A promising mechanism to form intermediate-mass black holes (IMBHs) is the runaway merger in dense star clusters, where main-sequence stars collide and form a very massive star (VMS), which then collapses to a black hole. Here we present the results of a new study of the effects of primordial mass segregation (as observed in young massive clusters) on the runaway growth of VMSs. We use a dynamical Monte Carlo code for N-body systems with N as high as 10^6 stars and compare the results of primordially mass-segregated clusters with primordially unsegregated clusters having the same initial conditions. We find that primordial mass segregation decreases the core collapse time ($t_{\rm cc}$) of star clusters increasing the possibility of having a runaway. For clusters with small degrees of mass segregation, the decrease in $t_{\rm cc}$ is mainly due to the change in density profile, which is a characteristic of the mass segregation recipe. However, in clusters with significant primordial mass segregation, the decrease in $t_{\rm cc}$ is primarily driven by the increase in the average stellar mass in the core. Moreover, the final mass of the VMS formed is always close to $\sim 10^{-3}$ of the total cluster mass and is reminiscent of the $M - \sigma$ relation for central black holes.