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Effect of polythene covers on the content of mineral elements in the needles and buds of *Picea abies* (L.) Karst. grafts

Abstract

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In shoots of 15-year-old Norway spruce grafts the content of some mineral nutrients was analysed. Covering grafts with polythene from 29th of June to 20th of July significantly increased the levels of phosphorus, nitrogen and potassium, but this was not connected with the flowering intensity of the treated grafts. Possible relation between mineral status of shoots and strobili initiation is discussed.

Additional key words: Norway spruce, mineral nutrients, strobili initiation.

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INTRODUCTION

Covering Norway spruce grafts with polythene during the time of strobili initiation appears to be an effective treatment stimulating flowering and the best time for the treatment was usually the turn of June and July (Brøndbo 1969, Remröd 1972, Chałupka and Giertych 1977, Olsen 1978, Chałupka 1981). Similar results were obtained by Tompsett and Fletcher (1977) in an experiment with Sitka spruce (*Picea sitchensis* (Bong.) Carr.).

Polythene covers cause many changes in the graft environment and the most significant is the rising of temperature (Brøndbo 1969, Chałupka 1985). It was also established that covering grafts with polythene significantly increased the content of less polar gibberellin-like substances in the shoots of Norway spruce (Chałupka et al. 1982), and retarded the metabolism of tritiated gibbrellin $A_{4/7}$ (Dunberg et al. 1983).

The present experiment was aimed at analysing another aspect of polythene cover treatment namely the changes in the levels of some mineral nutrients in the Norway spruce grafts.

MATERIALS AND METHODS

Four 15-year-old clones of Norway spruce from the clone archive of the Institute of Dendrology were selected, each represented by two grafts. Half of the grafts, one from each clone, were covered with polythene tubes for the period of 29th of June to 20th of July 1983. The remaining grafts acted as control. Samples for analysis were collected at eight different times (Tab. 1), taking randomly ten current growth shoots from each graft.

Table 1

Chronology of field work

Sampling time	Date	Notes
1	29 June	Collection shoots before covering
	29 June	Covering grafts with polythene at 9 a.m.
2	29 June	Collection shoots 5 hrs. after covering
3	30 June	
4	5 July	
5	12 July	
	15 July	Uncovering grafts at 9 a.m.
6	15 July	Collection shoots 5 hrs. after uncovering
7	16 July	
8	20 July	

After collection shoots were dried for 24 hrs. at 105°C, and then the needles and buds were separated and powdered. Mineral analyses were made for nitrogen, phosphorus, calcium, magnesium, potassium and sodium content. Nitrogen was analysed by the Kjeldahl method (Piper 1957), and phosphorus by the modified method of Kuttner and Lichtenstein (Fink 1963). All the metalic elements were analysed by flame photometry using an Atomic Absorption Spectrophotometer — Zeiss AAS 1 (Humphries 1956). The results of mineral analyses were subjected to a variance analysis.

RESULTS

Flowering of Norway spruce grafts in 1984 was poor and female strobili appeared only on 31 grafts and male on 85 grafts out of 623 growing in the clone archive. Covering grafts with the polythene did not increase the flowering this year (Tab. 2).

On the other hand polythene treatment significantly increased the levels of some mineral nutrients in Norway spruce grafts (Tab. 3 and 4). The levels of phosphorus,

Table 2

Flowering of treated grafts

Clone	Covered grafts	Control
01-03	no flowering	2 ♀ and 3 ♂
07-04	no flowering	1 ♂
04-04	no flowering	no flowering
03-44	1 ♂	2 ♂

Female strobili were counted, and male flowering intensity was estimated on a 5 – degree scale: 0 – no flowering, 1 – sparse strobili on a small part of crown, 2 – strobili on half of crown, 3 – sparse strobili on the whole crown, 4 – numerous strobili on the whole crown

nitrogen and potassium were respectively 9.7%, 5.3% and 11.4% higher in covered grafts than in the controls (Tab. 4).

