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Growth Analysis Studies and Their Possible Use In Selection Work In Safflower (*CARTHAMUS TINCTORIUS* l.)

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ABSTRACT: An intensive investigation showed that some physiological growth parametrers were determined for efficient selection work at early stages of crop growth in safflower (*Carthamus tinctorius* L.). Plant samples were taken three times at 15 days interval starting from 38 days of seeding. Results revealed significant genotypic differences in respect of Crop Growth rate (CGR) and Leaf area Index (LAI) between 38 and 53 days of seeding, whereas Net Assimilation Rate (NAR), Relative Growth Rate (RGR) and Specific Leaf Weight (SLW) gained in importance in the interval between 53 and 68 days. The magnitude of total correlation among and of direct effects of most of these growth parameters on seed yield were low and insignificant suggesting that dry matter accumulation at earliest stages of crop growth (before anthesis) would have little impact on seed yield. The object of the present investigation was found that the growth analysis indicates that leaf area was more effective in dry matter accumulation at the earliest stage of crop development while in the later stage both leaf area and leaf mass (SLW) played significant role in crop growth.

Keywords: Safflower (*Carthamus tinctorius* L.), Net Assimilation Rate (NAR Growth Rate (CGR), Specific Leaf Weight (SLW), Relative Growth Rate (RGR), Leaf Area Index (LAI), Seed Yield

INTRODUCTION

The classical concept of physiological basis of variation in crop yield nourishes the idea that the genotypic difference in yield in an environment is the ultimate reflection of variation in different growth processes of the successive stages of crop development. Such variation in growth processes can be efficiently measured by quantifying the different components of growth, collectively known as growth analysis (Gregory,1917; Blackman,1919; Watson,1952 and Radford,1967).Increasing demand for edible oil in the country urged for improvement of technology for cultivation of all conventional and unconventional types of oil seeds to increase the productivity of oil.Consequently,attempts are being made to increase the productivity of safflower widely grown under unirrigated rabi condition. Recently with the cultivation of safflower gaining momentum, the necessity to analyse the yield performance on the basis of manifestation of morphological parameters under a particular set of environments is being increasingly realized. Parameters commonly used in growth analysis study are Crop Growth Rate (CGR) defined as the increase in plant tissue per unit of time; Relative Growth Rate (RGR) expressed as the increase in plant tissue per unit plant tissue present per unit of time; Net Assimilation Rate (NAR) which is a measure of photosynthetic efficiency and Leaf Area Index (LAI) which is leaf area per unit land area. All these growth parameters may be usefully employed in selection of superior genotypes in plant breeding programme.They have made a substantial contribution to the understanding of efficient plant type conducive to high yield (Khan and Tsunoda, 1970 in wheat; Brinkman and Frey, 1977 in oat; Gardener et al., 1964 in barley; Koller et al., 1970 in soybean and others).Safflower, being an important oil yielding crop of the present day, however, has received little attention in this regard. In the present investigation, therefore, an attempt has been made to analyse all the important growth parameters in a collection of safflower germplasm.The object of this study was to relate the genotypic variations in growth pattern and growth analysis function to the differences in seed yield and to determine suitable physiological parameters for efficient selection work in relation to higher productivity.

MATERIALS AND METHODS

The experiment was carried out at the University Experimental Farm, Calcutta University, Baruipur, 24-Parganas, West Bengal during the Rabi season, in cultivated medium fertile clay textured alluvial soil. Twenty three safflower varieties consisting of four spineless and nineteen spionus types were employed in the experiment. It was laid out in a randomized block design with three replications.Spacing between plants within a row and amongst the rows was maintained at 30 and 45 cm. respectively. Recommended agronomic practices were undertaken with NPK fertilizer levels of 80,40 and 40 kg per hectare respectively (Jackson and Harbison,1973;Ann.,1974).At regular intervals different growth ,yield attributes and finally seed yield data were recorded for necessary computation using standard techniques(Gregory,1917;Blackman, 1919,Briggs et al.,1920,Watson,1947 Swarup and Chaugale,1962 and Gandhi et al.,1964).Correlation study (Al-Jibouri et al.,1958) and path coefficient analysis(Dewey and Lu,1959) were also to estimate interrelationships and direct and indirect influences of various growth and yield components on seed yield.

