Indian Journal of Agricultural Sciences 70 (9) : 581-3, September 2000

Relationship of yield and yield attributes with physiological traits in brassicas

RAJ SINGH[1], VUM RAO[2] and DIWAN SINGH[3]

Chaudhary Charan Singh Haryana Agricultural University, Hisar 125 004

Received: 6 December 1999

ABSTRACT

An experiment was conducted during 1996-97 and 1997-98 to study the relationship of yield and yield attributes with physiological traits. The study revealed that the correlation coefficients among the various growth indices in different brassica varieties showed that leaf area duration had significant positive association with total biomass. Correlation coefficients between physiological traits and yield and yield attributes during vegetative and reproductive phase showed that growth indices recorded during reproductive phase has better association with yield and yield attributes than during vegetative phase. The leaf area index, crop growth rate and dry matter accumulation have significant positive correlation with yield and yield attributes during vegetative phase, while crop growth rate and leaf area duration during reproductive phase. The leaf area index, dry matter production, crop growth rate and leaf area duration seemed to be important in improving grain yield in Indian brassicas and thus deserve consideration in the breeding programme.

Key words: growth indices, crop growth rate, leaf area duration, net assimilation rate

In India, rapeseed and mustard (*Brassica* sp) has very low productivity (1 002 kg/ha) as compared to France and Poland which produces 2 724, 2 282 kg/ha, respectively. In order to exploit the yield potential of rapeseed and mustard, certain agronomic practices are required to be manipulated, so as to find the most appropriate technology suitable for region. Physiological efficiency of a genotype is determined by various growth parameters. Understanding of association of physiological traits with yield is needed. Therefore, an attempt has been made to find out the association of physiological growth parameters with grain yield.

METHODS AND MATERIALS

A study was conducted at Hisar during winter (*rabi*) seasons of 1996-97 and 1997-98 to find out the relationship of yield and yield attributes with physiological traits in brassicas. The experiment comprised combinations of three sowing dates, viz. 5 Oct, 19 Oct and 24 Nov in 1996 and 24 Nov,4 Dec, 16 Dec in 1997 with 2 plant densities, viz 30 cm × 15 cm and 40 cm × 20 cm as main plots and 4 varieties, viz 'Varuna', 'Laxmi', 'RH 30' an 'BSH1' in sub-plots. The treatments has replicated thrice times in split- plot design. The soils was sandy loam, slightly alkaline with poor N content (195 kg/ha), medium in P (17 kg/ha) and rich in K (360 kg/ha). Urea @80 kg N/ha and single superphosphate @ 40 kg P_2O_5/ha were applied.The growth parameters like crop growth rate, relative growth rate, net assimilation rate, leaf area index, leaf area duration and specific leaf area were calculated using the formula given by Radford (1967).The yield and yield attributing characters such as number of siliquae /m^2, number of seeds/siliqua, 1 000 seed weight (test-weight), seed yield/m^2 and seed yield (kg/ha) were recorded at harvest in all plots of experiment.

RESULTS AND DISCUSSION

Among the various growth indices, leaf area duration had highest positive association with total biomass production (Table 1.) The crop growth rate and leaf area duration also had significant positive correlation with biomass accumulation. The relative growth rate had significantly negative association with biomass, leaf area duration, crop growth rate and specific leaf area, but it has significant positive relationship with net assimilation rate and no association with leaf area index. The leaf area index showed significant association with crop growth rate only. Similarly, specific leaf area had significant negative association with relative growth rate and no association with other parameters. The growth indices based on parameter of leaf size like leaf area index, leaf area duration and specific leaf area exhibited significantly positive correlation among themselves. Similarly, growth parameters like relative growth rate and net assimilation rate exhibited positive correlations among themselves. The net assimilation rate exhibited significant positive association with relative growth rate. This suggests that net assimilation rate could be considered as an index of photosynthetic efficiency and selection for this trait is useful to evaluate large number of genotypes for photosynthetic efficiency where

Table 1 Correlation coefficients among growth indices in brassica cultivars

Growth indices	NAR	LAI	SLA	CGR	RGR	LAD	DM	NAR	LAI	SLA	CGR	RGR	LAD	DM
			Varuna								RH-30			
NAR	1.00								1.00					
LAI	-0.22	1.00						-0.21	1.00					
SLA	-0.77	-0.03	1.00					-0.74	-0.02	1.00				
CGR	-0.12	0.50	-0.06	1.00				-0.09	0.47	0.10	1.00			
RGR	0.74	-0.09	-0.77	-0.53	1.00			0.72	-0.16	-0.70	-0.52	1.00		
LAD	-0.04	-0.05	-0.04	0.79	-0.49	1.00		0.08	0.07	0.05	0.81	-0.48	1.00	
DM	-0.03	-0.01	0.11	0.80	-0.56	0.99	1.00	-0.04	-0.08	0.12	0.79	-0.52	0.96	1.00
			'Laxmi'								'BSH-I'			
NAR	1.00							1.00						
LAI	-0.17	1.00						-0.20	1.00					
SLA	-1.77	-0.08	1.00					-0.75	-0.18	1.00				
CGR	-0.08	0.53	0.01	1.00				0.09	0.42	-0.07	1.00			
RGR	0.77	-0.09	-0.70	-0.48	1.00			0.58	-0.09	-0.67	-0.55	1.00		
LAD	-0.04	0.06	0.03	0.77	-0.48	1.00		0.24	0.07	0.01	0.83	-0.53	1.00	
DM	-0.02	0.01	0.09	0.79	-0.54	0.99	1.00	0.18	-0.02	0.10	0.86	-0.60	0.97	1.00

Critical value (1 - tail, 0.05) = ± 0.24, critical value (2 - tail, 0.05) = ± 0.28, N = 48

CGR,Crop growth rate; RGR, relative growth rate; NAR, net assimilation rate; LAI,leaf area index; LAD, leaf area duration; DM, dry matter and SLA, specific leaf area

measurement of leaf photosynthesis rate is a problem. Similar relationships among various growth indices have earlier been observed by Chauhan *et al.* (1999) in rice (*Oryza sativa* L.) and Venkataramana and Ramanujam (1999) in sugarcane (*Saccharum officinarum* L.).

