THE EFFECTS OF STUMP HEIGHT AND NUMBER OF SHOOTS PER STUMP ON THE STUMP COPPICING POWER, AND GROWTH AND YIELD OF EUCALYPTUS CAMALDULENSIS GROWN AS IRRIGATED PLANTATIONS IN NORTHERN IRAQ

Prof. Dr. Yavuz SHAFİQ[1]
Doç. M. A. MALİK[2]

Abstract

A 5×2 factorial experiment in three randomized complete block was laid out in an Eucalyptus camaldulensis Dehn. seedling stand in Feb. 1973; the stand was 9 years old and grown under irrigated conditions in the Nineval forest plantation. The study aimed at determining the effects of number of shoots/stump (with 5 levels comprising of 1, 2, 3, 4 and more shoots left per stump, one year after clear - cutting the seedling stand) and stump height (with 2 levels: low=15 cm and high=30 cm from the ground level) on the coppicing power of stools, and growth and yield of coppice stand. Coppicing power of stools was measured by the number of ots/stump (having 1 cm diameter or more at 15 cm height from the point of shooting from stumps) counted one year after clear - cutting the parent stand. Measurements on other stand characteristics were recorded in Feb. 1978 when experimental stand was 5 years old.

The analysis of covariance and the Duncan's new multiple range test were used to test the effects of above factors and their interaction statistically on a number of responses including coppicing power of stumps, and dominant diameter, top height, mean height, basal area, volume, and stem quality of the coppice stand. The results showed that number of shoots per stump had a highly significant effect on all stand characteristics studied except volume, while that of stump height non - significant except in the case of mean height. Interaction of shoot number/stump with stump height was found to be consistently non - significant.

For managing the coppice stands, two shoots/stump is recommended as the optimal silvicultural treatment from the stand point of several compromising considerations including volume, size and quality of wood produced and its handling costs. A thinning is also suggested which may be carried out when the stand is 6 years old.

[1,2] Department of Forestry, College of Agriculture and Forestry, Mosul University, Hammam Al - Alil MOSUL IRAQ.

1. INTRODUCTION

Eucalyptus camaldulensis Dehn. is the most widely planted species in the irrigated plantations of northern Iraq. Its popularity as a plantation tree stems from the fact that after having undergone extensive field tests over the past 25 years or so, it has emerged to be a well adapted species both to the soll and climatic variations encountered in the region besides being reasonably fast growing. Consequently, it covers nearly 85 % or more of the planted area of the irrigated plantations in torthern Iraq.

Much of the research work done so far on this species is restricted to nursery practices, while scientific information is almost lacking on various aspects relating to its silviculture and management. In other countries, a lot of published literature, centring around this theme, can be found on several important species of Eucalypts (SAATÇİOĞLU, 1979; F.A.O., 1976; SHERRY, 1972; GRUT, 1972; JACOBS, 1955), while works of CHAKROUN (1975), RIEDACKER (1973) and SAATÇIOĞLU - PAMAY (1958) on E. Camaldulensis in particular, quite closely resemble our study.

One very important question that a forest manager is commonly confronted with in management is how many shoots be retained per stump in coppice rotation so that the forester is able to get final harvest of the desired size, of maximum quantity and of optimal quality. Should a thinning be done or not when **Eucalyptus** coppice is worked on a short rotation of 10 years or so? If the answer is in the affirmative, then at what age of the coppice stand, should thinning be executed? The above are but a few examples of problems to which appropriate answers are sought by the forest manager for proper, scientific management of coppice stands of **Eucalyptus camaldulensis.** This study was, therefore, undertaken as one of the endeavours in the series to investigate the effects of the number of shoots left per stump and stump height on the coppicing power of stumps, and on growth and yield of **E. camaldulensis** coppice stands.

Though the results of several growth components of the experimental coppice stand are presented and discussed in this paper, yet the major purpose of their reporting here is information compilation of interim nature, evaluation of the effects of different treatments while the crop is still in a juvenile stage of development and comparing the performance of our coppice stand under different treatments with that of irrigated coppice and/or seedling stands of the same species in the neighbouring countries.

