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The effect of plant mineral nutrition on yield and quality of green tea (*Camellia sinensis* L.) under field conditions

In cooperation with the Tea Research Institute, Chinese Academy of Agricultural Sciences, Hangzhou, Zhejiang province, P. R. China, field experiments were conducted in 2002 and 2003 to study the responses of tea yield and quality to fertilization. A diagnosis system was developed to estimate plant N fertilizer demand, and the effect of shading on the diagnosis of N status in summer tea was considered as well. The impact of the application of N, K, Mg and S on yield and quality was investigated, too. In order to understand the direct effect of shading on tea quality, the interaction between light intensity and N supply was also studied. In addition the gas exchange was studied to extend the interpretation of the results.

Considering the economic profit, the optimum N application rate (N_{opty}) of 810 kg N ha^{-1} a^{-1} was calculated from 95% of the maximum yield, and it was closer to the N level at the lowest TP/AA (ratio of tea polyphenols to amino acids, the best quality). The critical soil N_{min} in 0-60 cm soil depth was 200-260 kg N ha^{-1} (spring) and 320-430 kg N ha^{-1} (autumn), respectively. In spring, the critical NO_3^- contents were 30-33, 6-7 and 10-11 mg L^{-1} in the young stem, new fully expanded leaves (NFEL) and in the top old leaves (TOL, which were growing on the brown stems and grew up from the former year), respectively. The critical AAN content was 714-732 mg L^{-1} in NFEL. In autumn, the critical indicator contents were 5-6 mg L^{-1} NO_3^- and 495-510 mg L^{-1} AAN in mature leaves, respectively. The optimum N application rates within a season (N_{opts}) were 240-340 kg N ha^{-1} (spring) and 130-240 kg N ha^{-1} (autumn). In summer, shading had strong effects on the N_{opty} (810 kg N ha^{-1} a^{-1} in full sun and 700 kg N ha^{-1} a^{-1} under shading) and the critical NO_3^- levels in young stem (20-33 mg L^{-1} in full sun and 32-51 mg L^{-1} under shading). But shading had no effects on the critical soil N_{min} and N_{opts}. According to this study, the application rate for autumn tea can be reduced and should be applied to spring and summer tea, especially to spring tea. Due to the limited information on nutrient diagnosis in tea available today, this study supplied the basic information to establish the diagnosis system.

The lower photosynthetic rate resulted in the decreased yield under shading, but tea flushes under shading showed higher content of free amino acids, lower content of tea polyphenols and lower TP/AA ratio than those in full sun, especially in summer of 2002. Shading increased the total contents of P and K in tea flushes. The reduced activities of nitrate reductase (NR) under shading might inhibit the synthesis of precursor amino acids of cinnamic acid and the reduced activities of phenylalanine ammonia-lyase (PAL) under shading could inhibit the synthesis of the precursors of catechin. The increased polyphenol oxidase (PPO) under shading enhanced the degradation of polyphenols. Under shading, an increase of the leaf water content and specific leaf area and a decrease of Chl a/b ratio and leaf total N content per unit leaf area were identified as typical adaptations of tea plants to low irradiance to capture more light energy per unit biomass. The decreased activities of ascorbate peroxidase, dehydroascorbate reductase, glutathione reductase and the reduced ascorbate content under shading implied that the light driven regulation of the antioxidant and anthocyanin protection system may not be as vital as in full sun.

The application of K and Mg fertilizers could slightly increase the yield and improve the quality, especially for variety Longjing43 in 2003. Due to the antagonism of K and Mg, the effect of K on increasing the content of amino acids and ascorbic acid in reduced form was more pronounced than that with K and Mg together. Sulphur application could slightly increase the fresh yield, the content of free amino acids, total ascorbate and decrease the content of polyphenols and the TP/AA ratio. The activities of NR and PAL were slightly increased by sulphur, but the activity of PPO was inhibited.