The Importance of Leaf Area Indexing in Selecting Poplar Clones for Bio-energy Production

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INTRODUCTION

Two hybrid poplar bio-energy demonstration farms were established in Hayden Idaho and Jefferson Oregon at the outset of the AHB in 2012. The magnitude of the Hayden and Jefferson demonstration farms is 65 and 86 acres, respectively. Two additional demonstration farms were established the following year in Pilchuck Washington (98 acres) and Clarksburg California (50 acres). Each demonstration farm is comprised of seven to 13 mono-clonal varietal production plots established at a density of 1,452 trees per acre. The average size of the mono-clonal plots varies among the four farms between 4.5 and 8.0 acres. The AHB farms are managed through two cutting cycles encompassing five years. This duration coincides with the AFRI CAP funding period. The first cutting cycle began with the planting of the farms and concluded with a harvest two years later. The second cycle began when the farms regenerates by coppicing for three years at which time the second harvest will be scheduled. Measurements of stem diameter, height, survival and number-of-sprouts per stool are collected yearly from each mono-clonal plot using permanent inventory plots. These data are converted to bone-dry tons per acre using age-specific least squares regression equations developed for each clone and site combination.

Leaf area indices (LAI), defined as the ratio of one-sided cumulative leaf surface area to the equivalent ground surface area, were measured during the peak of the 2016 growing season using a LI-COR® 2200C Plant Canopy and associated with standing biomass at the conclusion of the previous growing season.

METHODS

Leaf area index was measured indirectly with cross calibrated LAI-2200C Plant Canopy Analyzers (LiCor, Lincoln, NE, USA) by comparison of above- and below-canopy. Two sensors (wands) were used to record simultaneous readings within the stands and outside the stands. One of the sensor was detached from the console and placed in an nearby open area to automatically log above canopy records. The second sensor was attached to the console and used to record the below canopy reading. The above and below readings were used to calculate canopy light interception at five zenith angles. LAI was computed using a model of radiative transfer in vegetative canopies. The K records were also taken to make the scattering corrections.

LAI transects in the clonal blocks were initiated by a minimum of ten to fifteen feet from clonal block edges to minimize the edge and border effects. Measurement were taken at approximately 30 foot intervals. Two to three transects were taken through the clonal blocks, if high canopy variation occurred more transects were taken to encapsulate canopy variation. Data was evaluated with LI-COR's ® File Viewer 2200 software.

Figure 1. LAI-2270C Control Unit (console) is used to configure instrument settings, store recorded data, and compute results[1].

Figure 2. LAI-2250 Optical Sensor (wand) is the data collection component of the LAI-2200C. The optical sensor contains high precision optical components, including lenses, optical filters, and light sensors[1].

Figure 3. Five view restricting caps that serve to limit the azimuthal field of view of the optical sensor in circumstances in which it is necessary or desirable to block part of the view. The solid cap used to protect the lens when it is not in use and the white diffuser cap used for collecting the ancillary data for applying scattering corrections when operating in direct sunlight[1].

1/ LAI-2200C Plant Canopy Analyzer Instruction Manual. 2013, LI-COR, Inc. Publication No. 984-14112.

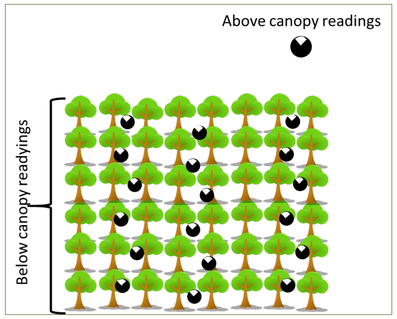

Figure 4. Sketch of LAI measurement on a hybrid poplar plantation

Fig. 5. Jason Mack (A) and Luke Murphy (B) taking readying below canopy using the LAI 2200C Canopy analyzer in at Jefferson

RESULTS

LAIs for the farms in their third year of coppice varied between 3.7 and 5.6 at Jefferson and 3.6 and 5.5 at Hayden. The farms in their second year of coppice exhibited a range in LAI of 1.4 to 4.7 at Clarksburg and 1.6 to 4.9 at Pilchuck. Significant, positive linear associations between LAI and previous-season biomass were noted at all four locations (0.77 Jefferson, 0.88 Hayden, 0.75 Clarksburg, and 0.89 Pilchuck.) The results are in agreement with published literature documenting correlations among woody biomass production, leaf area and net photosynthesis. GreenWood will incorporate leaf area into its genetic selection program to identify varieties that are capable of superior biomass production and/or excessive transpiration rates that have value in processing municipal effluent.

Site	Mean LAI	Min	Max	Ratio	R^2
Jefferson	5.0	3.7	5.6	Reg: LAI:BDT	0.59
Hayden	4.6	3.6	5.5	Reg: LAI:BDT	0.77
Clarksburg	3.1	1.4	4.7	Reg: LAI:BDT	0.57
Pilchuck	2.8	1.6	4.9	Reg: LAI:BDT	0.79
Overall	3.9	2.6	5.2	Reg: LAI:BDT	0.80

Figure 6. Profile of the hybrid poplar LAI for the third year of coppice at Hayden Demonstration Farm in Hayden, Idaho.

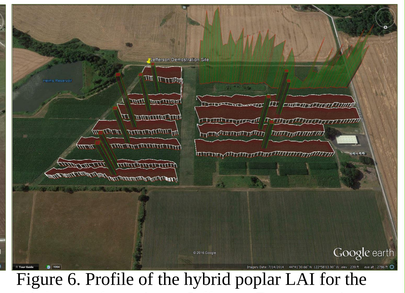

Figure 6. Profile of the hybrid poplar LAI for the third year of coppice at Jefferson Demonstration Farm in Jefferson , Oregon.

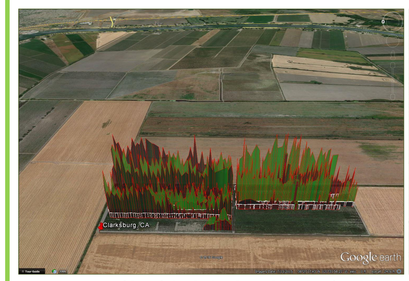

Figure 7. Profile of the hybrid poplar LAI for the second year of coppice at Clarksburg Demonstration Farm in Clarksburg, California.

Figure 8. Profile of the hybrid poplar LAI for the Second year of coppice at Pilchuck Demonstration Farm in Pilchuck, Washington.

DISCUSSION

This project has accomplished the first Leaf Area Index (LAI) determination of the hybrid poplar plantations established on the four Demonstration Farms of the Advance Hardwood Biomass (AHB) project. Significant LAI variability were found among clones within demonstration farm and across demonstrations farms per age. Based on the high correlation found between LAI and growth and in the published literature on this theme for different species, it could be inferred that the use of LAI could be a tremendous opportunity to maximize growth through selecting varieties with higher leaf area development for optimal light interception and wood production. LAI could be included in the future breeding and selection programs for improved yield of high density plantation for biomass production with hybrid poplar. LAI is also used to determine the level of fertilization regime needed to maximize the productivity of the plantations since the production of forest stands has been shown to be strongly correlated with total annual intercepted irradiance that take place in the leaves.

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