The experiment is planned to be maintained for another 5 - 6 years; at the end of this period, the effects of different treatments especially on growth and yield of the coppice stand for a complete coppice rotation would be evaluated again. The results available then would enable presentation of concrete recommendations with regard to the length of rotation besides providing confirmation of the hypotheses formulated now about the number of shoots which may be retained per stump.

2. METARIALS AND METHODS

A uniformly stocked (average density=0.8), 9 years old **E. camaldulensis** stand of seedling origin covering an area of one hectare (100×100 m) was chosen for the purpose of this study. This stand was initially established at a spacing of 3×3 m and had not been thinned in the past. Before cutting all trees were measured for DBH and for crown classification into dominant, codominant, intermediate and suppressed with last two categories forming 19 and 17 % respectively of the total number of living trees (624) of the parent stand.

The stand was divided into three blocks with ten experimental plots in each. The experiment was designed according to a two-factor factorial in three randomized complete blocks, with the two factors being number of coppice shoots per stump (5 levels: 1, 2, 3, 4 and more shoots i.e. control) and stump height (2 levels: low=15 cm and high=30 cm from the groung level). Thus, there were 10 treatment combinations each of which was allocated randomly to an experimental plot in a block.

The trees in respective plots were cut by power saw keeping high (30 cm) or low (15 cm) stumps in accordance with the above experimental plan. After cutting, the stumps were dressed so as to have a sloping surface of each to avoid the risk of fungal infection. The felled trees were cut in logs which were removed from the area to a forest depot. The lops and tops of these felled trees were collected by villagers for domestic use. All the above operations were completed by the first week of February 1973.

The reopening of ditches was done manually in March - April 1973 to bring them to the standard size of (70+50)/2 cm in width and 20 - 30 cm in depth. The irrigation of the experimental area began in May, 1973; before and after this period, no irrigation was normally required. The time taken to irrigate the entire experimental area averaged 8.5 hr. The coppice stand was irrigated every year according to the above pattern for the last 5 years period of study under report.

In Feb. 1974, one year after the time of cutting the seedling stand, the number of shoots measuring 1 cm and over in diameter at 15 cm height from the point of shooting was recorded as a measure of coppicing power of stumps. Simultaneously, the number of shoots per stool was reduced to one (1S), two (2S), three (3S), four (4S) or more (C) in respective plots according to the experimental design described earlier, while those of control (C) left all intact. Only shoots of better form and development were retained in this operation.

In Feb. 1978, when the coppice stand was 5 years of age, measurements were taken on total height and diameter at breast height (DBH) of each coppice shoot by individual stumps by Sunnto clinometer and light metal calliper respectively. DBH was recorded in whole centimeters, while height was calculated correctly up to one decimal place of a meter. The stem quality of each shoot was subjectively determined by identifying three classes; vigorously growing straight - stemmed shoots were given a score of 1 each and those of poor form and crown development were scored 3, while the average quality shoots received a score of 2.

From DBH measurements of the parent seedling stand, mean stand diameter (calculated as the diameter of a tree of mean basal area) and basal area (m^2) per plot before cutting were calculated. Similarly, various parameters of the coppice stand comprising mean height[1], dominant diameter at breast height, basal area, stand volume, stem quality, etc. were calculated for each plot.

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[1] derived as the aritmetic mean height of the tellest shoot per stump within each plot.

Statistical analysis : Analysis of covariance as described by STEEL and TORRİE (1962) was used as a procedure to test overall differences among number of shoots per stump and between stump heights. For detecting specific differences between treatments, use was made of the Duncan's new multiple range test (STEEL & TORRİE, 1962).

In the case of top dominant height and dominant diameter of coppice stand, and coppicing power of stumps, the concomitant variate used was average stand diameter of parent stand, while in the analyses of coppice basal area and volume per hectare, the covariate was basal area of seedling stand in the respective plots before cutting. Basal area of the surviving coppice shoots was employed as a concomitant variable for stem quality analysis, while in case of survival percentage of shoots only analysis of variance was performed, followed by the Duncan's new multiple range test.

