Table 3. Effect of defoliation on morpho-physiological characters at 45 DAS and seed yield and yield components of black gram (cv. T 9)

Treatment	Nodule number	Nodule weight (g)	TDM (g)	Leaf area (cm^2)	Seed yield (g)	Pod number	No. of seeds pod^{-1}	H.I (%)
Control	62	0.191	19.4	181.3	12.22	69	5.03	39.4
Low light	57	0.076	11.1 (42.8)	-	6.28 (48.6)	46 (33.3)	4.26 (15.1)	32.3
Complete defoliation	25	0.029	1.5	-	-	-	-	-
Deflowering at sixth node and below	47	0.078	4.5 (76.8)	373.0	4.83 (60.5)	39.0 (43.5)	3.90	34.8
Deflowering at seventh node and above	73	0.111	15.6 (19.6)	1593	7.22 (40.9)	50.0 (27.5)	4.33	32.6
CD at 5%	19	0.026	0.9	29.0	0.43	4.7	0.54	1.8

* Mean of 5 plants Figures in parentheses indicate per cent reduction over control

below removed as compared to other in which leaves of upper nodes were removed (Table 3). These results clearly demonstrated that lower leaves were the major contributors of assimilates to the roots and nodules. Further defoliation of the crop at sixth node and below reduced leaf area, DMP and ultimately the yield through lower number of seeds per pod and 100-seed weight. The yield reduction was more (60.5%) when defoliation was done at sixth node and below compared to other defoliation treatment (40.9%).

The above results suggest that retention of greater leaf area at specific positions of shoot at different growth stages is important and selection of genotypes for such a character or manipulation of leaf area retention by cultural and other management practices may probably help in enhancement of black gram yields.

REFERENCES

COOPER, C.S. and QUALLS, M. (1967). Morphology and chlorophyll content of shade and sun leaves of two legumes. **Crop Sci., 7:** 672-673.

JACKSON, M.L. (1967). **Soil Chemical Analysis.** Prentice Hall of India Pvt. Ltd., New Delhi.

MINCHIN, F .R., SUMMERFIELD, R.J. HADLEY, P. ROBERT, E.H. and RAWSTHONE, S. (1981). Carbon and nitrogen nutrition of nodulated roots of grain legumes. **Plant cell Env., 4:** 5-26.

PANSE, V.G. and SUKHATME, P.V. (1978) **Statistical Methods for Agricultural Workers.** ICAR, New Delhi.

WATSON, D.J. and WATSON, M.A.(1953) Comparative physiological studies on growth of field crops. The effect of infection with beet yellows and beet mosaic viruses on growth and yield of sugarbeet root crop. **Ann. Appl. Biol., 40:** 1-37.

WITHAM, F.H., BLAYDES, D.F. and DELVIN, R .M. (1971). Chlorophyll absorption spectrum and quantitative determinations.In : **Experiments in Plant Physiology.** Ven Nostrand Reinhold Company, New York, pp 55-56.

(Received : June 1992 Revised: April 1995)

Madras Agric. J., 82(12): 648-651 December 1995
https://doi.org/10.29321/MAJ.10.A01288

GROWTH ANALYSIS IN LINSEED

ARJUNSHARMA, GURURAJ HUMSIGI B.G. MOORTHY and S.A.DESAI
Regional Research Station
Bijapur

ABSTRACT

Sowing of two genotypes of linseed (DPL-21 and KL-31) on two spacings (10 x 10 cm and 30 x 10 cm) and four levels of nitrogen (0, 40, 80 and 120 kg/ha) showed that KL-31 recorded more leaf area, LAI, LAD, AGR, CGR, total dry matter accumulation (except 30 DAS) at all crop growth stages, Grain, straw and fibre yield were also highest in this genotype. The spacing of 10 x 10 cm recorded highest LAI, LAD and CGR but at this spacing, leaf area and AGR were minimum. The maximum DMA and grain yield were seen in the case of 30 x 10 cm spacing. However, straw and fibre yield were maximum at 10 x10 cm spacing. All the growth analysis functions, dry matter accumulations at all crop growth stages and grain, straw yield were on the increase with increasing N-levels.

