INFLUENCIA DE MALLAS SOMBREADORAS SOBRE CARACTERÍSTICAS MORFOLÓGICAS, FISIOLÓGICAS Y PRODUCTIVAS DE *VACCINIUM CORYMBOSUM* L.

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RESUMEN

Se estudiaron las respuestas fisiológicas, vegetativas y reproductivas de arándano de arbusto alto (*Vaccinum corymbosum* L. cv. Elliott) a mallas foto-selectivas de diversos colores (negro, rojo y blanco) y niveles de sombra (25, 50 y 75%), además de un control a pleno sol, en ambientes contrastantes, Chillán-Chile y Michigan-USA. Las irradiaciones variaron fuertemente entre mallas; las rojas redujeron PAR y aumentaron la radiación infrarroja, las blancas redujeron radiación UV, y las negras cambiaron poco el espectro. Las tasas de asimilación de CO2 (en USA), aumentaron hasta 50-60% PAR, en ambas temporadas. Hubo correlación entre máxima actividad fotoquímica del PSII (Fv/Fm), contenido total de clorofila y relación Chl/N foliar ($r \geq -0.866$) con %PAR, pero gs tuvo poca relación con %PAR. El contenido de agua foliar se correlacionó con %PAR en USA ($r = -0.917$), pero no en Chile. El área específica foliar se asoció con %PAR ($r = -0.787$ en USA y -0.742 en Chile). La temperatura del dosel aumentó con %PAR ($r = 0.849$), pero el potencial hídrico del xilema no se relacionó con %PAR. La densidad estomática se correlacionó significativamente con %PAR ($r = 0.818$). Las mallas afectaron PPFD transmitido a través del dosel. Dentro del dosel (90-180 cm sobre el piso del huerto) todas las mallas tuvieron > 700 µmol m-2 s-1 PPFD, aunque en las blancas penetró significativamente mayor radiación. Las yemas florales abiertas disminuyeron linealmente con mayor %PPFD, pero las yemas florales por caña y por brote aumentaron gradualmente con el aumento en radiación, hasta 50% PPFD. Las mallas atrasaron la madurez; los frutos maduros (%) en una cierta fecha disminuyeron exponencialmente con la reducción del %PPFD. Los sólidos solubles aumentaron linealmente ($r = 0.927$, $P < 0.0001$) y el contenido de agua disminuyó linealmente ($r = 0.938$, $P < 0.0001$) al aumentar %PPFD. El rendimiento tuvo relación curvilínea positiva con PPFD hasta

50%, en USA (2007) y Chile (2006/2007 y 2007/2008). La interacción color vs. sombra no fue significativa en ambas zonas. La calidad de la fruta tuvo interacciones significativas de color x sombra (peso, sólidos solubles y firmeza), y color x fecha de cosecha (peso, sólidos solubles y acidez titulable). Estos resultados indican que *V. corymbosum* se aclimata fuertemente al ambiente luminoso bajo mallas y que al reducir hasta 50% la luz directa (y la temperatura foliar) se mejora en general el comportamiento fotosintético y variables foliares. El %PAR tiene mayor efecto que la calidad de la luz sobre la respuesta fotosintética. En este contexto, la selección del nivel de sombra y color apropiados variarán según las necesidades específicas. Un nivel de sombra roja o blanca intermedio (40-60 %PPFD) sobre plantas maduras debiera entregar, en la mayor parte de los casos, un atraso aceptable en la cosecha sin efectos negativos en el retorno floral y la calidad de la fruta.

ABSTRACT

Physiological, vegetative and reproductive responses of highbush blueberry (*Vaccinum corymbosum* L. cv. Elliott) to photo-selective nets of various colors (black, red and white) and shade levels (25, 50 and 75%), plus a full sun control, were studied in contrasting environments, Chillán-Chile and Michigan-USA. Irradiances varied greatly among nets; red ones reduced PAR and increased infrared radiation, white nets reduced UV radiation, and black nets changed little the spectrum. CO2 assimilation rates (in USA), increased up to 50-60% PAR, in both growing seasons. Maximum PSII photochemical activity (Fv/Fm), total chlorophyll content and total Chl/leaf N ratio were correlated ($r \geq -0.866$) with %PAR, but gs was little related with %PAR. Leaf water content was correlated with %PAR in USA (r2 = -0.917), but not in Chile. Specific leaf area was associated with %PAR (r = -0.787 in USA and -0.742 in Chile). Canopy temperature increased with %PAR (r = 0.849), but xylem water potential was not related with %PAR. Stomatal density was significantly associated with %PAR (r = 0.818). Nets influenced PPFD transmitted through the canopy. Within the canopy (90-180 cm above the ground) all nets provided > 700 µmol m-2 s-1 PPFD, although white nets allowed significantly higher radiation to penetrate. Open flower buds decreased linearly as %PPFD increased, but flower buds/cane and flower buds/shoot increased gradually as radiation increased, up to 50% PPFD. Nets delayed maturity; mature fruit (%) in a given date decreased exponentially as %PPFD was reduced. Soluble solids increased linearly ($r = 0.927$, $P < 0.0001$) and fruit water content decreased linearly ($r = 0.938$, $P < 0.0001$) as %PPFD increased. Yield had a positive curvilinear relationship with light up to 50% PPFD, in both USA (2007) and Chile (2006/2007 and 2007/2008). The interaction color vs. shade was not significant in both sites. Fruit quality had