3. RESULTS AND DISCUSSIONS

The independent analysis of variance of concomitant variates (seedling stand diameter and basal area) showed that seedling stand diameter significantly differed in plots under various treatment, while the differences in the basal area of parent stand failed to reach significance level among plots of different treatments. Inspite of the latter covariate being non - significant, yet it was utilized to eliminate as much of the variation as possible in the criterion variables that was attributable to the predictor or concomitant variable as advised by Li (1964).

The effects of the treatments on different stand characteristics studied are briefly presented below :

3.1. Survival percentage of after sutting

The stump record showed that except for a few casualties, practically all the stumps of the living trees sprouted satisfactorily. Furthermore, the stump height had no effect on the survival of stumps because they originated from a healthy, young parent stand aged 9 years only (and having average diameter of 16.49 cm) with vigorous growth and hence the mortality was negligible. This finding is very much similar to the observations of F.A.O. (1976) and SAATÇİOĞLU - PAMAY (1958) about Eucalyptus in general that the mortality rate is high only among the very large stumps, 20 - 38 cm in diameter. In our experimental stand, more than 80 % of the stumps were less than 20 cm in diameter and those above this size were quite healthy and as such sprouted well.

3.2. Coppicing power of stumps

Coppicing power of stumps was measured by shoot count per stump, one year after clear - cutting the parent stand.

The results of analysis of variance of the criterion variable alone indicated that neither the number of shoots retained per stump (NS) nor stump height (STH) had a significant effect on the coppicing power of stumps. Similarly, the interaction (NS×STH) was non - existent. The above results were further confirmed by the analysis of covariance (Table 1) with the average stand diameter used as a covariate. The overall correlation between the criterion variable and the predictor variable i.e. average stand diameter was statistically non - significant.

The range of shoot count per stump, averaged over the two levels of stump height, was 10.0 to 11.5 for the factor NS and that for the factor STH, averaged over all the levels of factor NS, was 10.6 to 11.0. The overall average shoot count per stump was 10.8 or say 11.

3.3. Survival percentage of coppice shoots

In the calculation of this response, the numerator was the surviving shoot count per stool at the time of final measurement in Feb. 1978, while the denominator formed the number of shoots retained per stool, one year after cutting the seeding sand. The above procedure was employed for calculating survival percentage of stumps for all plots except those of control in which case the denominator constituted shoot count (of 1 cm and over in diameter at 15 cm height from the point of shooting from stump) per stool, one year after cutting the parent seedling stand.

The results of analysis of variance (Table 1), using arc sin $\sqrt{\text{percentage}}$ transformation of the original percentages, showed highly significant differences among shoot treatments. In the case of IS, there was no mortality at all among the shoots. However, the survival percentage decreased with increasing number of shoots per stump (Table 2). The rate of mortality among shoots was gradual up to three shoots but thereafter became strikingly high so much so that only 34.8 % of the initial number of shoots per stump survived in the control treatment. The Duncan's new multiple range test (Table 2) further indicated that survival percentage of shoots retained per stump differed significantly from one shoot treatment to the other with the survivors per stump number, on average, 1.00, 1.93, 2.61, 2.96 and 3.59 in respect of treatments 1S, 2S, 3S, 4S and control, respectively.

From these results it can safely be inferred that it is not worthwhile retaining more than two shoots per stump because high incidence of mortality in four shoots or more per stump will automatically reduce the shoot count markedly in the following four or five years from the time of coppicing. Apart from this, adverse residual effects caused by the intra - competition of conjested shoots per stump are expected to persist in the surviving shoots which will be weak and of inferior or poor quality, yielding low valued products.

Stump height (STH) as well as interaction (NS×STH) had no effect on the survival percentage (Table 1). The surviving shoots per stump in plots subjected to low stump height treatment averaged 2.44 in number, with their number averaging 2.39 in high stump height plots. The less stable shoots produced by heigh stump height were unable to sustain for long and consequently the average number of surviving shoots per stool is slightly less than that of low stump height (20 cm from the ground level).