KEY WORDS : Linseed, Physiological Parameters, Growth Analysis Functions

Linseed (*Linum usitatissimum* L) supplies major portion of drying oils in the world. It occupies an area of about 1.15 million ha in India, with a production of 0.37 million tonnes and the average yield is 323 kg/ha (Anon., 1988). Grain yield per ha of this crop is very low in India, which necessitates to analyse the causes for low yields and the measures to increase it. Many a times, scientists are confronted with the causes of variation in yield of field crops. Such difficulties can be safely overcome by systematically analysing the causes of variation. Technique of growth analysis has become very useful tool to the research workers in answering the variation in yields and this study of growth analysis is gaining importance in all the field crops. The information on the growth analysis aspects of linseed is very scanty and hence an attempt was made to study the growth analysis in this crop.

MATERIALS AND METHODS

A field experiment was conducted on red sandy loam soil at University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bangalore during 1992-93 *rabi* season. The experiment consisting of 16 treatment combinations, *viz.*, two genotypes (DPL-21 and KL-31), two spacing regimes (10 x10 cm and 30 x 10 cm) and four levels of N (0,40 80 and 120 kg N/ha) was laid out in a factorial complete randomised block design with three replications. The fertilizers were applied in the form of urea, single superphosphate and muriate of potash. Half dose of N as per treatment was applied as basal a long with 40 kg each of P_2O_5 and K_2O/ha and the remaining half N applied 35 days after sowing. The sowing was done on 29th October 1992. The soil was low in available nitrogen (189.0 kg/ha) phosphorus (18.30 kg/ha) and medium in available potassium (224.0 kg/ha) with pH 5.60. Crop was irrigated once in 8-10 days depending upon the weather conditions. Other cultural practices were followed as per recommendations. Observations were collected from randomly selected five plants from the rows after eliminating the border rows, one on either side of each plot at 30, 60, 90 days after sowing and at harvest. Leaf area per plant of the sampled linseed was recorded by using leaf are meter (model LI-Cor 3100 area meter). The randomly selected five plants were used to record total dry

Table 1. Leaf area, leaf area index, leaf area duration, absolute growth rate and crop growth rate as influenced by genotypes, spacing regimes and N-levels

Treatment	Leaf area (cm^2/plant)			Leaf area index			Leaf area duration (days)		Absolute growth rate (g/plant/day)		Crop growth rate (g/dm^2/day)	
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	31-60 days	61-90 days	31-60 days	61-90 days	31-60 days	61-90 days
Genotypes												
DPL-21	148.60	282.94	96.33	0.957	1.817	0.601	41.62	36.27	0.323	0.396	0.194	0.247
KL-31	156.33	347.61	119.76	0.986	2.223	0.737	48.14	44.40	0.406	0.503	0.248	0.313
SEm ±	0.37	0.47	0.35	0.003	0.004	0.003	0.071	0.060	0.001	0.002	0.001	0.001
C.D. at 5%	1.04	1.31	0.99	0.008	0.010	0.008	0.196	0.166	0.001	0.005	0.001	0.002
Spacing regimes												
10 x 10 cm	139.20	290.72	92.73	1.392	2.907	0.927	64.48	57.51	0.269	0.316	0.282	0.350
30 x 10 cm	165.73	339.83	123.36	0.552	1.132	0.411	25.27	23.16	0.460	0.584	0.160	0.211
SEm ±	0.37	0.47	0.35	0.003	0.004	0.004	0.071	0.060	0.001	0.002	0.001	0.001
C.D. at 5%	1.04	1.31	0.99	0.008	0.010	0.012	0.196	0.166	0.001	0.005	0.001	0.002
N (kg ha^{-1})												
0	69.70	118.94	41.40	0.458	0.765	0.264	18.362	15.44	0.144	0.153	0.089	0.105
40	120.00	213.69	75.97	0.733	1.330	0.477	30.962	27.11	0.273	0.378	0.157	0.233
80	185.16	437.13	143.12	1.189	2.780	0.851	59.547	54.48	0.507	0.608	0.312	0.378
120	235.00	491.34	171.70	1.507	3.203	1.084	70.662	64.31	0.535	0.660	0.327	0.405
SEm ±	0.53	0.66	0.50	0.004	0.005	0.004	0.100	0.085	0.001	0.002	0.001	0.001
C.D. at 5%	1.48	1.85	1.40	0.011	0.015	0.012	0.277	0.235	0.002	0.007	0.002	0.003

