AES/CE MAR 84 Workgroup/Department:

University of California
Division of Agricultural Sciences

PROJECT PLAN/RESEARCH GRANT PROPOSAL

Project Year 2009 Anticipated Duration of Project

Project Leader Bruce Lampinen Location Davis Campus

Cooperating Campus Personnel Greg Browne, Shrini Upadhyaya, David Slaughter, Sam Metcalf
Cooperating Farm Advisors Bob Beede, Carolyn DeBuse, Janet Caprille, Bill Coates, John Edstrom, Rachel Elkins, Joe Grant, Janine Hasey, Kathy Kelley, Bill Krueger and any other interested farm advisors

Project Title Refining the relationship between canopy light interception and yield in walnut

Keywords
Commodity(s) light interception, yield Relevant AES/CE Project No.

Problem and its Significance:
Data collected by the authors over the past several years has provided a rough upper limit to productivity in walnut and almond based on the percentage of the available midday canopy photosynthetically active radiation (PAR) that is intercepted and the age of trees. However, most of the data that was collected previously had limitations. The methods of measuring percent PAR interception using a handheld lightbar (Decagon Devices, Pullman, WA 99163) were relatively slow and labor intensive. For this reason, much of the lightbar data that was used to develop the relationship was based on sampling of relatively small samples of trees. Often the area for the yield and PAR interception data did not match (i.e. PAR data from 5 trees and yield data from either one tree or from an entire row). We have recently retrofitted a Kawasaki Mule with a light bar, that is able to measure light across an entire row (up to 26 feet wide). The data can be stored on a datalogger at intervals of less than 1 foot down the row at a travel speed of about 4.5 mph giving us a much better spatial resolution in much less time than was possible in the past.

These data are of useful for any studies that aim to quantify the impact of treatments on yield. By measuring canopy light interception on a large scale, the impacts of differences in canopy development can be separated out from other treatment impacts allowing much more robust data interpretation.

Objectives:
This project will have two goals. The first is to provide support to Shrini Upadhyaya and David Slaughter to modify the lightbar design to make it more robust as well as user friendly and also to work toward automating the data processing. The lightbar setup was developed with funding from the almond industry as the well as the USDA almond methyl bromide areawide project. It would be helpful if the walnut industry could provide funding to improve the design and to study its utilization in walnuts. The second goal will be to find orchard sites, in cooperation with farm advisors, throughout the walnut growing areas of California. These sites will be chosen in orchards that have a variety of ages and light interception levels. The goal will be to find orchards that are well managed and as productive as possible to attempt to place upper limits on the light interception/yield relationship.

Plans and Procedures:

Lightbar modification- The existing Mule mounted lightbar will be modified in order to make it more robust. The current setup was tested over about 12 miles through an almond orchard in Kern County. The adjustable, spring loaded section on the end of the light bar had problems with low hanging branches resulting in scratches in the lens covering the sensors. Alternatives to the plastic covering and/or means of protecting the surface from contact with low hanging branches will be developed. Also a variable height adjustment mechanism will be added to the light bar to allow the bar to be lowered as far as possible to avoid low hanging branches but retain capability of being raised to clear berms and/or sprinkler heads as needed. Further areas to be investigated include a better method of supporting the overhanging portion of the bar and improved means of absorbing the impact that the moveable section of the bar takes when impacting tree trunks. We are also in the process of adding a LIDAR unit to the Mule. This system is expected to be able to provide information on the canopy architecture. Moreover, a better data storage system to record the immense amount of data that is collected is needed. We plan to use a CR 3000 data logger with a flash memory card to store data collected during a day. Furthermore, it is necessary to analyze the huge amount of data and produce user friendly and simple to interpret results. We plan to develop software to accomplish this goal with the ultimate aim of providing real-time data processing in the near future.

Fig. 1. Current design of Kawasaki Mule mounted lightbar showing adjustable end section. Cable support assembly will be replaced with bracing underneath lightbar as part of this project.

Orchard sites. Orchard sites of varying ages and varieties from throughout the walnut growing area of California will be selected for measurements. An attempt will be made to get the most productive orchards available from approximately age 2-3 years up to mature canopied orchards. An emphasis will be placed on finding Chandler orchards but other varieties will also be included. Light bar measurements will be done in 5-10 row middles (depending on orchard size and variability) in representative areas of the orchard during the mid June to late July period. These rows will then be flagged and at harvest time, rough field weights will be taken from each row middle. Subsamples from each row middle will be taken, hulled and dried to estimate in shell crop weight for each row.

