PHYSIOLOGICAL AND GROWTH REACTION OF SHIRAZ/101-14 MGT TO ROW ORIENTATION AND SOIL WATER STATUS

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Abstract:

Context and purpose of the study - Advanced knowledge on grapevine row orientation is required to improve establishment, management and outcomes of vineyards on terroirs with different environmental conditions (climate, soil, topography) and in view of a future change to more extreme climatic conditions. The purpose of this study was to determine the combined effect of row orientation, plant water status and ripeness level on the physiological and viticultural reaction of Shiraz/101-14 Mgt.

Material and methods – The project is carried out in the Breede River Valley, Robertson, South Africa. Shiraz(clone SH 9C)/101-14 Mgt vines were planted during 2003 to a VSP trellis and four row orientations (NS, EW, NE-SW, NW-SE), replicated five times on a flat terroir with uniform clayey loam soil. Vines are spaced to a fixed distance of 1.8 x 2.7 m and pruned to two buds per spur. Since 2014, two water deficit levels are applied to each row orientation treatment, i.e. 75 % and 50 % of the control (reference), the latter receiving the full soil water adjustment per week (based on ET_0 values and standard seasonal crop factors). Grapes are harvested at two ripeness levels, i.e. targeting 23 °B and 25 °B.

Results - Total relative evapotranspiration (ETo) fluctuated prominently according to T_{max}, RH_{min} and especially Radiation changes. Photosynthetic activity of the 50 % irrigation treatment tended to be lower across row orientations. Photosynthetic activity of primary leaves decreased during the season. Stem water potential generally decreased with higher water deficit. Clear diurnal and nocturnal profiles of photosynthesis and water potential occurred. The collective physiological response of vines to various environmental factors (light, water availability, temperature, humidity) is complicated and requires understanding at whole plant level. Results on vegetative and reproductive growth characteristics as well as grape composition were variable, but trends are surfacing. Primary and secondary leaf area as well as total leaf area/vine seemed reduced by water deficit treatment. This led to a general increase in primary:secondary leaf area ratio for water deficit treatments. This ratio is an indication of the presence of young leaves in the canopy and is an important measure of canopy capacity to support the obtainment of full grape ripeness. Canopies of control vines thus seemed better suited for supporting complete grape ripening, confirming the importance of judicious vine management to increase the presence of younger leaves. Mass and volume parameters of berries and bunches as well as yields at the two ripeness levels were mostly reduced by water deficit treatments. Differences between the 100% and 75% irrigation treatments were not consistent. Yields generally showed large losses from the first to the second ripeness level.

Key words: Row orientation, Water deficit, Ripeness level, Physiology, Growth

1. Introduction.

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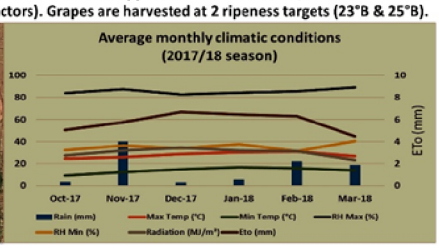
Context and Purpose

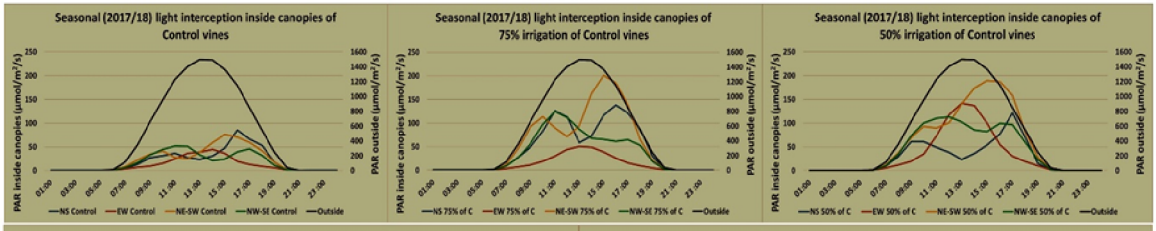
Climate change is a global concern. Drier and warmer conditions may be expected in future and stored water may become less available for agricultural use. Advanced knowledge is required to aid the choice of scion-rootstock combination, vineyard practices, and management techniques of vineyards in order to improve the capacity of the grapevine to endure stressful conditions over seasons on complex terroirs that are often marginal in soil type and water holding capacity. Prediction of grapevine behaviour in different soil-climatic-geomorphometric environments is a priority. Together with temperature, plant water status is generally recognised as one of the most critical factors impacting on grapevine growth balances (Smart & Coombe, 1983; Schultz & Stoll, 2010; Hunter & Bonnardot, 2011). It is known that vineyard row orientation affects canopy microclimate, thus also evapotranspiration; the grapevine may therefore experience prevailing macro- and mesoclimate and soil conditions differently depending on the orientation of the vineyard rows (Zufferey *et al.*, 1999; Intrieri *et al.*, 1999; Hunter *et al.*, 2010; Hunter *et al.*, 2016, 2017a, 2017b). The combined effect of a specific row orientation, soil/plant water status level and grape ripeness level/harvest date would clarify the impact that row orientation may have on plant water relations, growth, yield, grape composition and wine quality/style.

