A MOBILE PLATFORM FOR MEASURING CANOPY PHOTOSYNTHETICALLY ACTIVE RADIAION INTERCEPTION IN TREE CROPS

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Introduction

Collecting yield data to quantify effects of fumigation treatments is difficult in perennial tree crops. Results to date have shown a good relationship between photosynthetically active radiation (PAR) interception and yield potential in almond and walnut. A new method of assessing midday canopy PAR interception using a mobile platform mounted lightbar will be described. This method has the potential to provide new information on the impact of fumigation on productivity since it will allow the separation of the effect of canopy size from the effect of productivity per unit PAR intercepted. Furthermore, once PAR intercepted is validated as an accurate measure of yield potential, it can be substituted for costly, time-consuming yield estimates, thereby permitting investigators to monitor productivity in more trials than would be possible otherwise.

Materials and Methods

We have been collecting light interception data on walnuts and almonds using a handheld light bar (Decagon Ceptometer, Decagon Devices, Pullman, WA, 99163 USA) and relating this to yield potential for many years. We have found that there is an upper limit to yield potential in both crops for a given level of midday canopy light interception (Fig. 1). Management practices can impact the relationship between PAR interception and yield. Orchards that are mechanically hedged or pruned tend to be below the maximum potential as are orchards with irrigation problems (either too much or too little water). Alternate bearing and poor weather conditions during bloom can also cause yield to be significantly below the potential yield.

Because collecting the midday canopy light interception data by hand is time consuming, the area of the orchard that can be covered at midday is limited. Therefore, the PAR interception data in Fig. 1 does not often cover the exact same area as the area from which yield data is collected. For example, PAR interception data might be collected on 3 trees and yield data on an orchard row. In 2008, we began using a new mobile platform mounted lightbar that is able to give a much more detailed map of the midday canopy light interception than we could get previously. The mobile platform has 640 photodiodes mounted on a bar attached to the front of a Kawasaki Mule (Fig. 2). The bar width is adjustable for orchard row spacings from about 20-28 feet. The data from the photodiodes is logged on a CR3000 datalogger (Campbell Scientific, Logan, Utah 84321-

1784 USA). Position is determined using an AgGPS 132 (Trimble Navigation Ltd., Sunnyvale, CA, USA) GPS unit at the end of each row (where better GPS reception can be obtained). Within the orchard, position is determined with radar (part number 063-0159-835; Raven Industries, Sioux Falls, SD, USA) and when combined with the GPS data, The light data points are assigned a position as they are accumulated. The data are then used to construct a map of the light interception pattern in the orchard (Fig. 2). We can then harvest the nuts from a given plot or row and get a much more accurate relationship between midday light interception and yield than was previously possible due to the limited area that PAR interception could be measured with the hand lightbar method. The mobile platform will allow us to determine if the impacts of fumigation on orchard growth are a result of decreased canopy growth or if there is an additional impact of yield per unit PAR intercepted.

Preliminary Results

Preliminary results (with PAR measured with the old hand method) suggest that the effects of fumigant were largely related to canopy size differences and that productivity per unit light intercepted were similar for all treatments (Table 1). Data collected this year for peach (using the new mobile platform lightbar) also suggests that the effect of fumigation is largely on canopy growth rather than on productivity per unit light intercepted (Fig. 4). In 2008, we have taken extensive PAR interception data with the new mobile platform lightbar on a number of fumigation, nutrition, and pruning trials in walnut and almond as well. The yield data and sample processing for walnut and almond had not been completed at the time of the writing of this report but we will have data to report next year. We expect that this new mobile platform will be a great benefit in evaluating fumigation efficacy results in tree crops. It will also allow us to assess treatment impacts on larger areas than is currently possible due to the time and expense of harvesting.

Table 1. Kernel yield and PAR interception by fumigation treatment for Madera Grower South fumigation trial in the fourth growing season.

