OPTIMUM STAND DENSITY FOR SHISHAM (*DALBERGIA SISSOO* LINN. f.) —INTERIM REPORT

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Introduction. Stand growth is the outcome of a complex interaction of age, site and stand densitv (17). Other factors kept constant the last one being a function of number of trees, their size and their spatial distribution affects the growth rate of the stand (5). Stand density can be expressed in terms of tree material measurable through volume , basal area, number of trees, or crown closure (11). Of all these the basal area has been considered the best measure of stand density on account of its easy computation and application (8,25).

Stand density requires to be regulated at various stages of the stand development by thinnings i. e., reducing the basal area for achieving specific management objectives (3) which may be:-

(*a*) production of certain type of material
(*b*) development of residual crop
(*c*) improvement of quality of the residual crop.

Although the subject of thinnings has remained a controversial issue yet its efficacy for the stand development particularly during the period of rapid height growth has been acknowledged by a large number of research workers like Wiedmann, Buckman etc. (8). Each species has its own trend of development and rate of growth and as such requires a specific thinnning treatment for inducing maximum growth. A need thus arises for working out optimum stand density for a species at various stages of its development to have maximum growth.

Shisham (*Dalbergia sissoo*) is being grown as a principal species in the irrigated plantations of the Punjab for about a century or so. To start with, the object of raising these plantations was to get fuelwood for the newly started railways but with the use of coal for engines, it gradually developed into timber-cum-fuelwood management. At present shisham timber is considered to be almost an omni-purpose wood, being one of the best in the country so far as quality, grain texture, figure and durability is concerned(18).

Though the tree is being raised in the plantations for such a long time, thinning treatment given to it has always been based on "thumb rules" or subjective prescriptions (1,2,5,7,14). No systematic research seems to have been carried out on thinning

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regmies to fix optimum density levels for shisham crop at various stages of its rotation. The yield tables available for the speices (19) lack information on thinning grades and their effect on volume increment.

In veiw of the economic importance of the species and its scientific management it was felt necessary to undertake a comprehensive study for determining the effect of variable density on growth leading to formulation of guide lines on optimum values.

The Plan of Study. Keeping in view the above objective, experiments were planned from 1966 onwards in the irrigated plantations of Chichawatni, Shorkot, and Kundian.

Following three factors were proposed for investigation in the study :—

(*i*) Comparison of different thinning cycles at a constant thinning grade.

(*ii*) Comparison of different thinning grades at a constant thinning cycle.

(*iii*) Comparison of different thinning grades at different thinning cycles.

Following treatments i. e. thinning grades were proposed in the plan:

T_1—Heavy, in which 55% of the original basal area was to be retained.

T_2—Medium, in which 70% of the original basal area was to be retained.

T_3—Light, in which 85% of the original basal area was to be retained.

T_4—Control, no thinning was to be carried out.

No thinning cycle was prescribed in the plan. It was proposed to carry out thinning when the basal area would exceed the limit fixed for the next lower grade. The plan also provided for laying out each set of experiment in at least two site qualities with three replications in each age and site class.

However the provisions of the plan were not strictly adhered to. Only one factor *i. e.*, comparison of different thinning grades at different thinning cycles out of the three was picked up for study. Control was not directly applied as a treatment. Basal area of the plot at the time of selection was taken as control with, perhaps, this presumption that it will remain constant. Various age and site classes were not represented as indicated in TABLE-1.

Basic Date. The provisions of the plan with certain deviations as indicated above were executed and the measurements recorded as and when required under the plan.

The data collected upto 1972 were tabulated and annual basal area incremenet per acre computed for each plot and put to statistical tests. Details of analysis of variance and significance or otherwise of the effect of treatments are given in TABLE-2.

Results of analysis. (*a*) *Crop due for first thinning.* Analysis of combined data of various localities in TABLE-2 (*i*) reveals that the treatments are significant but when data were further subjected to 't-test' T_2 was found to be the best whereas T_1 and T_3 did not indicate any significant difference. This shows that removal of 30% of basal area seems to induce better increment.