RESULTS AND DISCUSSION

A critical analysis of data on different growth attributes clearly indicates wide range of variation of growth parameters in safflower. Amongst spineless strains (Table 1) leaf area index, specific leaf weight, crop growth rate and relative growth rates were observed to be maximum in CTS 7403 whereas net assimilation rate was maximum in NS 133(7.7mg/dm^{-2}day^{-1}).In spinous strains, highest average leaf area index was in EC 31367(0.82).Average specific leaf weight, crop growth rate, relative growth rate and net assimilation rate were noted to be maximum in 731 (9.3mg/cm.$^{-2}$),B263-2A (0.805g/
day^{-1}), EC 32008(0.132g/g^{-1}/day^{-1}) and Tara (12.6mg/dm^{-2}/day^{-1}) respectively.

Morphological characters including yield components at harvest also revealed remarkable variations the strains of safflower (Table 2 and 3).Linear growth in safflower, irrespective of spineless and spinous types was maximum in CTS 7403(125.8 cm.) and minimum in NS488-1 (60.0 cm.).The spreading of safflower plant was recorded in ANO-1 (54.5 cm.).However, minimum plant spread was in nonspiny type NS 133 (32.2 cm.).Number of branches per plant varied widely in safflower strains, the maximum being 84.5 per cent in 731, whereas minimum was noted in EC 30212 (15 per plant).The basal diameter of the safflower plants, in the present experiment, ranged from 0.93 to 2.03 cm.The safflower strains revealed significant differences in respect of basal diameter amongst themselves. A similar result is discernible while considering branching angle of the safflower strains. The branching angles were in the range of 35.5 to 46.5 degrees. The minimum and maximum head sizes (size of capitulum) were in C-431 (1.45 cm.) and EC-30212(3.10cm.) respectively. Number of capsules (heads) per plant varied within wide range of 18.5 to 82.0.Number of fertile seeds per head also showed wide variation ranging from 6.5 to 40.5.Thus, there is a significant difference amongst safflower strains, maximum number being in the variety EC 30212 (40.5).Again, data on 100 seed weight revealed significant differences amongst the safflower strains, the minimum and maximum seed weights (100 seeds) were noted in 199935 C (2.82g.) and NC 199 (5.89g.) respectively. Highest yield was recorded in 731 (43.88 g. per plant) and lowest in C-431 (4.58g. per plant).The present experiment thus aimed at identification of suitable safflower varieties to be grown under coastal alluvial soil of West Bengal in terms of growth and yield attributes and yield of seeds and also to determine some physiological growth parameters for efficient selection work at early stages of crop growth.

Table 1. Mean performance in respect of maximum leaf area index(LAI), specific leaf weight(SLW), crop growth rate(CGR), relative growth rate(RGR) and net assimilation rate (NAR)in safflower

Strain	Leaf area index	Specific leaf weight (mg/cm^{-2})	Crop growth rate (g/day^{-1})	Relative growth rate(g/g^{-1}/day^{-1})	Net assimilation rate (mg/dm^{-2} day $^{-1}$1)
Spineless					
NS 199	0.62	5.36	0.300	0.125	3.3
NS 133	0.51	4.81	0.215	0.110	7.7
CTS 7403	0.95	6.00	0.635	0.145	6.5
199935C	0.89	5.62	0.502	0.145	6.1
Spiny					
731	0.38	9.31	0.350	0.130	6.2
EC 76730	0.57	4.27	0.495	0.075	7.4
EC31374	0.81	6.83	0.750	0.115	8.7
EC11175A	0.53	6.85	0.355	0.087	5.6
EC 31367	0.82	6.69	0.705	0.115	9.5

