We consider high-dimensional location test problems in which the number of variables $p$ may exceed the sample size $n$. The classical $T^2$ test does not work well because the contamination bias in estimating the covariance matrix grows rapidly with $p$. Unlike most existing remedies abandoning all the correlation information, the method developed here is to make use of them in a practical and efficient way. Our method, called composite $T^2$ test, consists of two steps. The first step is to sequentially select $K$ variables which have the largest correlation among all combinations of $K$ elements from the remaining variables. The second step is to construct $p/K$ $T^2$ test statistics and combining them together. Under mild conditions, the proposed test statistic is asymptotically normal, and allows the dimensionality to almost exponentially increase in $n$. This test inherits certain appealing features of the classical $T^2$ test and does not suffer from large bias contamination. Due to incorporating much correlation information, the proposed test can delivery more robust performance than existing methods in many cases. Simulation studies demonstrate the validity of asymptotic analysis.