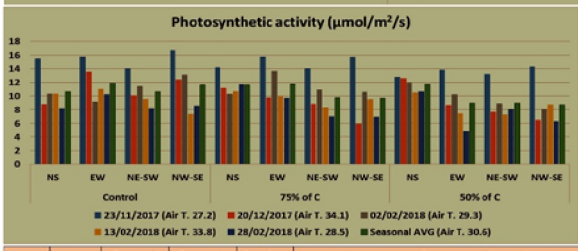
Material and Methods

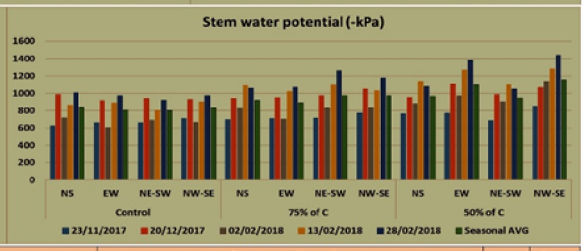
Shiraz(clone SH 9C)/101-14 Mgt vines were planted in 2003 to a VSP trellis and 4 row orientations (NS, EW, NE-SW, NW-SE), replicated 5 times on a flat terroir with uniform clayey loam soil. Vines are spaced 1.8 x 2.7m and pruned to 2 buds/spur. Since 2014, 2 water deficit levels are applied to each treatment, i.e. 75% & 50% of control, the latter receiving a weekly full soil water adjustment (based on ET0 & standard seasonal crop factors). Grapes are harvested at 2 ripeness targets (23°B & 25°B).



Results







Row orient.	Irrigation level	Total leaf area/prim. shoot (cm²)	Total leaf area/vine (cm²)	Prim:Sec leaf area ratio	Ripeness level/Harvest 1							Ripeness level/Harvest 2							% Yield loss	Shoot mass (kg/vine)
					Yield (t/ha)	Bunch mass (g)	Bunch vol. (cm3)	Berry vol. (cm3)	Sugar (°B)	TA (g/l)	pH	°B:TA ratio	Yield (t/ha)	Bunch mass (g)	Bunch vol. (cm3)	Berry vol. (cm3)	Sugar (°B)	TA (g/l)	pH	°B:TA ratio		
NS	Control	2631,3	63150,5	0,9	13,00	152,3	125,7	1,3	22,22	5,03	4,16	4,47	10,45	190,3	166,4	1,1	25,04	4,74	4,20	5,32	19,61	1,10
	75% of C	2115,4	50770,2	1,1	8,96	162,5	133,3	1,2	23,04	4,54	4,11	5,11	7,87	179,7	154,2	1,1	25,58	4,56	4,11	5,62	12,18	0,76
	50% of C	2244,8	53875,6	1,7	8,34	158,6	138,9	1,1	22,72	4,69	4,09	4,90	7,93	139,9	120,5	0,9	25,98	4,75	4,14	5,48	4,97	0,83
EW	Control	2859,4	68626,1	1,1	12,18	164,3	125,8	1,3	21,68	5,02	4,04	4,45	9,62	187,2	158,8	1,2	25,32	4,91	4,15	5,24	21,04	1,27
	75% of C	2903,7	69690,0	1,0	10,36	166,8	139,7	1,3	22,00	4,94	4,08	4,46	9,38	168,8	150,9	1,2	25,26	4,90	4,19	5,16	9,45	1,01
	50% of C	2047,8	49147,5	1,7	7,41	135,9	116,4	1,0	22,90	4,93	4,28	4,70	6,71	169,8	148,5	1,1	26,04	5,05	4,14	5,15	9,51	0,67
NE-SW	Control	2693,7	64648,3	1,4	11,63	155,3	129,2	1,3	23,14	4,95	4,11	4,73	11,00	184,0	158,4	1,2	25,52	4,70	4,17	5,45	5,47	1,13
	75% of C	2692,4	64618,3	1,1	11,94	185,0	160,8	1,2	22,34	4,39	4,06	5,12	10,70	153,9	141,9	1,0	26,12	4,65	4,11	5,68	10,39	0,88
	50% of C	2277,6	54661,9	1,7	10,92	149,5	131,3	1,1	22,92	4,81	4,08	4,79	8,82	169,8	151,5	1,1	26,10	4,85	4,14	5,45	19,29	0,81
NW-SE	Control	2869,1	68859,2	1,1	11,66	193,1	160,6	1,3	21,58	4,67	4,32	4,71	10,18	189,9	172,9	1,2	25,70	4,70	4,21	5,49	12,67	1,21
	75% of C	2941,6	70597,7	1,2	11,93	197,4	169,4	1,2	22,52	4,93	4,10	4,58	7,94	176,6	156,5	1,0	25,80	4,78	4,17	5,45	33,42	0,81
	50% of C	2459,9	59038,2	1,5	8,71	196,5	166,5	1,1	22,64	4,83	4,09	4,74	7,57	142,9	124,8	1,1	25,82	4,72	4,15	5,54	13,14	0,75

Conclusions

The ET0 fluctuated according to Tmax, RHmin and radiation changes. Photosynthesis and stem water potential of primary leaves indicate a general seasonal decline. At this stage of the study, NS orientation shows higher seasonal stability under water deficit. Growth is deleteriously affected by water deficit (especially 50%), yields reduced and must sugar increased. The seasonal decrease in primary leaf photosynthesis points to correct management to increase younger leaves in the canopy to support grape ripening. Understanding of physiological response mechanisms at whole vine level is required for sound deductions under field conditions.

Acknowledgements

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