Information obtained from statistical infectious disease transmission models can be used to inform the development of containment strategies. Inference procedures such as Bayesian Markov chain Monte Carlo are typically used to estimate parameters of such models, but are often computationally expensive. However, in an emerging epidemic, stakeholders must move quickly to contain spread. Here, we explore machine learning methods for carrying out fast inference via supervised classification. We consider the issues of regularization, model choice and parameter estimation. This is done within the context of spatial models, applied to both diseases of agriculture and the COVID-19 epidemic. We also consider how accurate such methods are in comparison with naïve, and much slower, MCMC approaches.