Fumigation treatment	Treated area (% of total)	Mulch system	2007 kernel lbs/acre	2007 yield per unit PAR
Telonec35, 535 lb/ac	Broadcast (100%)	none	2385 a	48.7 ab
Iodomethane:chloropicrin (50:50), 400 lb/ac	Broadcast (100%)	none	2364 a	45.8 b
Chloropicrin, 400 lb/ac	Rowstrip (38%)	none	2301 ab	50.1 ab
Chloropicrin, 400 lb/ac	Rowstrip (38%)	VIF	2267 abc	48.4 ab
Iodomethane:chloropicrin (50:50), 400 lb/ac	Rowstrip (38%)	none	2241 abc	48.1 ab
Telone II, 340 lb/ac	Broadcast (100%)	none	2199 abc	49.1 ab
Chloropicrin, 400 lb/ac	Broadcast (100%)	none	2191 abcd	50.6 ab
Telonec35, 535 lb/ac	Rowstrip (38%)	none	2133 abcd	45.8 b
Methyl bromide, 400 lb/ac	Rowstrip (38%)	VIF	2080 abcd	50.5 ab
Methyl bromide, 400 lb/ac	Broadcast (100%)	none	2062 abcd	50.8 ab
Telone II, 340 lb/ac	Rowstrip (38%)	VIF	2059 abcd	50.1 ab
Telone II, 340 lb/ac	Rowstrip (38%)	none	2026 abcde	49.9 ab
Methyl bromide, 1 lb/tree site	Tree site	none	1975 abcde	52.3 a
Chloropicrin, 1 lb/tree site	Tree site	none	1919 bcde	47.7 ab
Telone II, 1 lb/tree site	Tree site	none	1911 bcde	50.6 ab
Methyl bromide, 400 lb/ac	Rowstrip (38%)	none	1894 cde	50.2 ab
Control	none	VIF	1811 de	51.4 ab
Control	none	none	1669 e	46.0 b

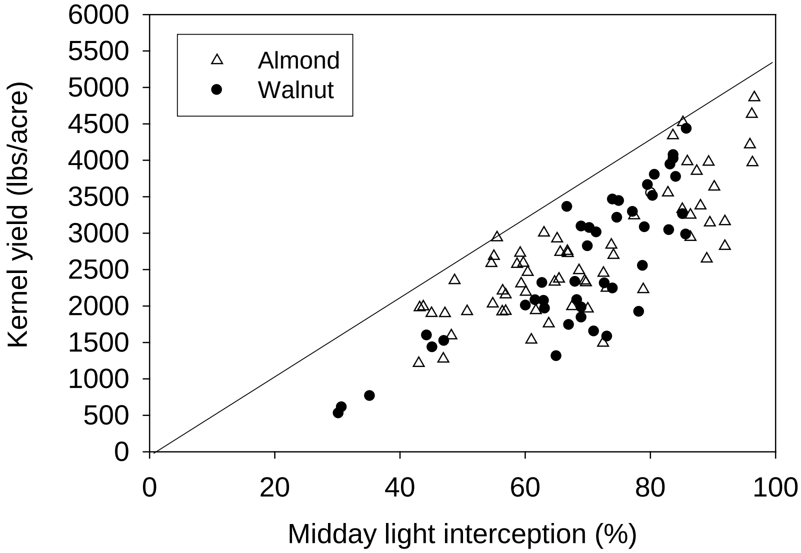

Fig. 1. Midday canopy light interception versus yield for a large number of almond and walnut trials conducted from 2001 to 2008. Walnut yield data is normally expressed as in-shell weights but data here have been converted to kernel yield.


Fig. 2. Lightbar mounted on Kawasaki Mule.

