based on evapotranspiration from the total soil surface area irrespective of the irrigation system. The Hutton soil had a capacity of 151 mm/m available soil water and the corresponding figure for the Oakleaf soil was 124 mm/m.

Relevant parameters of plant performance were determined annually on the full-bearing vineyard, must analysed at harvesting and experimental wines made from grapes of four vintages using standard VORI-methods. Experimental wines were judged by a 14-member tasting panel according to the score-card system described by Tromp & Conradie (1979).

**Lutzville:** A comparative study between border and trickle irrigation was conducted over two years in a full-bearing vineyard consisting of 24 wine grape cultivars. Treatment plots (61,0 m x 18,3 m) were replicated four times. The vineyard was planted on an alluvial soil which contained 65% fine sand, was prone to compaction and retained 150 mm/m available soil water. The experimental vineyard was trained on a 1,5 m slanting trellis and had already been irrigated by the two methods for several years, when the study commenced. Border irrigation was scheduled with the aid of tensiometers. A tensiometer reading of 40 kPa in the main root zone (0,35 m – 0,55 m depth) indicated that irrigation was necessary. Tricklers had a spacing of 3,0 x 1,0 m, a delivery rate of 4 *l*/h and irrigations were applied thrice weekly. Tensiometers installed at depths of 0,25, 0,45, 0,65 and 1,0 m and 0,25 m from the trickler were used to establish the correct volume of water applied and to prevent both permanent saturation and drying out of the subsoil. The investigation included measurements of grape yield, pruning mass and the quality of experimental wines made from a selected number of cultivars.

## RESULTS AND DISCUSSION

**Oudtshoorn:** From the start of the experiment a substantial water saving was obtained with furrow irrigation compared to border irrigation at the same irrigation frequency, but grapevine performance suffered severely (Table 1). Grape yield and pruning mass decreased by 32,4% and 35,3% respectively. Typically, the sugar concentration increased and the total titratable acidity declined with the reduced irrigation quantity.

**TABLE 1**
Performance and must composition of Colombar irrigated by two methods at identical frequencies (1978/79 – 1981/82) : Oudtshoorn.

| Irrigation | | Yield (kg/vine) | Pruning Mass (kg/vine) | Sugar (°B) | Total Titratable Acidity (g/l) | pH |
|---|---|---|---|---|---|---|
| Method | Frequency (days) | | | | | |
| Furrow | 21 | 7,96 | 2,44 | 19,19 | 8,83 | 3,21 |
| Border | 21 | 11,78 | 3,77 | 18,44 | 9,24 | 3,22 |
| Significance | | * | ** | * | * | NS |

NS – Not significant
* – Significant (P≤0,05)
** – Highly significant (P≤0,01)

A study of the wetting pattern under furrows revealed a limited soil water reservoir, approximately 2 m wide and 0,60 – 0,75 m deep. It was obvious that this small soil water supply could not sustain the grapevine sufficiently between irrigations. Consequently the irrigation frequency of furrow irrigation was increased by 33% above that of border irrigation. This new schedule resulted, on average, in a period of 14 days for furrow irrigation compared to the 21 days for the border irrigation. After this change, the grapevines watered by furrows went through an adaptation phase of one year. Thereafter the yield, growth and grape composition of furrow and border irrigated vines were similar (Table 2).

**TABLE 2**
Performance and must composition of Colombar after increasing the irrigation frequency in furrows by 33% (1983/84 – 1985/86) : Oudtshoorn.

| Irrigation | | Yield (kg/vine) | Pruning Mass (kg/vine) | Sugar (°B) | Total Titratable Acidity (g/l) | pH |
|---|---|---|---|---|---|---|
| Method | Frequency (days) | | | | | |
| Furrow | 14 | 13,64 | 1,73 | 19,56 | 9,30 | 3,28 |
| Border | 21 | 12,46 | 1,88 | 19,85 | 9,17 | 3,26 |
| Significance | | NS | NS | NS | NS | NS |

NS – Not significant (P≤0,05)

A very large saving of 53,7% in irrigation water was still obtained with furrows (Table 3). The 457 mm of water applied through furrow irrigation was lower than the 594 mm seasonal requirement of vineyards as proposed by Van Zyl (1981) for the Little Karoo. Root studies and soil water determinations, however, showed that the vines were able to utilize water from rainfall or winter irrigations stored between the furrows (Van Zyl, 1988). Actual evapotranspiration (AET) on this treatment can be calculated to be 581,4 mm by employing the following formula:

$$AET = I + P \pm \triangle SW$$

where,

I = Irrigation water applied (mm)
P = Precipitation during growing season (mm)
$\triangle$ SW = Change in soil water content between the beginning and end of the season (mm)

In view of the shallow wetting under the furrows and absence of a water table, drainage and capillary rise were considered negligible and disregarded in the above formula. No run-off occurred.