Significant differences between the collection times were established for phosphorus, magnesium and potassium (Tab. 3, Fig. 1). An increase of phosphorus level was noticed at least one day after covering grafts, and then a decrease was observed without any dependence on uncovering time. The content of magnesium

Table 3

Effect of polythene covers on the level of mineral nutrients in Norway spruce grafts. Results of variance analyses

Source of variance	Degree of freedom	Minerals					
		P	N	Ca	Mg	K	Na
Total	63						
Polythene covers (P)	1	10.95**	5.56**	1.36	3.53	11.49**	0.07
Times (T)	7	9.20**	1.08	1.63	4.84**	9.64**	1.38
P×T	7	0.78	1.47	0.76	0.44	0.25	1.08
Clones	3	5.57**	4.79**	7.71**	7.06**	2.41	0.89
Residual	45						

** — Significant at 0.01 level: * Significant at 0.05 level

Table 4

Level of mineral nutrients in Norway spruce grafts, % of dry weight

Minerals	P	N	Ca	Mg	K	Na
Covered grafts	0.181	1.40	0.617	0.063	0.803	0.044
Controls	0.165	1.33	0.588	0.051	0.721	0.042

constantly increased without any visible influence of treatment. As regards to potassium covering grafts caused a major decrease of its content, and after uncovering an increase to a more stable level of this mineral was noticed. In the case of nitrogen, calcium and sodium no significant changes in their content were observed during sampling time (Fig. 1).

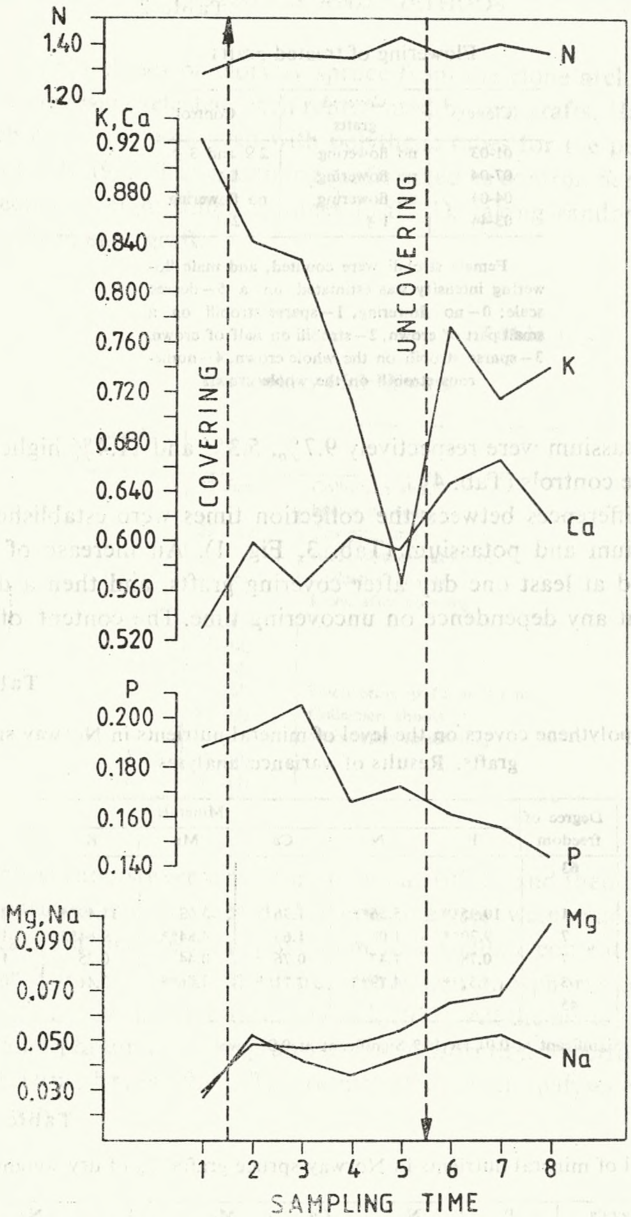

Fig.1. Effect of polythene covers on nutrients in spruce (% of dry weight)

A clonal variation was statistically significant for phosphorus, nitrogen, calcium and magnesium content (Tab. 3), but only in the case of calcium a significant difference was noticed between northeastern clones (01-03 and 07-04), and southern ones (03-44 and 04-04) (Tab. 5).

No interaction was observed between polythene covers and time of sample collection.

