In the past decades, many geometric-optical (GO) models and hybrid models are developed to simulating the bidirectional reflectance over heterogeneous canopy. In almost all these models, the tree crowns are assumed as horizontally Poisson distributed. However, the Poisson distribution assumption does not apply to many plants, because it allows probability of overlapping of tree crowns in vertical view direction, i.e., it is possible to have one tree on top of another. Some researchers have recognized this problem and introduced some new coefficients to adjust the results. Usually a plant prevents the growth of related species around itself, typically within a circular range. The resulting mathematical distribution is called a Poisson disc distribution. In this paper, we employ the Poisson disc distribution instead the Poisson distribution to describe the tree crowns horizontal distribution in a GO model. The tree crowns are assumed horizontally non-overlap each other. We analyses the characteristic of the the tree distribution, and derive the probability of one tree’s projection overlaps anther in different zenith angles. The overlap probabilities show distinct difference for the two distribution assumptions, especially at small zenith angle. This can explain why the models with Poisson distribution overestimate the bidirectional reflectance factor (BRF) values in red band and underestimate the values in near-infrared band. We validate our derivation with the results generated with a Monte Carlo ray tracing method, and find that both assumptions provide good simulations for sparse forest, while the model with poisson disc assumption performs much better for denser forest.