In the case of partial wetting of the soil volume, $\triangle$SW differed between wetted and non-irrigated areas. Taking this into account as well as a 2:1 ratio of wetted:dry volume, the $\triangle$SW for furrow irrigation was 66,8 mm on average. In this particular experiment effective rainfall amounted to a seasonal average of 57,6 mm; showers of less than 10 mm were considered as ineffective in replenishing the soil water content.

**TABLE 3**
Gross quantity of irrigation water (seasonal average 1983/84–1985/86) applied in a Colombar vineyard under two methods of flood irrigation at Oudtshoorn.

| Irrigation Method | Irrigation Quantity | | Water Saving (%) |
|---|---|---|---|
| | Average/ application (mm) | Total/ season (mm) | |
| Furrow | 55 | 457 | 53,7 |
| Border | 137 | 987 | – |

The saving of water obtained with furrows is explained by a shallow wetting depth due to easier control, which prevented water losses from the root zone. Evaporation losses were also limited in the furrow-irrigated treatments because the wet surface area was small and mostly shaded which was in contrast to the border irrigated treatment. The heavy water application of 137 mm in the case of border-irrigated plots led to undesirable water percolation beyond the lower boundary of the root zone.

Tensiometer readings on trickle irrigation plots showed that the schedule was correct and that water loss through percolation was limited to a minimum (Fig. 1). On this high potential soil during the 1986/87 season, tricklers (551 mm per season) did not save irrigation water compared to furrows nor dit it increase the yield above that of the other two conventional irrigation methods (Table 4).

**TABLE 4**
Performance and must composition of Colombar under three irrigation systems at Oudtshoorn (1986/87).

| Irrigation system | Grape yield (kg/vine) | Pruning mass (kg/vine) | Sugar (°B) | Total titratable acidity (g/l) |
|---|---|---|---|---|
| Trickle | 13,56 | 1,55 | 21,42 | 9,40 |
| Furrow | 13,87 | 1,71 | 21,16 | 9,60 |
| Border | 13,70 | 1,70 | 19,98 | 10,00 |
| Significance | NS | NS | NS | NS |

NS – Not significant (P≤0,05)

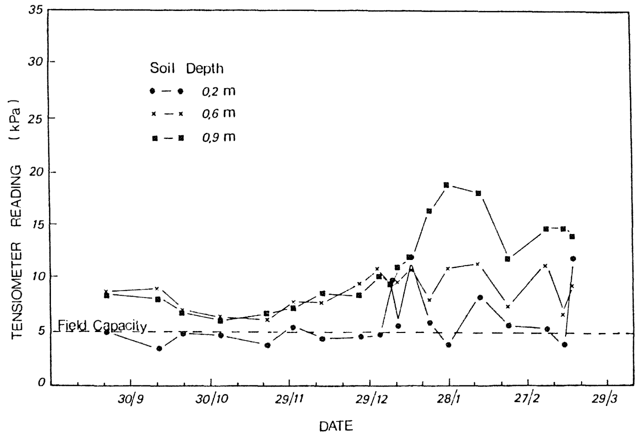


**FIG. 1**
Tensiometer readings on trickle irrigated plots in a Colombar vineyard at Oudtshoorn during the 1986/87 season.

Crop factors calculated for border irrigation, furrows and tricklers are presented in Fig. 2. The figures for trickle and furrow irrigation compare well, and are on average 13,3% lower than for full surface flooding from October to February. During the two months of peak water consumption (December and January) the crop factor for furrows surpassed that of the trickle plots.

