

# Oregon Wine Advisory Board Research Progress Report

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## Plant Growth, Leaf Gas-Exchange, Fruit Yield and Quality as Affected by Green Covers

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### ABSTRACT

Three different green cover treatments were compared in their effect on leaf gas-exchange, vine growth, yield and fruit composition. The treatments were: grass cover, resident plants, and an insectary plant mixture. Photosynthesis, transpiration, and water use efficiency were lower for vines with a grass cover. Leaf area and shoot growth did not show a response to green cover treatment. There were no treatment responses in yield and yield components except for mean berry weights which were lower for vines with a grass cover. There were no differences in must soluble solids or total sugar per vine. Titratable acidity was higher for vines with a resident plant cover and pH was higher for vines with an insectary plant cover. The results reflect, to some extent, the higher degree of root zone competition experienced by vines with a grass cover.

### INTRODUCTION

Increasing ecological awareness led to the conceptualization and implementation of sustainable production system such as Integrated Production. Integrated Production (IP) aims at achieving optimum yields of high quality fruit utilizing environmentally safe procedures. Priority is given to the utilization and enhancement of natural regulating processes and to the reduction of pesticides and fertilizers. The concept of IP requires the optimization of all measures taken by the grape grower to avoid inappropriate activities that exert a negative impact on the agro-ecosystem.

The crucial element of Integrated Production in viticulture is the ecological diversification of the agro-ecosystem "vineyard" and the maintenance of its ecological stability by minimizing potentially disturbing factors. The green cover is utilized to increase biodiversity and ecological stability of the vineyard ecosystem. It is closely related to 3 other important components: (1) beneficial insects (insect predators and parasitoids), (2) predatory mites and (3) the nitrogen cycle. The presence of flowering plants dramatically increases the faunistic diversity of the vineyard, contributing to the natural regulation of pests and, by providing pollen as an alternative food source, contributes to the survival of beneficial insects during times of low prey densities. An "alternate mowing regime" (the oldest interrow is mowed when the youngest interrow begins flowering) permits the maintenance of this important equilibrium, by assuring the constant supply of flowering plants. Other elements directly linked to the presence of a green cover are erosion control, improved soil structure, reduced nutrient loss, and if nitrogen fixing plants are present, it also contributes to the supply of nitrogen to the vines.

With the aim of increasing vineyard biodiversity, a replicated trial with three different soil management

strategies was established at the OSU Woodhall vineyard. The effect of the green cover on vine performance was evaluated by measuring photosynthetic rate, water use efficiency, vegetative growth, yield and fruit composition.

## **MATERIALS AND METHODS**

### **Experimental design**

Three different green cover treatments were established in an own-rooted Pinot noir (clone UCD 22) seventeen-year-old vineyard at Alpine, Oregon. The perennial grass cover that dominates the entire vineyard was compared to a treatment where the soil was tilled in the Spring to allow the emergence of other resident species, particularly broad leaf species, and to a commercial insectary plant mixture of low growing plants sown in the spring after tilling. The plant mixture includes the following species: carrot, chervil, coriander, clovers (crimson, white, rose), subclovers, nasturtium, parsley, alyssum and yarrow.

Each green cover treatment was replicated four times, and the replicates consisted of two adjacent inter-rows. Data was collected in five homogeneous vines per replicate in the rows with the same cover on both sides. The vine rows with different treatments on each side were not used in the experiment. The grass cover was mowed in alternate rows, three during the growing season. The other two treatments did not grow enough to justify mowing

### **Gas exchange measurements**

Gas exchange measurements were conducted approximately at weekly intervals on the 10th main leaf from the base of one shoot per vine in three vines per replicate. Leaf gas exchange was measured with a portable infra-red gas analyzer (Ciras-1, PP SYSTEMS, Hitchin, Herts SG5 1RT UK). The measurements were carried out between 9:00 and 12:00 a.m., at photosynthetic flux densities above 1000  $\mu\text{mol m}^{-2} \text{s}^{-1}$  and cloudless skies. The sampled leaves were fully exposed to the sunlight. The air temperature ranged between 26 and 31°C. The measurement period started three weeks after full bloom and continued until mid November.

### **Vegetative Growth**

At veraison (August 29), shoot length and diameter of the third internode, and number of main and lateral leaves were counted on two shoots per vine. Additionally, five shoots per replicate were harvested for primary and lateral leaf area measurement.