3.4. Dominant diameter of coppice stand

The covariance analysis (Table 1) of this stand characteristics, in which average stand diameter of parent stand was used as the concomitant variate, showed that factor NS had a highly significant (P 0.01) effect on the dominant diameter of coppice stand, while factor STH failed to produce any significant influence on the criterion variable. The interaction (NS×STH) was also non - significant.

The Duncan's new multiple range test (Table 2) further exhibited that 1S produced a significantly larger dominant diameter as compared with its counterpart

TABLE 1 : ADJUSTED MEAN SQUARES OF MEASURED STAND CHRACTERISTICS CORRESPONDING TO DIFFERENT EFFECTS.

S.O.V.	df.	Shoot count per stump, one year after coppicing	Dominant diameter	Top/dominant height	Mean height	Basal area	Stand volume	Stem quality
Shoots per stump		NS	**	*	**	**	NS	**
(NS)	4	0.359504	2.107010	2.471891	23.004514	0.048572	0.139330	0.471053
Stump Height		NS	NS	NS	*	NS	NS	NS
(STH)	1	2.199587	0.388560	1.795329	3.099910	0.004495	0.319849	0.021812
Interaction		NS	NS	NS	NS	NS	NS	NS
(NS×STH)	4	3.082188	0.647403	0.140268	0.315237	0.0008778	0.031460	0.021732
Error	17	2.2317737	0.328220	0.584962	0.545085	0.001412	0.076550	0.012824

N.S. = EFFECTS NOT SIGNIFICANT AT THE 5 % LEVEL.

* = EFFECTS SIGNIFICANT AT THE 5 % LEVEL OF SIGNIFICANCE ($P < 0.05$).

** = EFFECTS HIGHLY SIGNIFICANT AT THE 1 % LEVEL OF SIGNIFICANCE ($P < 0.01$).

treatments 2S, 3S, 4S and control; however, the effect of the latter four shoot treatments on the dominant diameter was of the same order of magnitude.

The dominant diameter generally increased with decreasing number of shoots per stump. Treatment 4S resulted in the production of smallest dominant diameter (11.99 cm[1]), while that of the stands receiving treatments, C, 3S, 2S & 1S, was 12.14, 12.47, 12.77 and 13.53 cm, respectively. For the low and high stump height treatments, the dominant diameter averaged over factor NS, was 12.54 and 12.63 cm respectively, with the difference between these being statistically non - significant.

Furthermore, a significantly ($P < 0.05$) positive correlation (correlation coefficient 'r' = 0.5531) was found to exist between the seedling stand diameter and dominan diameter of the coppice stand. Almost similar results were obtained by VENTER (1972) while studying the effect of stump diameter on coppice vigour (as meas-

TABLE 2 : EFFECTS OF NUMBER OF SHOOTS/STUMP ON DIFFERENT COPPICE STAND CHARACTERISTICS (ADJUSTED MEANS).

Stand	Number of shoots per stump				
characteristics	1S	2S	3S	4S	Control
Shoot count per stump, one year after coppicing	11.33 a*	10.17 a	11.50 a	10.00 a	10.83 a
Dominant diameter at breast height (cm)	13.53 a	12.77 b	12.47 b	11.99 b	12.14 b
Top height (m)	12.46 a	11.69 ab	11.47 ab	11.19 b	10.72 b
Mean height (m)	12.36 a	10.49 b	9.24 c	8.66 c	7.09 d
Basal area** per hactare (m^2)	7.8210 b	10.8720 a	12.3000 a	12.1170 a	12.2580 a
Stand volume** per hectare (m^3)	50.0400 a	57.2190 a	62.4600 a	59.2260 a	56.3580 a
Stem quality	1.24 a	1.52 b	1.75 c	1.92 d	2.07 d
Surviving shoots/stump (%)	100.0 a	96.3 b	87.1 c	73.9 d	34.9 e
(No.)	(1.00)	(1.93)	(2.61)	(2.96)	(3.59)

* = Treatment means followed by the same lower case letters in each row are not significantly different from one another at the 5 % level of significance (P 0.05) according to the Duncan's new multiple range test.