Table 5

Clonal variation in the level of mineral nutrients,
% of dry weight

Minerals	Clones			
	01-03	07-04	03-44	04-04
P	0.172b	0.160b	0.188a	0.172b
N	1.37a	1.27b	1.41a	1.41a
Ca	0.553a	0.535a	0.659b	0.661b
Mg	0.049a	0.052a	0.045a	0.082a
K	0.777a	0.721a	0.744a	0.806a
Na	0.043a	0.040a	0.039a	0.050a

Values with the same letter are not significantly differed according to Duncan's test

DISCUSSION

Covering Norway spruce grafts with polythene positively influenced the total content of nitrogen, phosphorus and potassium in the needles and buds. The higher level of nitrogen remained nearly the same during the time of experiment, while the levels of phosphorus and potassium significantly changed during the time of sample collections (Fig. 1). An increase in phosphorus content during the first day after covering grafts was very similar to the dynamics in the activity of gibberellin-like substances observed in a similar experiment (Chałupka et al., 1982).

The rapid decrease of the potassium content after covering grafts was also of interest. It seems to be possible that the „greenhouse effect" created the favourable conditions for more intensive vegetative growth of covered shoots, and it was earlier noticed that such situation may result in decrease of potassium content in trees (Baule and Fricker, 1973). Unfortunately these significant changes in the content of some minerals caused by covering Norway spruce grafts with polythene were not clearly connected with flowering of the treated grafts.

There are not many data on the relation between the level of mineral nutrients and flowering in coniferous trees. According to some suggestions there exists a close relationship between nutritional status of shoots and the sex of initiated strobili: female strobili are induced on shoots with good mineral nutrient supply, and male ones in condition of limited supply of minerals (Wareing 1958, Sweet and Will 1965). Fober (1976) came to an opposite conclusion after his detailed studies on the distribution of mineral nutrients in the crowns of the Scots pine and Norway spruce.

Lack of flowering in the treated grafts in 1984 seems to confirm the suggestion of Wareing (1958) rather than the results of Fober (1976) (Tab. 2). The higher level of some mineral nutrients caused by polythene covers perhaps proved unfavourable to the initiation of male strobili. However the relationship is too low to be conclusive.

It is possible that the increased content of mineral nutrients in the needles and guds of covered grafts was the result of changed distribution of nutrients inside brafts. It is a well known fact in fruit trees a higher level of phosphorus in buds was closely correlated with the number of flowers initiated (Baxter 1972, Grochowska 1979). Similarily in Douglas-fir nitrogen fertilization promoted flowering and simultaneously increased the content of that mineral nutrient in the treated trees (Puritch 1972, Ebell and McMullan 1970). One can suspect that buds during the time of strobili initiation act as a sink for mineral nutrients. Such a hypothesis was postulated by Sachs (1977) for herbaceous and woody angiosperms with respect to assimilates. The data of Sweet (1979) and Ross et al. (1984) support this suggestion also in the case of *Pinus radiata*.

Unfortunately we still have no adequate data to support such a hypothesis in the case of mineral nutrients and further detailed studies are needed to answer this question.

LITERATURE

1. Baule, H., Fricker, C., 1973. Nawożenie drzew leśnych. PWRiL, Warszawa.
2. Baxter, P., 1972. The flowering process — a new theory. In: Plant Growth Substances, Springer Verlag, Berlin: 775 - 779.
3. Brøndbo, P., 1969. Blomstringinduksjon ved varmebehandling hos granpodninger. Medd. Norske Skogforsoksvesen, 27 (98): 295 - 311.
4. Chałupka, W., 1981. Influence of growth regulators and polythene covers on flowering of Scots pine and Norway spruce grafts. Silvae Genet., 30 (4 - 5): 142 - 146.
5. Chałupka, W., 1985. Regulacja kwitnienia na plantacjach nasiennych sosny zwyczajnej (*Pinus sylvestris* L.) i świerka pospolitego (*Picea abies* (L.) Karst.). Instytut Dendrologii PAN, Kórnik, pp. 1 - 146.
6. Chałupka, W., Giertych, M., 1977. The effect of polyethylene covers on the flowering of Norway spruce (*Picea abies* (L.) Karst.) grafts. Arbor. Kórnickie, 22: 185 - 192.
7. Chałupka, W., Giertych, M., Kopcewicz, J., 1982. Effect of polythene covers, a flower inducing treatment, on the content of endogenous gibberellin-like substances in grafts of Norway spruce. Physiol. Plant., 54: 79 - 82.
8. Dunberg, A., Malmberg, G., Sassa, T., Pharis., R. P., 1983. Metabolism of tritiated gibberellins A_4 and A_9 in Norway spruce, *Picea abies* (L.) Karst. Effects of a cultural treatment known to enhance flowering. Plant Physiol., 71: 257 - 262.
9. Ebell, L. F., McMullan, E. E., 1970. Nitrogen substances associated with differential cone production responses of Douglas-fir to ammonium and nitrate fertilization. Can. J. Bot., 48: 2169 - 2177.
10. Fink, J., 1963. Wstęp do biochemii fosforu roślin. PWRiL, Warszawa.
11. Fober, H., 1976. Distribution of mineral elements within the crown of Scots pine (*Pinus silvestris* L.) and Norway spruce (*Picea abies* (L.) Karst.). Arbor. Kórnickie, 21: 323 - 331.
12. Grochowska, M. J., 1979. Zawiązywanie pąków kwiatowych. In: Fizjologia roślin sadowniczych, Ed. L. Jankiewicz, PWN, Warszawa: 371 - 408.
13. Humphries, E. C., 1956. Mineral components and ash analysis. In: Modern methods of plant analysis, Ed. Paech and Tracey, vol. 1: 468 - 502.
14. Olsen, H. C., 1978. Blomstringsinduktion hos rodgran. Forstl. Forsogsvaesen Denmark, 36 (2): 231 - 266.
15. Piper, C. S., 1957. Analiza gleby i roślin. PWN, Warszawa.
16. Puritch, G. S., 1972. Cone production in Conifers: a review of the literature and evaluation of research needs: with an economic analysis, by A. H. Vyse. Can. For. Serv. Inform. Rep. BC-X-65, pp. 1 - 94.
17. Remröd, J., 1972. Försök med blomningsstimulering i en granfröplantage. Årsbok Föreningen Skogsträdsförädling, Inst. Skogsförbättring: 160 - 178.