SPECTRAL IRRADIANCE UNDER PHOTO-SELECTIVE NETS AND ITS INFLUENCE ON PHOTOSYNTHETIC CHARACTERISTICS AND LEAF TRAITS OF *VACCINIUM CORYMBOSUM* L. CV. ELLIOTT.

ABSTRACT

Physiological responses of mature northern highbush blueberry plants (*Vaccinum corymbosum* L. cv. Elliott) growing under photo-selective nets of different colors (black, red and white) and shade intensities (25, 50 and 75%) plus a control (full sun), were studied in Chillán-Chile and Michigan-USA. Large differences in irradiances were observed under nets; red ones reduced the visible spectrum and increased infrared wavelengths, whereas white nets reduced ultra violet radiation. Black nets had almost neutral effects on the whole spectrum. CO2 assimilation rates, measured under nets in the USA, increased with % PAR of full sun, up to 50-60% in both growing seasons. Maximum PSII photochemical activity (Fv/Fm), total leaf chlorophyll content and total Chl/leaf N content ratio were negatively correlated ($r2 \geq 0.75$) with %PAR, but gs showed little relationship with %PAR. Leaf water content was negatively correlated with %PAR in USA ($r2 = 0.84$), but not in Chile. Specific leaf area was negatively associated with %PAR ($r2 = 0.62$ in USA and 0.55 in Chile). Canopy temperature increased with %PAR ($r2 = 0.72$) but xylem water potential showed no relationship with light levels. Percentage PAR was significantly associated with stomatal density ($r2 = 0.67$). Results from this study indicate that northern highbush blueberries growing under photo-selective nets acclimate strongly to the light environment and that a reduction up to 50% in direct light (and leaf temperature) improves overall plant photosynthetic characteristics and leaf traits. Light quality has a weaker effect on photosynthetic performance than %PAR.

Keywords: canopy temperature, chlorophyll, fluorescence, Fv/Fm, highbush blueberry, leaf water content, nitrogen, shade, specific leaf area, stomatal density.

EFFECTS OF PHOTO-SELECTIVE SHADING NETS ON THE PRODUCTIVITY DEVELOPMENT OF *VACCINIUM CORYMBOSUM* CV. ELLIOTT

ABSTRACT

Responses of vegetative and productive traits in northern highbush blueberry plants (*Vaccinum corymbosum* L. cv. Elliott) growing under photo-selective nets of different colors (black, red and white) and shade intensities (25, 50 and 75%) plus a control (full sun), were studied in two contrasting environments, Chillán-Chile and Michigan-USA. Photoselective nets influenced the photon flux density transmitted through the canopy. Within the plant all nets provided > 700 µmol m-2 s-1 PPFD from 90 to 180 cm above the ground, although white shade allowed significantly higher radiation to penetrate. The number of open flower buds decreased linearly as %PPFD increased, but the number of flower buds per cane and flower buds per shoot increased gradually as light levels increased, reaching an asymptote at 50% PPFD. Shading nets delayed fruit maturity, thus mature fruit (%) in a particular date, was higher in the control plants and decreased as the %PPFD was reduced. In addition, harvest delay was maximum at the lowest light level (20%) and decreased exponentially with increasing %PPFD. On the other hand, soluble solids increased linearly ($r^2 = 0.86$, $P < 0.0001$) and fruit water content decreased linearly ($r^2 = 0.88$, $P < 0.0001$) as %PPFD increased. Fruit yield showed a positive and curvilinear relationship with %PPFD and reached an asymptote at 50% PPFD, in both USA (2007) and Chile (2006/2007 and 2007/2008). The interaction between color and shade was not significant in Chile nor USA. Fruit quality (fruit weight, soluble solid and firmness) showed a significant color x shade, and color x harvest time (fruit weight, soluble solids and titratable acidity) interactions. Our results indicate that the selection of the appropriate shade level and net color will depend on the needs for specific responses, where in general intermediate shade level (40-60 %PPFD) of red and white nets over mature plants would provide a desired harvest delay without detrimental effects on return bloom and fruit quality.