** = Figures are blown up by multiplying plot averages by 30.

[1] It is the adjusted average dominant diameter calculated by the formula: adj $\overline{Y}_{i..} = \overline{Y}_{i..} - b(X_{i..} - \overline{X}_{...})$

ured by DBH of coppice) in **Eucalyptus grandis**; he found that there was a strong correlation between stump diameter and DBH of coppice.

3.5. Top/dominant height of coppice stand

The results of covariance analysis (Table 1) indicated that factor NS had a significant ($P<0.05$) effect on the top height of coppice stand. The top height increased with decreasing number of shoots per stump but the linear regression of top height on number of shoots per stump was not statistically significant. As may be seen in Table 2, top height produced by 1S was significantly more than that by 4S or control. However, the performance of 1S, 2S and 3S treatments was of the same magnitude. Top height averaged 12.46, 11.69, 11.47, 11.19 and 10.72 m for the 1S, 2S, 3S, 4S and control treatments respectively.

On the other hand, the effect of stump height (STH) and that of interaction (NS×STH) was statistically non - significant. Low and high stump heights resulted in an overall average top height of 11.29 and 11.72 m, respectively.

3.6. Mean height of coppice stand

The results of analysis (Table 1) showed that factor NS highly significantly ($P<0.01$) affected this stand characteristics. The mean coppice height decreased consistently with increasing number of shoots per stump with a trend of relationship resembling an inverse - J shaped curve.

By reference to Table 2 it may be seen that 1S produced the tallest coppice stand with a mean height of 12.36 m, which was significantly more than that of its counterpart treatments, 2S, 3S, 4S and control. Next in the ranking order was 2S which resulted in a mean stand height of 10.49 m and was also significantly more than either treatment 3S, 4S or control with average values of 9.24, 8.66 and 7.09 m, respectively. However, treatments 3S and 4S performed similarly, while control was significantly inferior to all the rest of the treatments on this score.

The correlation of seedling stand diameter and mean height of coppice stand with an 'r' value of 0.4154, failed to reach the significance level ($P<0.05$) by a narrow margin.

Stump height also affected the mean height significantly ($P<0.05$) unlike its behaviour in all the remaining characteristics studied wherein it displayed uniformly non - significant effects. The adjusted mean height of coppice stand in respect of the low and high stump height treatments were 9.26 and 9.87 m, respectively.

The interaction (NS×STH) was non - significant.

It would be interesting to observe that only treatments 1S and 2S are the ones which meet the world standard of 2 m mean annual increment (M.A.I.) in height on good sites (F.A.O., 1976). Infact 1S has put on mean annual height increment of 2.47 (Table 2) which is markedly (23.5 %) more than the above figure fixed for the species, while M.A.I. of 2S i.e. 2.10 m almost equals the world standard. It was also noted visually that the mean height of coppice stand was more than that of the seedling stand of the same age.

3.7. Stem quality of coppice stand

After eliminating the effect of stand density as measured by the existing basal area of coppice stand, the results of analysis (Table 1) showed that factor NS had a highly significant ($P<0.01$) effect on stem quality which diminished progressively with increasing number of shoots per stump. The Duncan's multiple range test (Table 2) further indicated that treatment 1S produced significantly ($P<0.05$) superior quality stems as compared to its set of counterparts 2S, 3S, 4S and control. Next in the order was treatment 2S having significantly better quality stems than those in either treatment 3S, 4S or control. Similarly, 3S performed better than either 4S or control. There was, however, no significant difference between treatments 4S and control.

Contrary to the above, the effects of stump height (STH) and interaction (NS×STH) on stem quality were non - significant.