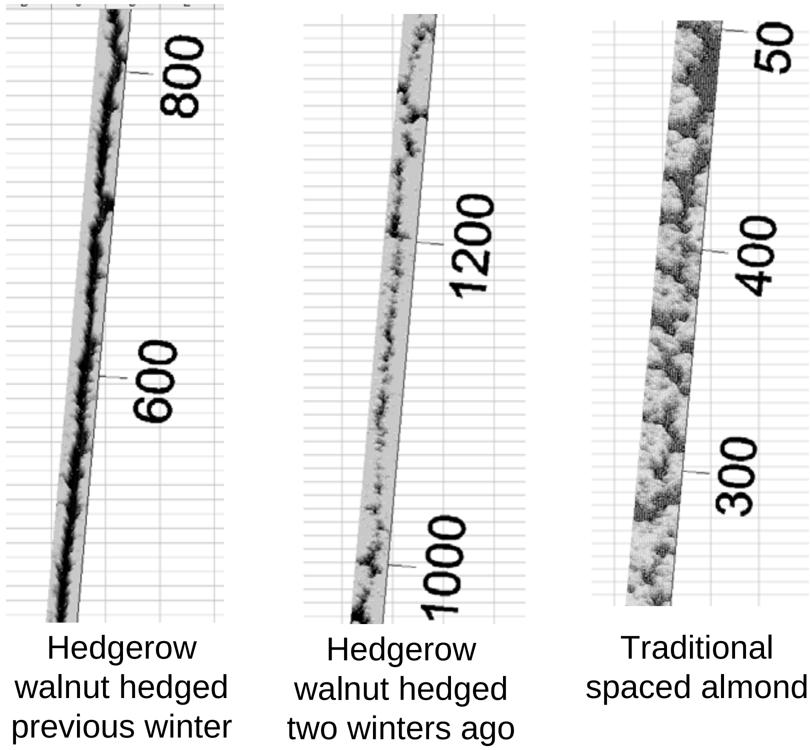

Fig. 3. Pattern of PAR interception in a walnut orchard which was mechanically hedged the previous winter or mechanically hedged two winters ago, and a traditionally spaced almond orchard. The darkest color indicates the area where PAR is reaching the orchard floor and the lightest where the highest percentage of PAR is being intercepted.

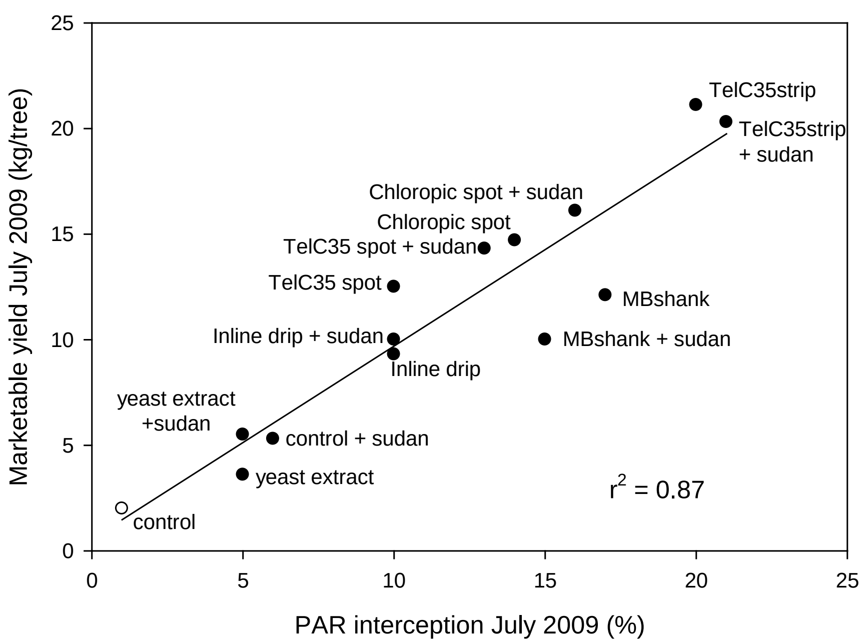

Fig. 4. Photosynthetically active radiation interception in July 2009 versus peach yield for Fresno peach fumigation trial 2009.