Table 2. Total dry matter accumulation at different growth stages and grain straw and fibre yield as influenced by genotypes, spacing regimes and N-levels

Treatment	Total dry matter accumulation (g/plant)				Grain yield (q/ha)	Straw yield (q/ha)	Fibre yield (q/ha)
	30 DAS	60 DAS	90 DAS	At harvest			
Genotypes							
DPL-21	2.39	12.09	24.00	28.74	6.81	16.41	6.64
KL-31	2.28	14.47	29.59	33.74	7.48	17.58	7.50
SEm ±	0.007	0.018	0.056	0.061	0.039	0.046	0.068
C.D. at 5%	0.020	0.051	0.156	0.169	0.107	0.127	0.187
Spacing regimes							
10 x 10 cm	1.52	9.62	19.11	23.26	6.02	18.19	8.32
30 x 10 cm	3.14	16.95	34.48	39.22	8.28	15.79	5.81
SEm ±	0.007	0.018	0.056	0.061	0.039	0.046	0.068
C.D. at 5%	0.020	0.051	0.156	0.169	0.107	0.127	0.187
N (kg ha^{-1})							
0	0.88	5.20	9.81	13.77	4.39	10.88	4.78
40	1.71	9.90	21.25	25.47	5.99	13.85	6.78
80	3.28	18.51	36.78	41.43	8.92	20.88	9.74
120	3.47	19.52	39.34	44.30	9.29	22.36	6.96
SEm ±	0.010	0.026	0.079	0.086	0.055	0.065	0.096
C.D. at 5%	0.029	0.072	0.220	0.239	0.152	0.179	0.265

matter production after oven drying at 70^0C in hot air oven till constant weight was attained. From the dry matter production, the growth parameters were calculated. Leaf area index was worked out by dividing the leaf area per plant by the land area occupied by the plant (Sestak *et al.*, 1971). Leaf area duration, absolute growth rate and crop growth rate between 31 to 60 and 61 to 90 days were worked out using the formulate of Power *et al.* (1967), Radford (1967) and Watson (1952) respectively. Harvesting of genotype KL-31 was done on 10.3.1993 and DPL-21 on 20.3.93.

RESULTS AND DISCUSSION

Performance of genotypes

KL-31 recorded significantly higher grain yield as compared to DPL-21. Also, dry matter production in KL-31 was significantly more, because of higher leaf area per plant upto 60 days. This has provided greater photosynthetic surface enabling the plant to produce higher grain yield. Further, leaf area index, was higher in KL-31 upto 60 days. Significantly higher LAD was observed in KL-31 between 31 to 60 days (Table 1). Dry matter accumulation continued to be higher at all growth stages in KL-31 as compared to DPL-21. It may be because of building of efficient photosynthetic structure in KL-31 in early stages of growth. There was significant positive correlation between grain yield and leaf area at 60 days (r=0.95). LAT at 60 days (r=0.92) and LAD between 31 and 60 days (r=0.78). The increased seed yield in KL-31 was attributed to growth component such as the functional leaf area, leaf area duration etc., It is worth noting that the functional leaf area progressed gradually form 30 DAS and attained the highest values at 60 DAS and declined sharply after 90 DAS in both the genotypes. The average LAD of KL-31 was 46.27 days as compared to 38.94 days in DPL-21. Higher LAD ensures prolonged functioning of the leaves contributing to higher production of photo synthates. Further, the genotype KL-31 had the LAI of 2.22 during flowering phase (60 DAS) as compared to 1.81 in DPL-21.