From the above exposition it is quite clear that for producing high quality timber one shoot per stump would be the most promising among all the shoot treatments. However, the adoption of this alternative in the management of coppice stands is feasible provided there is a demand for high quality timber in the country and can fetch higher price to offset the disadvantage of smaller yield obtainable from 1S (Table 2) as compared with either 2S, 3S, 4S or control. As there is no market for quality timber in Iraq at the present time, the applicability of this alternative is therefore doubtful for sometime to come. On the other hand, treatment 2S has bright prospects of its application to the management of irrigated coppice stands **E. camaldulensis** when adjudged from the combined criteria of quality and yield (Table 2).

3.8. Basal area per hectare

In determining the effects of different treatments on this stand characteristics, basal area of parent stand was used as a covariate in the analysis of covariance. It is interesting to observe that the seedling stand basal area (covariate) had a highly significant ($P<0.01$) correlation ('r' $=0.6169$) with the basal area of coppice stand and as such it was necessary to remove the variation in the coppice basal area that was due to the covariate so as to determine pure effects of the treatments studied.

By using the Duncan's new multiple range test (Table 2) it was further found that treatment 1S produced an adjusted basal area of 7.821 m^2/ha, which was significantly lesser than that of either treatment 2S, 3S, 4S or control with basal area respectively of 10.872, 12.300, 12.117 and 12.258 m^2/ha. However, treatments 2S, 3S, 4S and control did not differ significantly from one another but treatment 3S yielded the maximum basal area of 12.300 m^2/ha among all of them.

Factor STH failed to exhibit significant effect on this stand characteristics. Likewise, interaction (NS×STH) was non - significant.

3.9. Volume per hectare

The 'F' test in the covariance analysis (Table 1) failed to show any overall difference in this stand parameter as a consequence of the influence of either factor NS or STH. Similarly, the interaction (NS×STH) effect was also non - significant.

However, volume ha (Table 2) increased quite sharply from 50.040 m³ with 1S to 57.219 m³ with 2S, reaching a culmination of 62.46 m³ with 3S, whereafter it fell off consistently as the number of shoots per stump increased to four or more. In the case of latter two treatments i.e. 4S and control, volume was 59.226 and 56.358 m³/ha, respectively.

Low stump height resulted in an average volume of 51.897 m³/ha, while the high stump height produced 59.224 m³/ha.

Based on the actual data of 52 sample stands (more than 90 % of which were one hectare each in area) of seedling origin and comprising a sampling intensity of about 25 %, MAJİD (1979) developed a simple yield model, log V=2.52341 - 4.746463 (1/A), where V is yield in m³/ha and A is age of seedling stand in years. According to this model which has a rather low 'r' value of 39 %, the yield of 5 years old seedling stand on an average site is estimated to be 37.51 m³/ha, while that of our experimental coppice stand of the same age under treatments 2S and 3S is 57.219 and 62.470 m³, which is 19.709 m³ (52.54 %) and 24.95 m³ (66.52 %) more than that of seedling stand. Averaged over all shoot treatments, the coppice yield of 56.061 m³ is 52.12 % in excess of the above estimated seedling stand yield.

The mean annual volume increment of 5 years old coppice stand under treatments 2S and 3S is 11.44 and 12.49 m³/ha/an, respectively; this is almost equal to M.A.I. of 11.23 - 11.73 m³/ha/an estimated by MAJİD (1979) for the 11 years old **Eucalyptus camaldulensis** stands of seedling origin. It can therefore be logically concluded that the coppice stands have a faster growth rate as compared to seedling stands and that the yield of the former is anticipated to be higher (by 25 to 50 %) than that of seedling stands of corresponding ages; the later statement is however subject to further confirmation.

