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The Galactic Center (GC) black hole Sgr A* gives us an opportunity to perform horizon scale tests of black hole physics and deviations from General Relativity, thanks to observations carried out by the Event Horizon Telescope (EHT). In this work we study the impact of the scalar degree of freedom (scalaron) of $f(R)$ gravity theory on the size and shape of GC black hole by using a recently developed stationary, axisymmetric and vacuum metric of $f(R)$ theory. We encounter a minimum bound of 10^{-17} eV for the scalaron mass using 1σ upper bound on the deviation parameter produced by EHT-Keck and EHT-VLT measurements. Lighter scalarons increase the shadow size beyond that measured by the EHT. The displacement and asymmetry in the shape of the black hole shadow are employed to test the no-hair theorem and it is observed that 10^{-16} eV scalarons yield the exact Kerr like shadow and a 6% departure from the Kerr quadrupole. We infer preservation of the no-hair theorem for such scalaron mass and further examine the possibility of violation of the theorem. The same mass scale reproduces the PPN parameter γ constrained in the weak field limit of the solar system. This is for the first time we report a convergence of horizon scale test and solar system test of $f(R)$ gravity by using the scalaron mass. The prospect of constraining the scalaron mass using gravitational waves is an exciting avenue to be highlighted.

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