### **Yield and fruit composition**

The crop was harvested on October 6. Vines were harvested individually. A sample of 12 clusters per vine was crushed for determination of soluble solids, pH and titratable acidity. A sample of five clusters per vine was used to estimate berry weights and number of berries per cluster. Cluster weight was calculated by averaging the pooled 17 cluster sample. Sugar per vine was calculated by multiplying must sugar content in °Brix (equivalent to percentage by weight of sucrose) by total yield per vine.

## **RESULTS AND DISCUSSION**

Figure 1 shows the gas-exchange patterns during the growing season. Photosynthetic rate was highest at the beginning of the measurement period and declined until veraison, as the leaves aged. The onset of

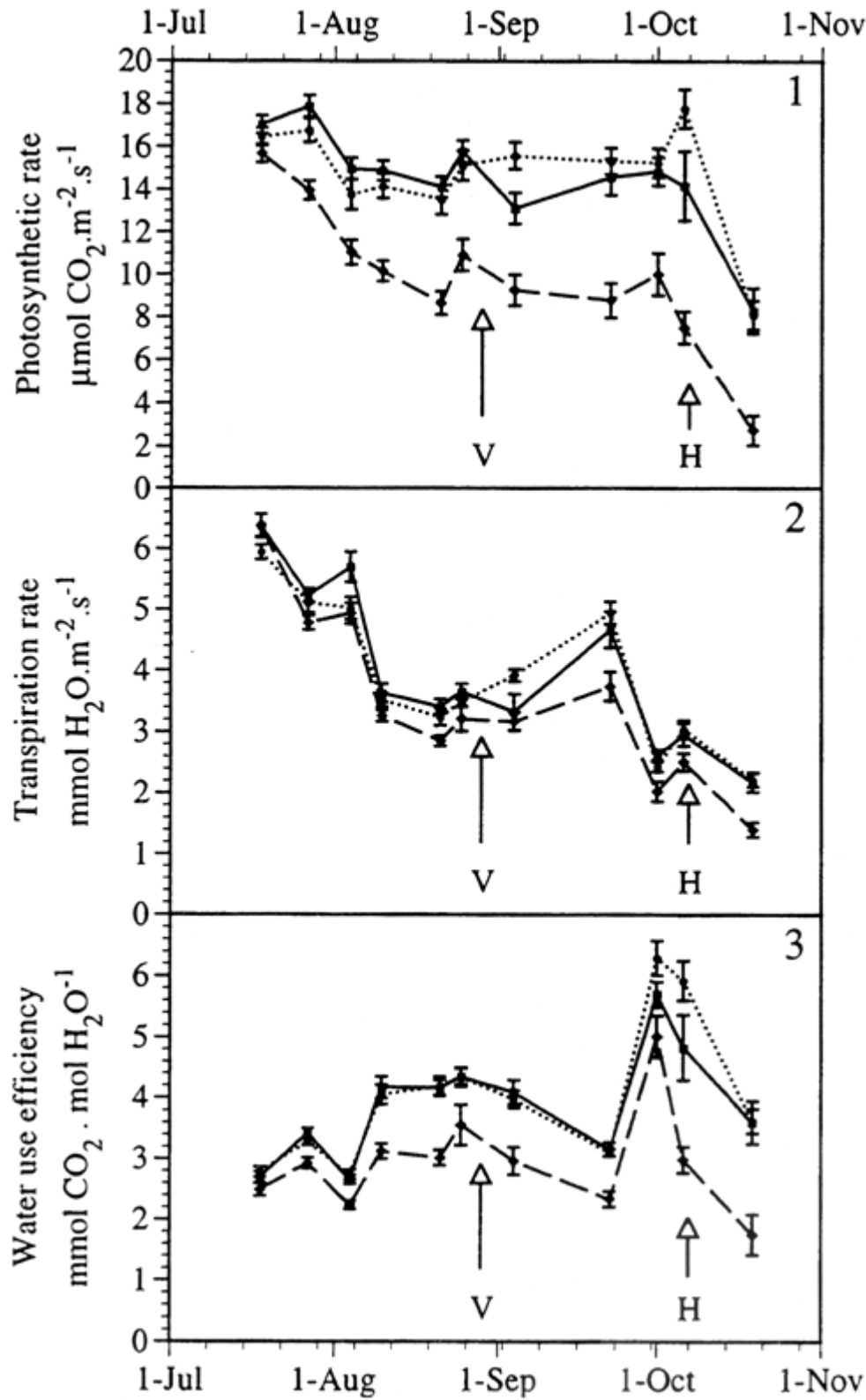
fruit maturation shifted the photosynthetic rates to higher values and, after a lag period, it decreased again, particularly after harvest. This pattern reflects the effect of the sink activity of the ripening fruit on photosynthesis.