Separate analysis for each locality in TABLE-2 (*ii*) and (*iii*) has shown that the treatment effects in Chichawatni plantation are significant and in that case too, T_2 is significantly superior to other treatments.

(*b*) *Crop due for second thinning.* Both combined and separate analysis for various localities failed to give any significant difference in the results of various treatments as per TABLE-2 (*iv*). However, T_2 in this case too, indicated its superiority over other treatments.

Discussion. Although this study indicates the superiority of treatment T_2 it suffered from the following inherent defects introduced during planning and execution which greatly limited the scope of investigation and side-tracked the main objective of the study. (12).

(*i*) Control, although provided in the study plan, was not kept throughout. It was presumed that the basal area of the unthinned crop at the time of selection of the plots will remain constant and this value was erroneously adopted as the control. The left-over crop basal area was considered as the control for the plots of next higher grade.

(*ii*) No definite thinning cycles were provided in the study. Instead, the plots were required to be thinned when they would exceed the basal area limits fixed for next lower grade.

(*iii*) The experiment was not properly replicated in each age and site quality as initially proposed in the study plan. This is clear from TABLE-1.

(*iv*) Three replications for the three treatments limit the degree of freedom for error to four with which the data would not yield satisfactory analysis as the least degree of freedom should have been at least ten for providing valid results.

Besides the inherent lacuna enumerated above, the present study got a serious set back on account of the disturbances during 1971 war when crop condition was upset in most of the study plots thus rendering them unfit for further study.

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TABLE 1

DETAILS OF STUDY PLOTS

(*a*) *Crop due for first thinning.*

Year of formation	Age years	No. of plots	Locality	Replication	Last measured
March, 1968	5	9	Shorkot Cpt. 184	3	January, 1972
December, 1967	6	9	Chichawatni Cpt. 187.	3	January, 1972
(*b*) *Crop due for second thinning.*					
February, 1966	11	9	Kundian Cpt. 180, 166.	3	January, 1972
March, 1969	12	12	Shorkot Cpt. 157	3	January, 1971

TABLE 2

ANALYSIS OF VARIANCE

Average annual increase in basal area (on acre basis)

FIRST THINNING

(i) Combined Stand Density Experiment.

Source	D.F.	S.S.	M.S.	'F' Value
Localities ..	1	214.52	214.52	564.63**
Blocks ..	4	3.35	8.84	2.21
Treatments ..	2	5.51	2.76	7.26*
Interaction: localities × treatments.	2	0.08	0.04	0.11
Error ..	8	3.02	0.38	
Total : ..	17	226.48		

't' test provided the following inferences:

$T_1 \sim T_2 = 1.312^{**}$

$T_1 \sim T_3 = 0.954^{*}$

$T_2 \sim T_3 = 0.358$

Separate Stand Density Experiment

(ii)—Shorkot Plantation.

Source	D.F.	S.S.	M.S.	'F' Value
Blocks ..	2	0.71	0.35	0.58
Treatments ..	2	2.22	1.11	1.85
Error ..	4	2.41	0.60	
Total : ..	8	5.34		

**Highly significant (1% level)

*Significant (5% level)

TABLE 2—(*Contd.*)

(iii) Chichawatni Plantations.

Source	D.F.	S.S.	M.S.	'F' Value
Blocks ..	2	2.64	1.32	8.80*
Treatments ..	2	3.39	1.69	11.27*
Error ..	4	0.60	0.15	
Total :	8	6.63	..	..

't' test gave the following information :

$T_1 \sim T_2 = 1.430^*$

$T_1 \sim T_3 = 1.114^*$

$T_2 \sim T_3 = 0.316$

SECOND THINNING

(iv) Combined Stand Density Experiment.

Source	D.F.	S.S..	M.S.	'F' Value
Localities ..	1	6.58	6.58	4.98
Blocks ..	4	1.94	0.48	0.36
Treatment ..	2	3.06	1.53	1.16
Interaction; localities × treatment	2	0.93	0.46	0.35
Error ..	8	10.52	1.32	
Total : ..	17	23.03		