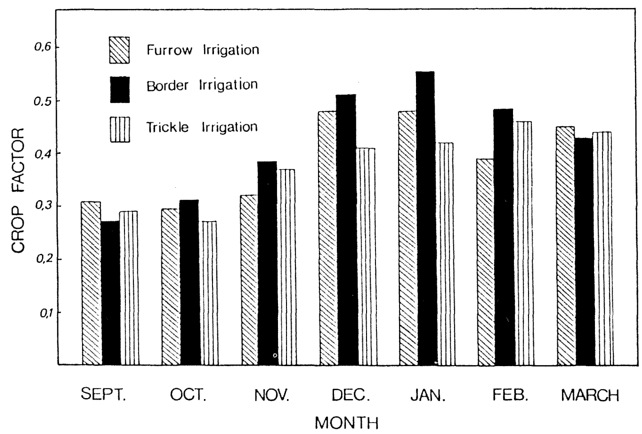


**FIG. 2**
Crop factors determined for three irrigation systems in a full bearing Colombar vineyard at Oudtshoorn.

**Robertson:** Trickle irrigation resulted in the lowest pruning mass of the four irrigation systems in most of the seasons as illustrated by cumulative data (Table 5). A reduction in vegetative growth is not necessarily a negative effect, because excessive growth can be unfavourable for grape production and quality and conducive to fungal diseases. The four irrigation systems did in fact yield similar grape masses (Table 5). Moreover, grapes from trickle irrigated vines had a significantly higher sugar concentration and tended to produce lower concentrations of TTA. The malic acid concentration in grapes from trickler plots was also lower than in grapes produced under micro-jets (Van Zyl, 1984). Grapes from trickle treatments could consequently be harvested up to three weeks earlier than those of the other treatments due to the more favourable sugar/acid ratio. This difference in grape composition was most probably a result of the micro-climate inside the grapevine canopy as affected by shoot growth.

Micro-jets, sprinklers and flood irrigation did not differ as regards the quantity of irrigation water required (data not shown). However, under less optimal conditions than those of the experiment (management, soil depth, etc.), the gross quantity of irrigation water required would be higher for the latter two systems. Colombar, a late cultivar with a long growing season, had a nett irrigation requirement of 594 mm between bud burst and harvesting at Robertson for total surface area wetting. A water saving of 25–30% was obtained with trickle irrigation compared to the three other systems (data not shown). This saving could be attributed to the fact that only 33% of the total soil volume was wetted by the tricklers. Although 65% of the total number of grapevine roots was confined to this wet area, live roots were observed in the non-irrigated soil volume between rows (Van Zyl, 1988). Water extraction by these roots probably explains why gravimetric determination of soil water content, both at Robertson and Oudtshoorn, showed fairly rapid soil water depletion from the inter-row soil volume (Van Zyl, 1988). Consequently the total quantity of soil water available for evapotranspiration should include the 81,3 mm and 101,4 mm in the Oakleaf and Hutton soil, respectively, which were stored from rainfall in the soil volume outside the wetted area as well as the 40,6 mm of effective rain which occurred in showers of more than 10 mm. Therefore, the quantity of water available to trickle irrigated vines (AET) depended on soil type, viz. 494,8 mm for the Oakleaf and 514,9 mm for the Hutton. These quantities agreed well with the approximately 500 mm which Van Zyl & Van Huyssteen (1984) estimated to be the water requirement of grapevines.

Applying water through micro-jets in small quantities (10–12 mm) resulted in insufficient percolation of water to the subsoil. Consequently the water content of the two shallower soil layers, 0–250 mm and 250–500 mm, remained close to field capacity while water

**TABLE 5**
Mean* effect of irrigation system on the performance, must composition and wine quality of Colombar at Robertson.

| Irrigation System | Grape Yield (kg/vine) | Pruning Mass (kg/vine) | Sugar (°B) | Total titratable Acidity (g/l) | pH | Wine Quality (%) |
|---|---|---|---|---|---|---|
| Micro-jets | 15,58 a | 1,99 a | 17,90 a | 9,76 a | 3,29 a | 48,8 a |
| Tricklers | 14,81 a | 1,44 b | 18,37 b | 9,09 b | 3,27 a | 51,0 a |
| Sprinklers | 15,91 a | 1,92 a | 17,87 a | 9,74 a | 3,28 a | 49,6 a |
| Border | 15,33 a | 1,80 a | 17,81 a | 9,54 a | 3,29 a | 52,0 a |

Figures followed by the same letter do not differ significantly at a 5% level.

* Data are means obtained over six years except wine quality which was evaluated in only four seasons.

deficits often occurred in the deeper layers (Fig. 3). Drying of the subsoil could only be prevented by heavier irrigations from time to time.

