The objective of this study was the application of the synthetic promoter library (SPL) technology for modulation of actinorhodin production in Streptomyces coelicolor A3(2). The SPL technology was used to optimize the expression of a pathway specific positive transcriptional regulator Actll orf4, which activates the transcription of the S. coelicolor actinorhodin biosynthetic gene cluster. The native actll orf4 promoter was replaced with synthetic promoters, generating a S. coelicolor library with a broad range of expression levels of actll orf4. The resulting library was screened based on the yield of actinorhodin. Selected strains were further physiologically characterized. One of the strains from the library, ScoSPL20, showed considerably higher yield of actinorhodin and final actinorhodin titer, compared to S. coelicolor wild type and S. coelicolor with actll orf4 expressed from a strong constitutive promoter. ScoSPL20 demonstrated exceptional productivity despite having a comparatively weak expression from the promoter. Interestingly, the ScoSPL20 promoter was activated at a much earlier stage of growth compared to the wild type, demonstrating the advantage of fine-tuning and temporal tuning of gene expression in metabolic engineering. Transcriptome studies were performed in exponential and actinorhodin-producing phase of growth to compare gene expression between ScoSPL20 and the wild type. To our knowledge, this is the first successful application of the SPL technology for secondary metabolite production in filamentous bacteria.