3.10. Between - stem spacings

In the shoot count made in Feb. 1974 after reducing the number of shoots stump according to the desing of the experiment, the total number of shoots were found to be 545, 1078, 1753, 2318 and 5265 per hectare in treatments 1S, 2S, 3S, 4S and control, respectively. The survivors count in Feb. 1978 showed their corresponding number to be 545, 1040, 1525, 1715 and 1890 per hectare. Assuming square spacing between the shoots, a comparison of the space actually occupied by a shoot at each point in time is as given below :

TABLE 3 : Square spacing between shoots in 1974 and 1978

Shoot treatment	Spacing in 1974	Spacing in 1978
1S	4.28×4.28 m	4.28×4.28 m
2S	3.05×3.05 m	3.10×3.10 m
3S	2.39×2.39 m	2.56×2.56 m
4S	2.08×2.08 m	2.41×2.41 m
Control	1.38×1.38 m	2.30×2.30 m

From Table 3 it may be seen that the between - shoot espacement in 1974 for 1S treatments is more than 3×3 m, while that of 2S very close to 3×3 m, the spacing currently used in raising irrigated plantations from seedling stock. In 1978, the spacings for 1S and 2S have practically stayed the same as for 1974, while those of treatments 3S, 4S and control registered marked changes in 1978 as compared with the 1974 spacings. This of course was due to the mortaiity which occured among shoots on account of intra - conjestion in three or more shoots kept per stump.

In South Africa where **E. saligna/grandis** comprises the principal species in the plantations, the most popular planting espacement is 2.7×2.7 m (1330 trees per hectare), although on first quality sites it is reduced to 2.4×2.4 m (about 1700 trees per hectare); stands regenerated from coppice are cleaned to 1 to 2 shoots per stump at an early age of 5 years (GRUT, 1972). For the production of pulpwood, pitprops or other small - dimensioned wood, two shoots per stump are preferred, but where there is only one dominant shoot this alone is left, all supressed shoots being removed.

From a comparison of growth rates of **E. saligna/grandis** stands in South Africa with those of **E. camaldulensis** in Iraq, it seems that not only the former species is inherently faster growing than the latter but also the site quality where **E. saligna/grandis** is grown, is superior on the whole to the ones of our **E. camaldulensis** plantations. Good sites provide congenial climatic and edaphic environmenta for rapid growth and accordingly a closer spacing of 2.4×2.4 m in the case of **E. saligna/grandis** is justified. In contrast to the above, the site quality of our plantations can be regarded as the average sites of West Africa warranting the use of a wider spacing which may range from 2.7×2.7 to 3.0×3.0 m for **E. camaldulensis**. More than the above espacement may not be desirable because the species has a smaller crown diameter and shorter total height as compared with **E. saligna/grandis** trees of the same age, requiring smaller growing space per tree for optimum development.

From the above discussion it can be concluded that about 1100 - 1350 shoots per hectare is an appropriate number to ensure the desired espacement between shoots in coppice stands of **E. camaldulensis.**

MAJİD (1979) found that the average number of surviving trees in the 10 and 11 years old **E. camaldulensis** plantations of northern Iraq, was 535 for a sample size of 25 stands, while in our experimental stand coppiced at the age of 9 years, there were on average 624 surviving stumps per hectare. The target of having 1100 - 1350 shoots/ha can, therefore, be achieved by retaining two dominant shoots per stump, and three shoots per stump only when the stumps are fringing blanks to obviate the necessity of refilling by seedling stock, the success of which as a future crop may be doubtful.

4. RECOMMENDATIONS

The wood of **E. camaldulensis** is in great demand for use as a raw material in the manufacture of chipboards (in the Chipboard Factory, Mosul with an annual intake capacity of 9000 tons of wood) and charcoal. Wood being short supply in Iraq, the overriding object of managing the irrigated plantations is tentatively defined to be maximum volume production on sustained yield basis and as a consequence these plantations have been proposed to be worked on a short rotation of 11 years (MAJİD, 1979). From the standpoint of almost all the characteristics discussed above, the retention of two shoots per stump in cleanings carried out one year after clear-cutting the seedling stand is recommended. Two shoots per stump provide the right answer to meet the stated management goal as it will yield at a rotation of 10 - 11 years, maximum quantity of wood matching with the Chipboard Factory's specifications (4 cm to 30 cm in diameter) apart from being of optimal size for pulpwood manufacture, if such a demand develops in the country in the future. It is interesting to observe here that **E. camaldulensis** constitutes the main pulpwood species in Morocco (F.A.O., 1976). Three or more shoots per stump may yield slightly higher total volume per unit area but the mean diameter of both the thinned material and final yield will be reduced, resulting in increased handling costs per unit of volume.

