**Optimizing nitrogen, phosphorus and cattle manure application in wheat production using Response-Surface Methodology (RSM)**

**Abstract**

Negative environmental impacts of chemical fertilizers need to be reduced by optimizing application rates and improving fertilizer use efficiencies plus applying natural resources such as manure. Optimal application rates of inorganic nitrogen (N) and phosphorus (P) as well as cattle manure were estimated, using Response Surface Methodology (RSM). A Box-Behnken design was conducted at field level during the 2013-14 and 2014-15 growing seasons. The applied levels of N were 0, 150 and 300 kg ha-1 pure N in form of urea and for P fertilizer were 0, 100 and 200 kg ha-1 (P2O5) and for cattle manure were 0, 15 and 30 t ha-1. Response variables were measured as Grain yield (GY), dry matter yield (DMY), fertile tiller per plant (FT), relative water content of leaves (RWCL), N losses (NL), and agronomical N use efficiency (ANUE). Both quadratic and linear regression functions were fitted to observed traits and those recognized significant (P ≤ 0.05) were analyzed. Increased N and P rates up to 200 kg ha-1 made in increased GY. At the highest N application rate (300 kg ha-1) FT per plant were increased linearly by 0 to 200 kg ha-1 P, however, a quadratic response to P was observed at lower N levels. Rate optimization of N, P and manure got based on economic, environmental and eco-environmental scenarios. In economic scenario, using 145.4 kg ha-1 N, 200 kg ha-1 P and 18.4 t ha-1 manure resulted in 6500 kg ha-1 GY with ANUE of 10.49%. In environmental scenario, with application of 21.21 kg ha-1 N and no application of P, by applying 16.3 t ha-1 manure, GY and ANUE of 3160 kg ha-1 and9.08% were obtained respectively. In eco-environmental scenario, 145 and 34 kg ha-1 N and P plus 30 t ha-1 manure resulted in 4031 kg ha-1 GY and a considerable high ANUE of 16.50% succeeding 36.4% higher than economic scenario. The results indicate the eco-environmental scenario have advantages over the other scenarios due to high ANUE which is more environmental user-friendly to sustainable production of winter wheat.

**Keywords:** Optimizing resources; Nitrogen losses; Eco-Environmental scenario; Grain yield; Box-Behnken design.