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Original article

Branching in young clonal oak

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Summary — Shoot length and branch production by 5 clones of oak were observed during 2 consecutive flushes of growth. The influence of decapitation was investigated by removal of the terminal bud at the start of each flush. The decapitation treatment had no effect on the length of the new leading shoot produced during each flush but there were significant differences between clones. The number of branches produced was usually greater in decapitated plants but clonal differences varied between flushes.

***Quercus petraea* / clone / decapitation / branching**

Résumé — Branchaison de jeunes boutures de chênes. *Des observations portant sur la longueur des pousses et la production de branches ont été faites au cours de 2 années successives sur 5 clones de chêne* (Q petraea). *Les observations ont également porté sur l'effet des décapitations du bourgeon terminal au début de la saison de végétation. La décapitation n'a pas d'effet significatif sur la longueur de pousse produite, malgré les différences observées entre clones. Le nombre de branches produites est plus important sur les boutures décapitées; des différences existent entre clones et entre pousses.*

Quercus petraea / *clone / décapitation / branchaison*

INTRODUCTION

Observations of mature oak trees indicate that there are considerable differences in stem and crown form but, at present, it is not possible to describe the processes leading to the formation of trees with different forms. The current Forestry Commission tree improvement program is studying branching patterns in oak. The aims are to gain more information on the process of crown formation and to develop methods for the early selecion of individual trees or clones that will form mature trees with good stem and crown forms. The following experiment describes our first investigation of variation in branch production by clonal *Quercus petraea*.

MATERIALS AND METHODS

In July 1989, cuttings were taken from coppice shoots regenerating from the stumps of 10-year-old trees felled in the winter of 1988. During the spring of 1990, rooted cuttings were potted into 10-cm pots of 3:1 peat:grit containing slow-release fertilizer and plants were grown in the nursery for 1 season. In February 1991,

plants from 5 clones were repotted into 12.5-cm pots and any lateral branches removed before transfer to a growth chamber with 16/8 h, 20/15 °C days/nights with a light level of 145 μmol $m^{-2} \cdot s^{-1}$ photosynthetically active radiation at the canopy. Pots were given 100 cm^3 of water every other day and fertilized fortnightly. Any leaves that developed mildew were removed. There were few aphids.

Plants were assigned to one of the following treatments and arranged in a single completely randomized block with 4–10 plants of each clone/treatment: 1) terminal bud removed from leader before start of growth and at start of 2nd flush; 2) control: terminal bud present on leader.

Lateral branches formed during the first flush of growth were removed at the end of the first flush of growth. When the terminal bud was removed, the new leader was defined as the longest lateral near the tip of the shoot. During the 2nd flush, all buds that started to expand on old wood formed in the previous year were rubbed off.

The following parameters were assessed: 1) lengths of the 1st and 2nd flushes of growth produced in the nursery in 1990; 2) lengths of 1st and 2nd flush produced in the growth chamber in 1991; 3) number of branches produced on each flush of growth.

Data for each flush were analyzed separately. As the number of branches is known to depend upon shoot length (Harmer, 1992), the significance of differences between clones and treatments was tested using shoot length as a covariate.

RESULTS

There were small differences in the rate of bud development between clones. For

Table I. Mean length (mm) ± standard error of leading shoots produced during the 1st an 2nd flushes of growth by different clones with or without the terminal bud.

Clone	*N* [a]	*1990 growth* [b]		*1991 growth* [b]	
		1st flush	*2nd flush*	*1st flush*	*2nd flush*
2	5	25 ± 8	50 ± 12	39 ± 21	118 ± 38
	(5)	(45 ± 25)[a]	(27 ± 9)	(39 ± 21)	(130 ± 9)
4	4	18 ± 6	40 ± 14	41 ± 13	227 ± 52
	(5)	(20 ± 7)	(38 ± 7)	(24 ± 5)	(194 ± 22)
5	4	44 ± 14	40 ± 20	27 ± 6	158 ± 19
	(5)	(24 ± 11)	(44 ± 16)	(31 ± 8)	(123 ± 27)
7	10	24 ± 4	47 ± 8	14 ± 2	72 ± 12
	(10)	(17 ± 2)	(53 ± 6)	(17 ± 6)	(48 ± 13)
10	10	25 ± 4	50 ± 9	16 ± 3	81 ± 15
	(10)	(21 ± 4)	(30 ± 8)	(14 ± 3)	(75 ± 12)
Treatment effects					
Clone		NS [d]	NS	**	***
± terminal		NS	NS	NS	NS
clone x treatment		NS	NS	NS	NS