Photosynthesis was lower throughout the growing season for plants with a grass cover (Fig. 1. 1). There were no significant differences on the photosynthetic rate of vines with an insectary plant cover or a cover of resident plants. The grass cover was much denser than the other two treatments, which grew little during the season and did not cover the soil completely. The competition for water and nutrients was therefore higher for the vines with a grass cover. This is the first year of establishment of the green cover treatments. The gas exchange patterns may change as the cover crops establish.

The Stomata serve to balance the need for the leaf to allow the entry of CO<sub>2</sub> for photosynthesis whilst limiting the transpiratory loss of water vapor. A measure of the carbon gain in relation to the water loss is the water use efficiency (quotient between photosynthesis and transpiration). Stomatal conductance (Fig. 1.5) and transpiration (Fig. 1.2) were lower for vines with a grass cover, indicating some degree of compensation for root zone competition. Water use efficiency of vines with a grass cover was, however, lower than that of the other two treatments (Fig. 1.3). Photosynthesis and intercellular CO<sub>2</sub> concentration (Figs. 1.1 and 1.6) varied in opposite directions, indicating a non-stomatal limitation of photosynthesis. In the temperature range that occurred during our measurements, the main component of the mesophyll conductance is the carboxylation efficiency. All treatments showed a high degree of mesophyll control over the photosynthesis, as judged by the similarity of the photosynthesis and mesophyll conductance patterns (Figs. 1.1 and 1.4).

Table 1 shows leaf area, vegetative growth, yield, yield components, and fruit composition as affected by green cover treatment. Many responses, including yield, yield components and vegetative growth tended to be lower for the grass treatment but, except for mean berry weight, the differences were not statistically significant. There were no differences among treatments in must soluble solids or total sugar produced per vine. Titratable acidity was higher for vines with a resident plant cover and pH was higher for vines with an insectary plant cover. The results reflect, to some extent, the higher degree of root zone competition experienced by vines with a grass cover. Vines with a grass cover probably stopped vegetative growth sooner, resulting in earlier fruit maturation compared to the other treatments.

These are the first year results of a long term study. When all of the covers are well established and the vine root system adapted to the surrounding environment, we expect to see changes in vine response.