The association of the growth indices on one hand and yield and yield attributes at vegetative and reproductive stage of development of crop has been studies and presented in Table 2 and 3. The perusal of data indicted that growth indices recorded during reproductive phase has better association with yield and yield attributes than those during vegetative phase. Among the various growth indices, the leaf area duration at reproductive stage had highest significant positive correlation with yield and yield attributes along with dry matter production and crop growth rate. The association of yield and yield attributes with relative growth rate and leaf area index was poor during reproductive stage. However, leaf area index during vegetative phase had positive significant association with yield and yield attributes, whereas, specific leaf area had a significant negative association. Net assimilation rate during reproductive phase had a significant positive relationship with yield and yield attributes. This might be due to gain in dry weight of plant mainly because of the development of more siliquae and seed development in siliquae.

Most of the growth indices exhibited significant association with yield and yield attributes. Leaf area index, crop growth rate and dry matter production were significantly and positively correlated with yield and yield attributes during vegetative phases because of greater significance of leaf area and dry matter. It may, in fact, be a consequence of the relatively longer duration of these growth phases in the crop.

Table 2 Correlation coefficient of growth indices with yield and yield attributes at vegetative phase in brassica cultivars

Growth indices	Number of siliquae/m²	Number of seeds/siliqua	1000 seed weight	Seed yield/m²	Seed yield
NAR	-0.16	-0.10	0.09	0.13	-0.20
LAI	0.86	0.94	0.97	0.98	0.83
SLA	-0.76	-0.69	-0.70	-0.79	-0.78
CGR	0.80	0.84	0.91	0.96	0.89
RGR	-0.79	-0.68	-0.50	-0.55	-0.48
LAD	0.32	0.29	0.20	0.20	0.23
DM	0.56	0.58	0.61	0.65	0.66

Critical value (1 - tail, 0.05) = ± 0.24; critical value (2 - tail, 0.05) = ± 0.28; N = 48

Table 3 Correlation coefficients of growth indices with yield and yield attributes at reproductive phase in brassica cultivars

Yield attributes/ growth indices	Number of siliquae/m²	Number of seeds/siliqua	1000 seed weight	Seed yield/m²	Seed yield
NAR	0.83	0.67	0.62	0.77	0.61
LAI	0.52	0.61	0.42	0.47	0.44
SLA	-0.87	-0.68	-0.52	-0.64	-0.54
CGR	0.89	0.87	0.87	0.95	0.86
RGR	0.32	0.35	0.32	0.30	0.31
LAD	0.85	0.92	0.98	0.98	0.98
DM	0.85	0.88	0.94	0.97	0.93

Critical value (1-tail, 0.5) = ± 0.24; critical value (2-tail, 0.5) = ± 0.28; N=48

Whereas, poor relationship between leaf area index at reproductive phase with yield and yield attributes may be due to less dependence of plant photosynthesis on leaves due to senescence and development of strong sink in the form of siliquae which are also acting as a major source during reproductive phase. Moreover, the energy required for translocation of assimilates to active sink (siliquae) was too small in case of photosynthates synthesised in siliquae due to their green pod wall compared with the leaves which are located too far from the active sink at that time (Pannu *et al.* 1998). Similarly net assimilation rate, crop growth rate, leaf area duration and dry matter production were positively correlated during reproductive phase because of their higher significance as determinant of yield attributes during this phase. Similar relationship of various growth indices with seed yield had also been studied by Chauhan *et al.* (1999) in rice.

The present investigation revealed that leaf area index, crop growth rate, dry matter production at vegetative stage and net assimilation rate and leaf area duration at reproductive stage appeared very useful characters for increasing grain yield in Indian brassica. Because dry matter is related to leaf area index, therefore, genotype with fast leaf area development should be utilised for breeding programmes. Selection base on dry mater accumulation a vegetative phase coupled with high harvest index might lead to selection of physiologically efficient genotypes and hence higher grain yield.

ACKNOWLEDGMENT

Authors are highly thankful to the CSIR for providing financial assistance during this course of investigation.

REFERENCES

Anonymous. 1998.Project co-ordinator report 1997-98 . National Research Centre on Rapeseed-Mustard, Sewar, Bharatpur Rajasthan.

Chauhan J S, Singh C V and Singh R K. 1999.Interrelationship of growth parameters in rainfeed upland rice (*Oryza sativa* L.). *Indian Journal of Plant Physiology*, 4 (1) : 43-5.

Pannu R K, Singh, D P, Singh D, Chaudhary B D and Sharma H C. 1998. Effect of moisture and nutrient stress on biomass allocation to different plant parts a various growh sages in Indian mustard genotypes. *Agronomy Journal J.* **14**:138-46.

Radford PJ 1967. Growth analysis formulae, their use and disuse. *Crop Science.* 7: 171-5.

Venkataramana S and Ramanujam T. 1999. Influence of altered source size on growth and drymass accumulation in sugarcane. *Journal of Plant Physiology* 4 (1) : 10-4.