Determining the establishment success of tree species needs to be conducted before attempting to use a species in large-scale afforestation programs. In this study, the physiological performance of four Turkish red pine (*P. brutia* Ten.) provenances was investigated after their exposure to artificial cold temperature treatments. Seeds were sown and raised for 24 weeks, 28 weeks, and 32 weeks and exposed to decreasing temperatures in an artificial freezer. Relative electrolyte leakage, chlorophyll fluorescence, and carbohydrate concentrations were measured to determine the variability among *P. brutia* provenances and between species. Results showed that diameter and height growth of seedlings of *P. brutia* sources did not vary for each of the three seedling growth stages. Provenance affected stem and root electrolyte leakage, and our data revealed that cold stress effectively caused physiological damages when temperature decreased −15 °C during the early age of seedlings. The study also showed that in all provenances, roots were more susceptible to cold damage than stems. There were no significant differences of the chlorophyll fluorescence of *P. brutia* provenances. Carbohydrate concentrations were also very variable and varied significantly among growth stages and provenances. We could not find any clear trends related to provenance altitude. Further studies including more treatment and response variables are needed before any definite conclusion and recommendation can be made about the cold hardiness of this species.