Study of Greenhouse Effect on the Productivity and Area of Forage Grass Cultivated in Japan

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Summary

The optimum geographic ranges of grass species are likely to shift as a result of such climatic changes as rising temperature and increasing CO_2 concentration, and there will be corresponding changes in the cultivation zones in Japan. Changes in cultivation zones and the productivity of forage grass cultivation in Japan were estimated.

The apparent photosynthetic rate of three temperate grass species (tall fescue, perennial ryegrass and orchardgrass), and one tropical grass species (bahiagrass) increased and the optimum leaf temperatures tended to rise with doubled CO_2 concentration. The relative ratio of photosynthesis increased with increasing leaf temperature. The regression shows that when the CO_2 concentration rises, an increase in leaf temperature further accelerates the relative photosynthetic ratio of the forage grasses.

Two production models, one using a neural network and the other using a multiple regression analysis, were constructed based on data of monthly dry matter production under various climatic conditions for four grass species. Conformity analysis was carried out by comparing the estimated two models. The results clearly showed that the neural network had a higher coefficient between estimated data and actual production. Accordingly, the neural network model showed the better estimation for grass productivity.

The monthly dry matter productivity for each secondary grid square in Japan at the present and 100 years in the future was simulated by applying the neural network model. Then maps of suitable cultivation zones and productivity were drawn for each species. These maps show that the summer depression″ zone of individual grass species is limited to the southwestern part of Japan under present climatic conditions. After 100 years, the dry matter productivity is predicted to increase, and the summer depression zone and tropical grass zone will extend northwards.

Maps show future temperate grass zones, tropical grass zones, and summer depression″ zone, where the tropical grass will not be able to survive in winter and the productivity of the temperate grasses will be depressed in summer. The productivity of the temperate and tropical grasses will increase 40 and 360%, respectively, and sum of the both grass productivity will increase 50% in Japan.

Key words: Temperate grass, Tropical grass, Productivity, Global climate change, Cultivation zone