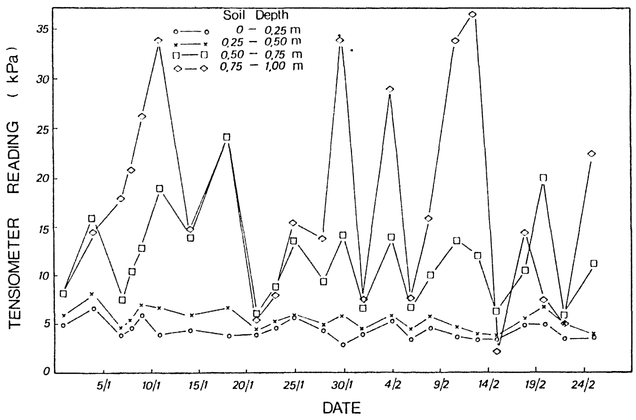


**FIG. 3**
Tensiometer readings at different depths on a micro-jet plot maintained at a 90% soil water regime during two months of peak water consumption of Colombar on an Oakleaf soil at Robertson.

Tensiometer readings at all depths increased at a very fast rate on trickle treatments due to a small reservoir of soil water (Fig. 4). This rapid change in soil water potential required an irrigation frequency of at least three water applications per week. Micro-jets,

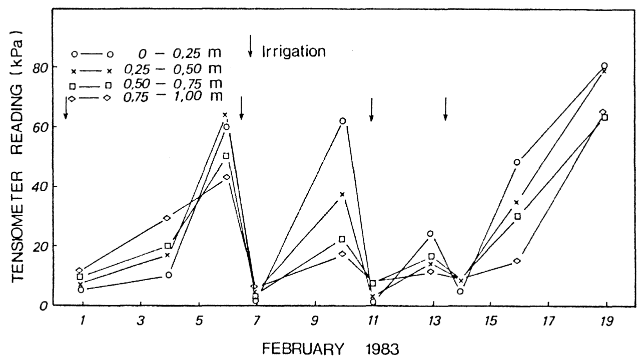


**FIG. 4**
Rapid increase in tensiometer readings at different depths on trickle plots due to the small reservoir of available soil water for a Colombar vineyard on an Oakleaf soil at Robertson.

wetting a larger soil volume than tricklers, were able to maintain a 90% soil water regime at an irrigation frequency of two applications per week. Sprinklers and flood irrigation which operated at a 50% soil water regime had a mean irrigation interval of 16 days on the Oakleaf soil and 22 days on the Hutton soil.

Similar to the irrigation water requirement data (not shown), crop factors calculated for micro-jets, sprinklers and flood irrigation were not significantly different (Table 6). These factors also agreed well with those determined for border irrigation at Oudtshoorn (Fig. 1). Crop factors increased sharply from October to November, but were quite stable from then onwards except for border irrigation where a definite increase was noted for January and February. The other irrigation systems yielded no distinct peak in any one month. The crop factors for border, sprinklers and micro-jets increased on average from 0,42 in November to a maximum 0,49 in January and 0,51 in February. The mean crop factor for these systems for March was 0,48 which was higher than the 0,30 accepted previously for wine grapes (Van Zyl, 1981). With the exception of October values, the crop factors in Table 6 (trickle irrigation excluded) were on average 20% higher than the factors presently in use for wine grapes.

Crop factors for trickle irrigated vines were significantly lower than those for the three other irrigation systems and in good agreement with Australian values of 0,30 used for grapevines throughout the season (Smart, *et al.*, 1974) and 0,30 – 0,40 used for trickle with sewage effluent on Shiraz (McCarthy, 1981).

**Lutzville:** No significant differences were found between flood and trickle irrigation as regards both grape yield and shoot growth for all 24 cultivars (Table 7). The organoleptic evaluation of experimental wines made from a selected number of red and white cultivars also showed a good similarity between the two irrigation systems. The small differences between irrigation systems were not significant.