Higher seed yield of KL-31 was ascribable to the higher crop growth rate and the absolute growth rate. The average growth rate of KL-31 was 0.280 as against 0.220 gm^{-2}d^{-1} in DPL-21. Reddy (1983) opined that synthesis, accumulation and translocation of photosynthates depend on the building up of the efficient photosynthetic super structure in the early phase of crop growth cycle.

Influence of spacing regimes

Dry matter accumulation differed significantly due to variation of spacing at all the growth stages and also the grain yield (Table 2). Maximum grain yield and dry matter production were recorded with 30 x 10 cm spacing. This variation can be attributed to significant difference in the leaf area LAI. Leaf area and AGR were maximum with 30 x 10 cm spacing regimes, resulting in maximum source of photosynthates. Further, LAI, LAD and CGR were significantly higher with 10 x 10 cm spacing as compared to 30 x 10 cm spacing. These results are congruent with the findings of Thimmappa and Radder (1982). The formation of optimum photosynthetic area and maintaining the leaves in photosynthetically active stage for longer duration under 30 x 10 cm spacing was achieved by less inter-row competition among the plant compared to 10 x 10 cm spacing regime. This might have led to maximum dry matter accumulation and grain yield at 30 x 10 cm spacing. Watson (1952) was also of the opinion that formation of optimum photo synthetic area and maintaining the leaves in photo syntheticaly active stage for longer duration are essential for increasing the grain yield.

Influence of nitrogen

Variation in N levels caused significant difference in the total dry matter accumulation at all stages of crops growth and also in grain yield. (Table 2). The effects of N on the total dry weight perplant was found to be significant, N at 120 kg/ha registered significantly higher dry weight than 40 kg and no nitrogen levels. However, the total dry weight at 120 Kg/N ha was at par with 80 kg N/ha. Grain yield increased with increase in N levels and the highest yield was recorded with 120 kg N/ha (Table 2). Maximum dry matter production at 120 kg N/ha may be due to highest leaf area per plant. Nitrogen application was also instrumental in enhancing the photosynthesising area and the duration of the functional leaves. In fact, highest leaf area and LAD were seen at 120 kg N/ha at the flowering phase. Leaf area index indicates the weight of crop production per unit area of land (Watson, 1947). In the present study, LAI increased with successive increase in N levels at all the growth stages. Thus at the N level of 120 kg/ha and with highest LAI of 3.20, highest grain yield recorded.

Application of nitrogen has influenced the physiological parameters such as AGR and CGR. An increase of N rates from 40 to 120 kg/ha had progresively increased the AGR and CGR values. The physiological parameters, LAI and LAD were positively influenced by N application. In addition, higher CGR at 120 Kg/ha level might have resulted in the production of highest grain yield. Yoshida (1972) stated that the total dry matter production is an integral of CGR over the growth period.

REFERENCES

ANONYMOUS (1988) **FAO Production Year Book 42:** 164

POWER, J.E., WILLS, W., OW GRUMES O.L. and REICHMAN, G.A. (1967) Effect of soil temperature, phosphorus and plant age on growth analysis in barley. **Agron.J., 59:** 231-234.

RADFORD (1967) Growth analysis formulae, their use and abuse. **Crop Sci.,7:** 171-175.

REDDY, D.S. (1983). Response of linseed varieties of varying fertility levels under irrigation. **Mysore J.Agric. Sci., 17:** 91.

SESTAK, Z., CATSKY, J. and JARRIS, P.G. (1971). **Plant Photosynthesis Production Manual of Methods.** Dr.W.Junk, N.V.Pull, the Hague, pp.343-381.

THIMMAPPA, K.E. and RADDER, G.D. (1982) Studies on growth analysis in linseed. **Oilseed J., 12:** 14-17.

WATSON, D.J. (1952), Comparative physiological studies on the growth of field crops. Variation in net assimiltion rate and leaf area between species and varieties on within and between years. **Ann. Bot., 11:** 41-76.

WATSON, D.J. (1952) The physiological basis of variation in yield. **Adv.Agron., 4:** 101-145.

YOSHIDA, S.(1972), Physiological aspects of grain yield. **Adv.Rev.Pl.Physiol., 23:** 437-464.

(Received : May 1994 Revised: June 1994)