A visual representation of the spatial data from a mechanically hedged Chandler orchard is shown in Fig. 2. The pattern of the orchard filling in after mechanically hedging can be clearly seen by comparing the left and right hand sides of Figure 2.

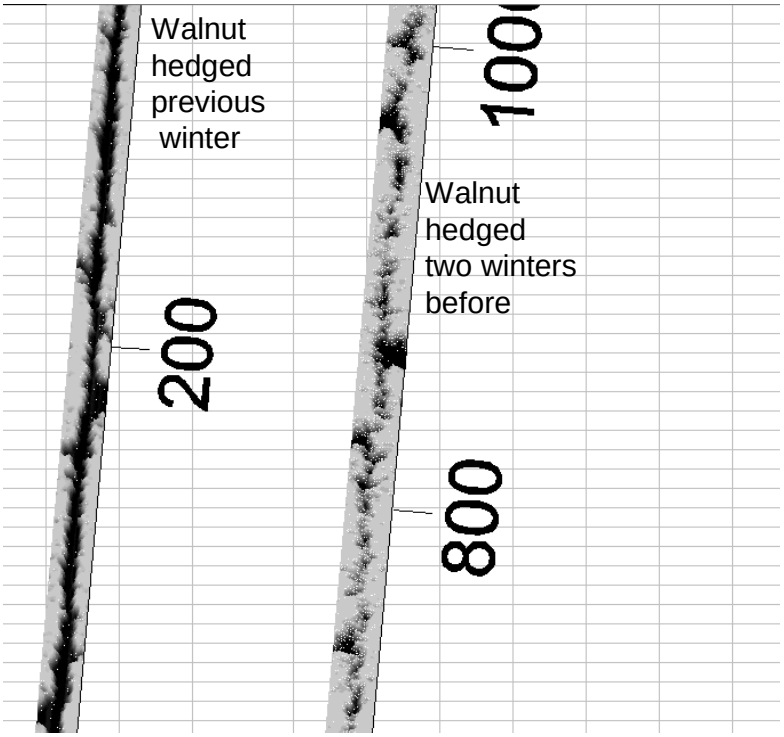

Fig. 2. Visual presentation of PAR data for a Chandler orchard the season after dormant mechanical hedging (left side of figure) and for a row hedged two winters previously. The dark color in the figure indicates the area where the light was reaching the orchard floor while lighter color indicates the tree canopy. Numbers indicate distance down row in feet.

The data for light interception and yield will be used to refine the relationship shown on the graph below for walnut. With a better estimate of the maximum productivity per unit light interception, these data can be used to assess potential orchard yield and will allow separating out canopy light interception as a variable in other research projects. For example, if a pruning study is being conducted, this tool will allow the separation of the effect of the pruning treatment on overall canopy light interception as opposed to the effect of the pruning treatment on productivity per unit canopy. It will also allow block to block variability to be assessed before or after a research trial in initiated.