At this time when the experimental stand is aged 6 years, there is a clear indication of competition for light, moisture and nutrients having begun among shoots in plots subjected to treatments 2S, 3S, 4S and control. Thus it is quite logical and realistic to propose a thinning at the age of 6 years. In thinnings about 25 % of the total basal area will be removable in stems of inferior form and vigour.

The experiment should be maintained till the mean annual volume increment starts declining after reaching culmination. It would then be possible to fix a suitable rotation length corresponding to maximum volume production; apart from this, exact figures of yield obtainable under different treatments would be available for proper evaluation and reporting.

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KUZEY IRAK'TA SULANAN PLANTASYONLARDA YETİŞTİRİLEN EUCALYPTUS CAMALDULENSİS MEŞCERELERİNDE KÜTÜK YÜKSEKLİĞİNİN VE KÜTÜKTEKİ SÜRGÜN SAYILARININ KÜTÜK SÜRGÜN VERME GÜCÜ ÜZERİNDEKİ ETKİLERİ İLE MEŞCERELERİN ARTIM VE BÜYÜMELERİ

ÖZET

1973 Şubatında Ninevah Orman plantasyonunda üç tam tesadüfi bloklarla 5×2 faktöriel düzenli bir deneme **Eucalyptus camaldulensis** Dehn meşceresinin araştırma alanında uygulanmıştır. Araştırma alanı dokuz yaşında olup sulama koşulları altında büyümektedir.

Araştırmanın amacı, sürgün kütük sayısının (meşcerenin traşlama kesiminden bir yıl sonra her kütükte bırakılan 1, 2, 3, 4 ve daha fazla sürgünle beş mukayese düzeyli) ve kütük yüksekliğinin (iki düzeyli, topraktan 15 cm yükseklikte=alçak ve topraktan 30 cm yükseklikte=yüksek) kütüğün sürgün verme gücüne ve baltalık meşcerenin büyüme ve artımına etkilerinin saptanmasıdır.

Kütüğün sürgün verme gücünün saptanması için kriter olarak ana meşcerede traşlama kesiminden bir yıl sonra her kütükte, kütükten çıkış noktasından 15 cm yükseklikte, 1 cm veya daha fazla çapa sahip olan sürgünler esas alınmış ve bunların sayıları tesbit edilmiştir. Araştırma objesinin diğer karakteristiklerine (çap, boy, kesit yüzeyi) ait ölçmeleri ise deneme alanı beş yaşına ulaştıktan sonra Şubat 1978 ayı içinde yapılmıştır. Yukarıdaki faktörlerin ve onların baltalık meşceresinin sürgün verme gücünü, Dominant çapı, üst boyu, orta boyu, kesit yüzeyi, hacim ve gövde kalitesini içeren birçok yönlerdeki etkileşimlerini ortaya çıkarmak için, çağdaş matematik istatistik yöntemlerine uygun olarak Kovarians analizi ve Dunkan'ın yeni çoğul değişim analizi kullanılmıştır. Bunlardan elde edilen değerler, kütüklerdeki sürgünlerin hacimleri dışında tüm meşcere karakteristikleri üzerinde yüksek önemlilik etkisine sahip olduğunu, buna karşılık kütük yüksekliğinin ortalama boy durumu dışında önemsiz etkiye sahip bulunduğunu göstermiştir. Sürgün/kütük ile kütük yüksekliği etkileşiminin devamlı olarak önemli olmadığı bulunmuştur.

Odun üretiminin hacim, ebadı, kalitesi ve yapılan masraflar bakımından elde edilen sonuçlar uzlaşmalı bir değerlendirmeye tabi tutulacak olursa, şu sarih hükümlere varılır ki, Ökaliptüs baltalık meşcerelerinin idaresinde optimal Silvikültürel işlem olarak her kütükde iki sürgün bırakılması ve meşcere altı yaşına geldiği zamanda münasip bir aralama uygulanması önerilmektedir.