Anna Kiełtyka-Dadasiewicz

Agrotechnics optimization of *Cymbopogon citratus* (DC) Stapf. in the Poland climatic conditions

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Cymbopogon citratus (DC) Stapf. (*Poaceae* family) is a subtropical perennial thermophilic plant of multidirectional utility. Its various parts and varieties can be used as food raw material, the most popular of which are fresh shoots, dried leaves and essential oil. The oil is valued in aromatherapy and herbal medicine for its high content of citral and in cosmetics for its refreshing smell and antiseptic properties.

To date there are no literature data concerning the attempts to cultivate this species in Poland. Considering the sensitivity of lemongrass to low temperatures, its cultivation in our climatic conditions can only be considered as annual. The aim of the present study was to examine the possibility of growing *C. citratus* under temperate climate conditions and to determine the optimal type and date of agrotechnical treatments. The yield was assessed regarding three potential directions of use: (1) leaves intended for drying as well as (2) a theoretical calculation of the yield of essential oil and (3) freshly harvested shoots. Five field experiments were carried out, four of which concerned agrotechnical factors aimed at optimizing plant growth conditions in the new habitat:

1. At the initial stage of plant growth in spring, polypropylene covers were temporarily used to protect plants from unfavourable low temperatures. The second factor of this experiment was different dates of plantation establishment: I, II and III decades of May.

2. The yield-inducing effects of the application of different nitrogen doses were tested: 30 and 60 kg N·ha^{-1} applied pre-sowing and increasing the amount of nitrogen introduced in the second dose reaching a total amount of 90 (60 + 30) kg N·ha^{-1} and 120 (60 + 60) kg N·ha^{-1}, compared to a control sample without nitrogen fertilization.

3. In the third experiment, the first factor was the diverse plant density: 37,500, 60,000, 80,000, 100,000, 125,000 plants per ha^{-1}, while the second factor was the harvest date: 15, 17 and 19 weeks after planting the plants, i.e. September 1–3, September 14–17 and September 27–30.

4. The fourth experiment was to determine appropriate antifungal protection in the cultivation of *C. citratus* for fresh shoots.

5. The last experiment consisted in assessing the risk of introducing lemongrass to Polish conditions. The durability of the species in polish conditions was determined, which allows to estimate the risk of uncontrolled spread of the species in the environment. Moreover, possible adverse effects of the site left after the cultivation of *C. citratus* on the growth of other plant species were examined (spring wheat, peppermint, carrots, strawberry).

Based on the study findings, it was concluded that the use of temporary polypropylene covers after planting protected the plants to some extent from late spring frosts commonly occurring in our climate yet did not significantly improve yields. Better yield-associated effects in all the areas studied (yield of dried leaves, oil and shoots) were obtained by delaying the date of planting until there was no risk of frosts. *C. citratus* plants responded well to nitrogen fertilization. The highest yields were obtained using the maximum tested dose of nitrogen, i.e. 120 kg N·ha^{-1} applied in two equal doses of 60 kg·ha^{-1} before the establishment of the plantation and after two months. The plants grew better at a higher density. Despite the smaller area left for individual plants, they formed a larger mass, more propagated clusters and consequently the yield of dried leaves and essential oil was the highest for the highest density tested, i.e. 125,000 plants per ha^{-1}. The highest yield of commercial shoots was obtained at a density of 100,000 plants·ha^{-1}. Harvesting plants at the latest date was found to be most beneficial for the yield of dried leaves, essential oil and shoots. Delaying the harvest intensified the effects of fungal diseases, especially with the highest plant density; however, the use of chemical antifungal protection brought about the expected results, preventing the development of fungal diseases, thus protecting against crop losses.

The risk of introducing a new species into domestic crops was assessed as slight, due to the negative winter temperature, which is destructive for this species. The site left after the cultivation of lemongrass turned out to be unfavorable for the yield of strawberries and spring wheat, in comparison with typical forecrops for these species. In the case of the other studied species of crops (carrots and peppermint), no significant differences in the yield or quality of raw materials were noted.

In conclusion, the optimal conditions for growing *C. citratus* under Polish climatic conditions are as follows:

– delaying the date of establishment of plantations until the period of frosts is over and using polypropylene covers when there is a risk of their later occurrence,

– use of nitrogen fertilization at a dose of at least 60 kg N·ha^{-1}, and preferably with an additional application in the amount of at least 30 kg N·ha^{-1},

– use of a density of 125,000 plants·ha^{-1} in plantations for harvesting leaves to be dried, and 100,000 in plantations for harvesting shoots,

– harvesting should begin after mid-September; when the harvest is planned to be delayed, prior antifungal protection should be applied in shoot plantations.