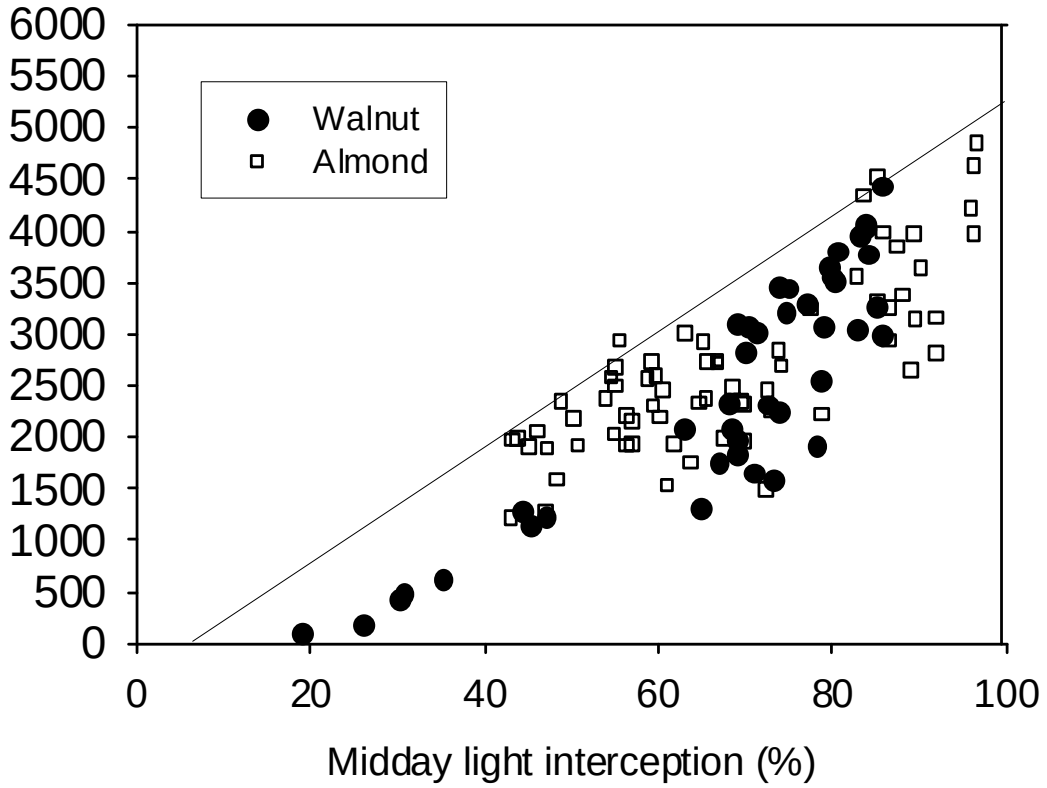

Fig. 3. Midday canopy light interception versus yield relationship from various almond and walnut trials from throughout state.

BUDGET REQUEST Budget Year

Lampinen/Browne

Funding Source

Salaries and Benefits

Postdocs/RA's _____ $_____

SRA's SRA II- Lampinen/Browne- 15% $_____7,886_____

Lab/Field Assistance _____ $_____

Subtotal Sub 2 $_____

Employee benefits- SRA II Sub 6 $_____ 2,287_____

SUBTOTAL $_____

Supplies and Expenses Sub 3 $_____

Equipment Sub 4 $_____

Travel – for PAR and yield data collection Sub 5 $____3,850_____

(20 trips for light and 15 for yield data collection at $110 each)

TOTAL $_____14,023_____

Department account number _____

Upadhyaya/Slaughter

Funding Source

Salaries and Benefits

Postdocs/RA's _____ $_____$1,200_____

SRA's _ $_____

Development Engineer for Upadhyaya/Slaughter- 5% $____$3,000

Lab/Field Assistance _____ $_____

Subtotal Sub 2 $_____

Employee benefits- SRA II Sub 6 $_____ _____

-RA $_____ _____

-Development Engineer_____$____900_____

SUBTOTAL $_____5,100_____

Supplies and Expenses Sub 3 $_____

Opal diffusing glass to cover lightbars plus supplies $___1,500_____

Equipment Sub 4 $_____

Campbell Scientific datalogger and accessories $____3,800_____

Travel – Sub 5 $____ 700_____

(for technical support of field data collection effort

TOTAL $_____11,100_____

Department account number _____

Overall Budget

Funding Source

Salaries and Benefits

Postdocs/RA's		$ 1,200
SRA's	SRA II- Lampinen/Browne- 15%	$ 7,886
Development Engineer	for Upadhyaya/Slaughter- 5%	$ $3,000
Lab/Field Assistance		$
Subtotal	Sub 2	$
Employee benefits- SRA II	Sub 6	$ 2,287
-Development Engineer		$ 900
SUBTOTAL	$ 15,273	
Supplies and Expenses	Sub 3	$
Opal diffusing glass to cover lightbars plus supplies		$ 1,500
Equipment	Sub 4	$
Campbell Scientific datalogger and accessories		$ 3,800
Travel – for PAR and yield data collection	Sub 5	$ 3,850
(20 trips for light and 15 for yield data collection at $110 each)		
Travel –	Sub 5	$ 700
(for technical support of field data collection effort		
TOTAL	$ 25,123	

Department account number _____

_____ Date _____

Originator's Signature

COOPERATIVE EXTENSION — County Director _____ Date _____

Program Director _____ Date _____

AGRICULTURAL EXPERIMENT STATION — Department Chair _____ Date _____

LIAISON OFFICER _____ Date _____

D2454-2(1/84)
(Rev. 9/96)