[a] N = number of replicates. [b] 1990 growth occurred prior to removal of the terminal bud of treated plants; 1991 growth occurred in the growth chamber. [c] Figures between parentheses are for plants on which the terminal bud on the leading shoot was removed. [d] Significance of treatment effects within each flush: NS : not significant; * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$.

overwintered buds, separation of the scales forming visible green areas took about 10 days, the flush being completed after a further 15 days growth. The 2nd flush started another 2–3 weeks later and finished after 2 weeks of growth.

The mean lengths of each flush are shown in table I; the large standard errors indicate that variation within clones was large. There was no significant difference between clones in the lengths of leaders produced during the 1st and 2nd flushes in 1990, with mean lengths of 26 and 42 mm, respectively. In contrast, in 1991, there were significant differences between clones in the lengths of both 1st flush leaders produced from overwintered terminal buds, and 2nd flush shoots that developed from current year buds. In 1991, average lengths of the 1st flush varied between 14 and 41 mm and the 2nd flush between 72 and 227 mm (table I). Removal of the terminal bud had no effect on the length of the new leader formed during either flush.

The mean number of branches produced on each flush of growth is shown in table II. Although there was large variation within clones, the number of branches produced varied between clones, treatments and flushes. Removal of the terminal bud usually increased the number of branches produced but this was not significant for the 1st flush in 1990. Fewest branches were produced on the 1990 1st flush (0–2.0, table II) and most on the 2nd flush formed in 1990 (1.2–3.6). There were significant clo-

Table II. Mean number of branches (± standard error) produced by different clones on the leading shoot formed by different flushes of growth with or without the terminal bud.

Clone	*N*	*1990 growth*		*1991 growth*
		1st flush	*2nd flush*	*1st flush*
2	5	0.8 ± 0.4	1.2 ± 0.6	0.4 ± 0.4
	(5)	(1.2 ± 0.6)	(3.2 ± 0.4)	(2.6 ± 0.7)
4	4	0.3 ± 0.3	3.4 ± 0.3	0.6 ± 0.4
	(5)	(1.8 ± 0.8)	(3.6 ± 1.6)	(2.0 ± 0.5)
5	4	2.0 ± 0.4	2.3 ± 0.9	2.8 ± 0.5
	(5)	(1.6 ± 0.9)	(3.4 ± 0.7)	(2.6 ± 0.9)
7	10	1.5 ± 0.5	1.6 ± 0.7	0.6 ± 0.3
	(10)	(1.3 ± 0.5)	(3.0 ± 0.3)	(1.6 ± 0.3)
10	10	0	2.8 ± 0.7	1.0 ± 0.4
	(10)	(0)	(3.3 ± 0.2)	(1.6 ± 0.4)
Treatment effects				
clone		***	NS	*
± terminal		NS	**	***
clone x treatment		NS	NS	NS

For other details see legend to table I. Shoot length was used as a covariate.

nal differences in the number of branches formed on 2 of the growth flushes (table II). For both treatments, over all flushes, the mean total number of branches produced was greatest on clone 5 and least on clone 10, being 7.4 and 4.4, respectively (table II).

CONCLUSION

These preliminary observations show that branch production in oak varied between clones but the number formed was dependent upon shoot length, treatment and age of flush. The rank order of clones, according to branch number, varied between flushes suggesting that the pattern of growth differs between clones and that procedures used to identify differences in branching pattern must be clearly defined.

REFERENCES

Harmer R (1992) Relationships between shoot length, bud number and branch production in *Quercus petraea* (Matt) Liebl. *Forestry* 65, 61-72