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郁闭柑橘园改造对植株光化学反应参数及果实品质的影响

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摘 要:【目的】探明不同整形改造技术对郁闭树体有效光合辐射、叶绿素荧光及果实品质等的影响,为果树冠层微生态环境优化及高产稳产提供理论依据。**【方法】**以15 a(年)生枳橙砧'奥林达'夏橙为试材,分别对郁闭植株(CK)进行开心形、篱壁形和变则主干形修剪处理,然后利用CI-110植物冠层分析仪测定植株冠层有效光合辐射分布、利用多功能植物效率分析仪M-PEA测定叶片快速叶绿素荧光的变化。**【结果】**不同处理植株的光合有效辐射、光合色素含量、快速叶绿素荧光参数在6月至9月差异明显:树体有效光合辐射(PAR)逐月明显下降;叶片光合色素呈先明显上升后略微下降的趋势;在试验测定阶段,植株叶片光系统活性、光能利用率、光合机构性能逐渐提高,叶片放氧复合体(OEC)受到伤害程度降低。几种整形改造方式对树体各项生理指标的影响明显,开心形、篱壁形和主干形等3种处理植株光合有效辐射、光合色素含量、光能利用率及光系统性能等均较对照明显提高。单株产量及果实品质以开心形最优,篱壁形、主干形次之,但均优于对照。**【结论】**通过树形改造改善了冠层微生态重要因子即光合有效辐射状况,树体的叶片光合色素含量、光合结构性能、光合机构自我保护能力、光合效率、PSI与PSII的协调性等都有极大的提升,明显改善了植株单株产量及果实品质。

关键词: 柑橘;整形改造;光合有效辐射;光合色素;叶绿素荧光;果实品质

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Effects of tree pruning in a closed citrus orchard on some parameters of photochemical reactions and fruit quality

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Abstract:【Objective】This study examined the effects of different tree pruning treatments on leaf photosynthesis, chlorophyll fluorescence and fruit quality in a closed citrus orchard in order to optimize tree canopy structure and improve the microenvironment in the orchard and productivity.【Methods】In the experiment, 15-year-old trees in a closed Valencia orange orchard were pruned into different canopy shapes, e.g. open center shape, hedgerow shape and trunk shape, and the effects of these different pruning treatments on photosynthetic active radiation (PAR), photosynthetic pigments, fast chlorophyll fluorescence, fruit yield and quality were studied. A digital plant canopy imager (CI-110, CID Bio-Science, Inc. Camas, USA) was used in this experiment, which consisted of an auto-leveling image capturing probe, PAR sensors and a built-in USB interface for an optional palm-top computer installed with CI-110 soft-

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ware. PARs in different treatments were recorded. The un-pruned trees in the closed orchard were used as the control (CK), and the signals of PF (prompt fluorescence) and DF (delayed fluorescence) in attached leaves in the treatments were collected. The kinetics of prompt chlorophyll a fluorescence (PF) at 820 nm (MR) was simultaneously recorded by a multifunctional plant efficiency analyzer, M-PEA (Hansatech Instrument Ltd., UK), which was programmed by a special computer software that controlled its operation, data recording and downloading. A well-developed leaf from the middle level of each tree was chosen for the above analyses throughout the whole experiment.【Results】The PAR, photosynthetic pigment contents and fast chlorophyll fluorescence parameters in plants under different treatments obtained in June to September were significantly different. PAR decreased significantly with time. From June to August, the photosynthetic pigments content showed an increasing trend but decreased in September. Chla/b constantly decreased throughout the experiment. After different pruning treatments, leaf Chl a, Chl b, Chl a+b and Car contents increased significantly compared with CK, indicating that the treatments promoted the accumulation of photosynthetic pigments and photosynthesis in closed orchards. By measuring and analyzing the dynamic changes in leaf chlorophyll fluorescence in different treatments, it was found that the values of F_m, F_J, F_I and F_o all decreased during the experiment, and the values in CK plants was the highest. The activity parameters per unit PSII reaction center (ABS/RC, DI_o/RC and TR_o/RC) and the activity parameters per unit cross sectional area (ABS/CS, TR_o/CS and DI_o/CS) all decreased with time, but RC/CS displayed an opposite trend. Among all the treatments, the values of ABS/RC, DI_o/RC, TR_o/RC, ET_o/RC, ABS/CS, DI_o/CS and TR_o/CS in CK were highest, while those of ET_o/CS and RC/CS followed a pattern of open center shape > hedgerow shape > trunk shape > CK. Ψ_o, φ_{Eo} and φ_{Po} increased constantly, while φ_{Do} increased. The values of φ_{Po} and φ_{Do} had little difference between CK and various trunk shapes, but the values of Ψ_o and φ_{Eo} in CK were significantly smaller than in the other treatments. The W_k, V_J and M_o in all the treatments were highest in June; V_I reached a maximum value in August, but Sm and N fell to minimum in August. At the same period, V_J, W_k, V_I and M_o were the highest and S_m and N were the lowest in CK and the electron transfer ability of leaf photosynthetic system was highest in the open center shape, followed by hedgerow shape and trunk shape, and CK had the lowest value. From July to August, the RE_o/RC, RE_o/CS, φ_{Ro}, ψ_{Ro} and δ_{Ro} in all the treatments decreased, and the PSI related fluorescence parameters in CK were lower than in the other three treatments. PI_{abs}, PI_{cs} and PI_{total} in the open center shape and hedgerow shape all increased with time, and were significantly higher than in CK. Yield and fruit quality of open center shape were the best, followed by hedgerow shape and trunk shape, and worst in CK.【Conclusion】Tree pruning could improve the micro environment in orchard with increased PAR, and thus significantly improved photosynthetic performance, plant productivity and fruit quality. Among the three pruning treatments, the open center shape was the best, followed by hedgerow shape and trunk shape.

Key words: Citrus; Tree shaping; Photosynthetic active radiation; Photosynthetic pigments; Chlorophyll fluorescence; Fruit quality

重庆三峡库区许多柑橘园，尤其是以枳橙作砧的柑橘园，树体郁闭、早衰、单产和果实品质下降等问题已普遍发生。笔者的前期调查发现，超过10 a生树龄的植株，高度为5 m左右、冠幅为4~5 m，果园行间、株间枝叶交叉，树冠内膛郁闭，通风透光差，内膛枝叶枯死，结果部位向上、向外推移，植株产量和果实品质均发生不同程度的下降，对柑橘优质高效生产和可持续发展构成较大影响。而较为乔化的砧木和不当的树体管理等，是导致这些问题的主要原因。可见，认识和了解郁闭柑橘树整形改造的生理、生态效应，对优化冠层微域环境、构建科学合理的整形改造树体管理技术、促进柑橘园持续优质丰产等