Tara	0.52	8.51	0.670	0.095	12.6
B 263-2A	0.59	6.95	0.805	0.080	11.6
C-431	0.68	4.98	0.375	0.110	4.6
EC 76731	0.66	5.67	0.495	0.125	6.5
EC 32016	0.43	6.91	0.315	0.075	6.6
EC 32008	0.44	5.13	0.320	0.132	5.8
EC 15889	0.72	4.30	0.325	0.088	4.7
EC 11175	0.57	6.96	0.545	0.085	10.3
C 437	0.45	5.62	0.310	0.087	6.4
EC 30212	0.57	5.04	0.375	0.074	6.7
ANO-1	0.66	5.10	0.450	0.088	7.0
87-11	0.48	6.61	0.410	0.083	6.7
NS-488-1	0.38	7.06	0.405	0.091	10.5
JLA-2	0.69	6.92	0.665	0.080	10.0
Mean	0.60	6.15	0.468	0.102	7.4
S.E $_m$±	0.031	0.26	0.033	0.004	0.49

Table 2. Mean performance in respect of some morphological characters in safflower at harvest.

Strain	Plant height(cm)	Plant spread(cm)	Number of branches	Basal diameter (cm)	Branching angle(degree)
Spineless					
NS 199	98.1	49.4	32.5	1.43	44.5
NS 133	125.4	34.2	24.5	1.27	38.5
CTS 7403	125.8	50.6	27.5	1.65	42.0
199935C	122.3	52.5	27.5	1.87	44.5
Spiny					
731	86.4	53.8	84.5	2.03	40.5
EC 76730	97.9	49.3	30.5	1.50	37.0
EC 31374	107.6	43.6	40.5	1.36	38.0
EC 11175	94.9	52.0	36.0	1.31	42.5
EC 31367	104.0	47.8	38.5	1.36	38.0
TARA	91.0	49.8	27.0	1.27	38.0
B263-2A	100.1	45.6	32.5	1.62	39.5
C431	67.9	35.0	21.5	0.97	39.5
EC 76731	114.4	48.6	30.0	1.63	39.5
EC 32016	107.2	35.5	28.0	1.28	35.5
EC 32008	102.2	34.9	26.5	1.22	38.0
EC 15889	89.1	46.8	31.0	1.22	38.5
EC 11175	77.7	43.9	30.5	1.09	39.0
C 437	78.2	42.1	31.5	0.93	46.5
EC 30212	97.1	41.6	15.0	1.19	44.0
ANO-1	84.0	54.5	30.5	1.47	42.0
87-11	82.3	36.4	27.5	1.13	41.5
NS-488-1	60.0	41.1	43.5	1.05	40.5
JLA-2	83.6	38.0	40.5	1.21	41.0
Mean	95.5	44.6	32.93	1.35	38.72
S.E $_m$±	3.59	1.37	7.51	0..56	2.55

Table 3. reproductive phase yield attributes in safflower

Strain	Diameter of head(cm)	No. of heads per plant	No. of fertile seeds per head	100 seed weight(gm)	Seed yield(gm/plant)
Spineless					
NS199	2.20	39.0	19.0	5.89	30.31
NS133	2.60	26.0	13.0	4.76	27.94
CST7403	3.00	31.5	28.0	5.50	31.07
199935C	2.80	31.5	27.5	2.82	33.24
Spiny					
731	2.40	82.0	39.0	5.09	43.88
EC76730	2.35	45.0	33.0	3.63	32.93
EC31374	2.30	53.0	32.0	3.70	42.68
EC11175A	1.90	42.5	12.0	5.09	13.57
EC31376	2.05	52.0	13.5	4.29	24.15
TARA	2.30	42.0	18.5	4.83	25.47
B263-2A	2.25	45.0	16.5	5.33	28.28
C431	1.45	25.5	6.5	3.97	4.58
EC76731	2.55	38.5	34.0	3.74	37.48
EC32016	2.47	37.0	18.5	4.52	21.54
Ec32008	2.31	36.5	12.0	5.20	16.19
EC11175	2.35	42.5	7.5	5.48	20.57

C 437	2.00	38.5	16.0	5.57	23.74
EC30212	3.10	39.5	11.5	5.44	17.85
ANO-1	2.05	43.0	13.5	3.28	21.71
87-11	2.35	42.0	13.5	5.32	33.56
NS-488-1	2.05	52.0	14.5	3.52	18.19
JLA-2	1.95	38.5	12.5	4.71	22.54
Mean	2.30	42.13	19.6	4.62	26.79
$S.E._m \pm$	0.08	1.70	1.5	0.18	2.00

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