During both seasons seven flood applications (gross quantity of 700 mm per season) were given between bud burst and harvest. Based on tensiometer readings an irrigation cycle of 16 days was used during the period of peak water consumption (January). The total water application with tricklers was 714 mm and 735 mm for the two seasons respectively and was practically the same as those applied with flood irrigation. The failure to save water with tricklers in this experiment was due to the very slow water infiltration rate on these soils which contained a high percentage of fine sand (10% clay; 6% silt; 66% fine sand; 15% medium sand and

**TABLE 6**
Crop factors for Colombar irrigated by different systems at Robertson (means of five years).

| | Irrigation System | | | | |
|---|---|---|---|---|---|
| Month | Micro-jets | Tricklers | Sprinklers | Border | Mean* |
| Oct. | 0,29 | 0,13 | 0,30 | 0,28 | 0,29 |
| Nov. | 0,45 | 0,36 | 0,44 | 0,36 | 0,42 |
| Dec. | 0,48 | 0,33 | 0,50 | 0,38 | 0,45 |
| Jan. | 0,49 | 0,33 | 0,47 | 0,52 | 0,49 |
| Feb. | 0,48 | 0,36 | 0,53 | 0,52 | 0,51 |
| March | 0,47 | 0,35 | 0,52 | 0,45 | 0,48 |
| Mean** | 0,44 | 0,31 | 0,46 | 0,42 | |

* Does not include tricklers
** Least significant difference ($P \leq 0,05$) for seasonal mean per irrigation system = 0,05.

**TABLE 7**

Mean grape and shoot mass for 24 grapevine cultivars and mean wine quality for selected cultivars obtained with two methods of irrigation during the 1978/79 and 1979/80 seasons – Lutzville.

| Irrigation Systems | Grape Yield (t/ha @ 20°B) | | Shoot Mass (t/ha) | | Organoleptic Wine Quality (%) | |
|---|---|---|---|---|---|---|
| | 1978/79 | 1979/80 | 1978/79 | 1979/80 | 1978/79* | 1979/80** |
| Border | 24,32 | 29,48 | 2,35 | 3,97 | 61,4 | 42,2 |
| Trickle | 23,44 | 29,73 | 2,43 | 4,17 | 61,3 | 42,0 |
| Significance | NS | NS | NS | NS | NS | NS |

NS – Not significant (P≤0,05)
* Mean of six cultivars
** Mean of ten cultivars

3% coarse sand) and tended to compact under irrigation and clean cultivation. Water formed small puddles on the soil surface along the trickle lines; a phenomenon which, in this arid climate, probably resulted in heavy losses through evaporation. This unfavourable situation became more acute towards the end of the season as manifested in the drying of the subsoil. Slow water infiltration did not occur to the same extent under border irrigation, probably due to cracks which formed in the drying soil and acted as channels for water infiltration.

## CONCLUSIONS

Irrigation experiments in three viticultural regions proved that a sophisticated irrigation system alone is no guarantee for increased grape yields compared to the more conventional flood and sprinkler irrigation. When managed properly the latter two systems can produce the same beneficial result obtained with micro-jets and tricklers. However, partial wetting of the soil surface area can result in a large saving of irrigation water. The use of furrow irrigation in the Little Karoo can save more than 50% water compared to full surface border irrigation without a negative effect on grapevine response or must quality. An increased irrigation frequency to provide for the smaller soil water reservoir is a prerequisite for this favourable effect with furrow irrigation. Irrigation frequency was in fact strongly dependent on the irrigation method. Trickle irrigation showed no advantage over furrows as regards the saving of water or grape quantity and quality. A system of permanent furrows also permits the watering of the areas between the furrows. In contrast to tricklers such between-furrow irrigations in winter allow the growing of a cover crop on the total surface area.

In the Robertson area a water saving of up to 25–30% can be obtained with trickle irrigation compared to sprinklers and micro-jets. Vines under trickler irrigation produced grapes with a more favourable sugar/acid ratio which can probably be attributed to their weaker vegetative growth and the resulting more favourable micro-climate around the bunches. This result demonstrated the possibility of growth and grape quality manipulation with the aid of localised irrigation such as tricklers.

Soil type affects the success and consequently also the choice of an irrigation system. In contrast to the successful use of tricklers on representative soils of two regions, viz. Oudtshoorn and Robertson, this system offered no advantages over flood irrigation on the compact silty soil of the Olifants River Valley. Insufficient percolation of irrigation water to the subsoil was a problem when low volume – high frequency irrigations were used on such a compact soil. This problem was probably due to dispersion of the clay fraction, directly as a result of leaching of salts by good quality irrigation water under the emitter.

The crop factors presented in this paper were determined over many years and should replace factors presently in use.

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