Nonlinear elastic wave methods such as nonlinear resonant ultrasound spectroscopy (NRUS) and nonlinear wave modulation spectroscopy have been used earlier to detect damages in several materials. It was observed that applying these techniques to composites materials becomes difficult due to the significant inherent baseline nonlinearity, i.e. nonlinearity in the undamaged state. Understanding the non-classical nonlinear nature of the composites plays a vital role in implementing nonlinear acoustic techniques for material characterization as well as qualitative nondestructive testing of composites. There are several factors which can influence the baseline nonlinear response in fiber reinforced composites, but this work limits to studying the effect of three factors, namely: fiber orientation, laminate sequence and type of fabric. Since fiber reinforced composites are orthotropic in nature, the baseline response variation with fiber orientation is very important. This work explores the nature of the inherent nonlinearity by performing nonlinear resonant spectroscopy (NRS) in intact or undamaged unidirectional carbon/epoxy samples with different fiber orientations with respect to major axis of the sample. Factors such as frequency shifts, modal damping ratio, and higher harmonics were analyzed to explore the non-classical nonlinear nature of these materials. Similarly, NRS tests were carried out on samples with different laminate sequence to observer the difference in nonlinear response. Similar comparisons were made between continuous fabric laminate and woven fabric laminate. A nonlinear-viscoelastic forced vibration model based on geometric nonlinearities was developed to explain the observed responses. The Kelvin-Voigt model was used to model viscoelasticity along with geometric nonlinearity in the form of von Kármán strains. The classical nonlinear and damping sources were identified and compared between experiment and theory. A semi-analytical experimental approach was used to extract model parameters from experiment, and compare model predictions against experimental results. The classical and the non-classical nonlinear parameters were compared for different laminate sequences to complete the baseline study.