18. Ross, S. D., Bollmann, M. P., Pharis, R. P., Sweet, G. B., 1984. Gibberellin $A_{4/7}$ and the promotion of flowering in *Pinus radiata*. Effects on partitioning of photoassimilate within the bud during primordia differentiation. Plant Physiol., 76: 326 - 330.
19. Sachs, R. M., 1977. Nutrient diversion: an hypothesis to explain the chemical control of flowering. Hort. Science 12 (3): 220 - 222.
20. Sweet, G. B., 1979. A physiological study of seed cone production in *Pinus radiata*. New Zeal. Journ. For. Sci., 9 (1): 20 - 33.
21. Sweet, G. B., Will, G. M., 1965. Precocious male cone production associated with low nutrient status in clones of *Pinus radiata*. Nature, 206 (4985): 739.
22. Tompsett, P. B., Fletcher, A. M., 1977. Increased flowering of Sitka spruce (*Picea sitchensis* (Bong.) Carr.) by high temperature in a polythene house. Silvae Genet., 26 (2 - 3): 84 - 85.
23. Wareing, P. F., 1958. Reproductive development in *Pinus sylvestris*. In: The Physiology of Forest Trees, Ed. K. V. Thimann, Rolland Press, N. Y.: 643 - 654.

Wpływ osłon polietylenowych na zawartość składników mineralnych w igłach i pąkach szczepów świerka pospolitego (*Picea abies* (L.) Karst.)

Streszczenie

W ośmiu terminach ze szczepów świerka pospolitego osłoniętych folią polietylenową oraz kontrolnych zebrano pędy bieżącego przyrostu. Zbioru dokonano w okresie od 29 czerwca do 20 lipca. Osłony polietylenowe spowodowały istotny statystycznie wzrost zawartości fosforu, azotu i potasu w analizowanych pędach. Zmiany te nie były jednak powiązane z kwitnieniem traktowanych szczepów.

18. Ross, S. D., Bollmann, M. P., Pharis, R. P., Sweet, G. B., 1984. Gibberellin A4/7 and the promotion of flowering in *Pinus radiata*. Effects on partitioning of photoassimilate within the bud during primordia differentiation. Plant Physiol., 76: 326 - 330.
19. Sachs, R. M., 1977. Nutrient diversion: an hypothesis to explain the chemical control of flowering. Hort. Science 12 (3): 220 - 222.
20. Sweet, G. B., 1975. A physiological study of seed cone production in *Pinus radiata*. New Zeal. Journ. For. Sci., 5 (1): 20 - 33.
21. Sweet, G. B., Will, G. M., 1965. Precocious male cone production associated with low nutrient status in clones of *Pinus radiata*. Nature, 206 (4985): 739.
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