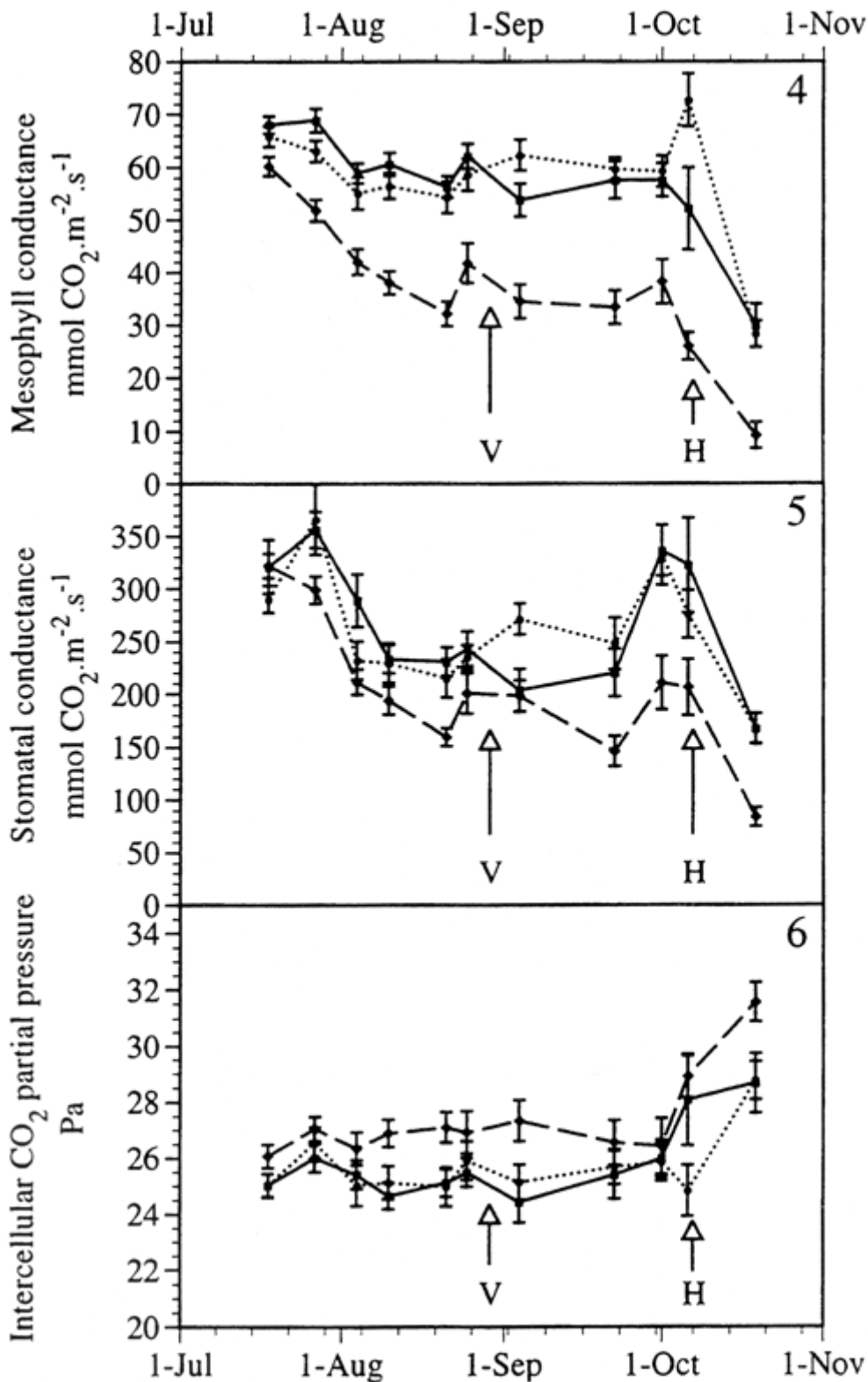


Figure 1: Effect of green cover treatment on photosynthesis (1), transpiration (2), water use efficiency (3), mesophyll conductance to  $\text{CO}_2$  transfer (4), stomatal conductance to  $\text{CO}_2$  transfer (5), and intercellular  $\text{CO}_2$  partial pressure (6) of the 10th main leaf (from the base) of mature Pinot noir grapevines. Full lines: resident plants; dotted lines: insectary plant mixture; dashed lines: grass. Vertical bars indicate  $\pm$  standard errors. V: véraison; H: harvest.

Table 1: Effect of green covert treatment on vegetative growth, yield, yield components, and fruit composition of Pinot noir grapevines.

	Green cover Treatment			Significant F
	Grass	Resident Plants	Insectary plants	
<b>Vegetative growth</b>				
• Shoot diameter (mm)	8.2	8.7	8.3	ns
• Shoot length (cm)	145	193	156	ns
• Total leaf area per vine (m <sup>2</sup> )	5.66	9.52	7.71	ns
• Percent of lateral leaf area	16.7	28.4	21	ns
<b>Yield</b>				
• Yield per vine (kg)	2.74	3.26	3.11	ns
• Clusters per vine	31	31	30	ns
• Shoots per vine	22	22	22	ns
• Cluster weight (g)	89.9	106.3	105.3	ns
• Berry weight (g)	1.12 b	1.22 a	1.17 ab	*
• Berries per cluster	81	87	90	ns
<b>Fruit composition</b>				
• Soluble solids (°Brix)	23.4	23.0	23.2	ns
• pH	2.96 b	2.96 b	3.00 a	*
• Titratable acidity (g/L)	7.88 b	8.92 a	8.07 b	**
• Total sugar per vine (kg/vine)	0.64	0.75	0.72	ns

<sup>1</sup> ns, \*, and \*\* indicate not significant, and statistically significant at the 0.05 and 0.01 levels of probability, respectively.