

Evaluation of growth parameters (AGR, RGR and NAR) in relation to seed yield of soybean

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ABSTRACT

The field experiment entitled "Evaluation of growth parameters (AGR, RGR and NAR) in relation to seed yield of soybean" was conducted at the Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri with a view to study evaluate the effect of various growth functions on the seed yield of soybean cultivars. The experiment was laid out in randomized block design (RBD) with 3 replications including eight soybean varieties namely V1) JS-335, V2) MACS-58, V3) MACS-124, V4) DS-186, V5) PK-472, V6) PK-1029, V7) Arati and V8) Pooja. The observations were recorded during two years (2000 and 2003). The mean pooled data of AGR showed that, high yielding varieties had high AGR. The pooled data of AGR (30-60 DAS) showed that, the significantly highest AGR was observed in variety Pooja (0.713 g/day). There was sudden increase in AGR of all varieties at 60-90 DAS. It is to note that at 90 DAS to harvest of crop pooled mean AGR had shown decrease in AGR values. Pooled data of both the years showed that there was positive correlation between AGR of period 30-60 DAS, 60-90 DAS and 90 DAS to harvest of crop with seed yield (q/ha). The pooled data showed that the highest RGR was noted at 30-60 DAS and it was decline from 60-90 DAS to harvest of crop. The pooled data revealed that, at 30-60 DAS the high yielded varieties had significantly highest NAR Pooja (0.051), MACS-58 (0.049) and MACS-124 (0.048 g dm⁻² day⁻¹) respectively than other varieties. At 60-90 DAS the short durational variety DS-186 had significantly lowest (-0.252 g dm⁻² .day) NAR than other varieties. It is observed from pooled data that, the variety Pooja had significantly highest seed yield of 24.045 q/ha over rest of all varieties studied. It might be due to better performance in respect of following plant characters. 1) Pooja had highest AGR 0.713 g/day at 30 DAS 2) Pooja had highest RGR at 30 DAS (0.090 g. g⁻¹ day⁻¹) 3) Pooja had highest NAR at 30 DAS 0.051 g m⁻² .day⁻¹. There was significant positive correlation between AGR at 30-60 DAS and 90 DAS to harvest of crop with seed yield of soybean. The RGR at 30-60 DAS showed significant positive correlation with seed yield. There was significantly positive correlation of NAR at 30-60 DAS with seed yield and negative correlation at 60-90 DAS.

Key words : Soybean, AGR, RGR, NAR.

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is an important pulse as well as oilseed crop. It has become wonder crop of the twentieth century and is often designated as 'Golden bean'. It is legume crop belonging to family leguminosae and sub family papilionaceae.

Soybean [*Glycin max*. (L.) Merill.] often called the "Miracle crop" is an excellent source of protein and has potential to adequate and nutritious food and feed for ever increasing world population. The importance was felt in the early sixties to the twentieth century in India, when problem of malnutrition especially for protein was felt acutely among masses.

Soybean is rich in Vit 'A', 'B' and 'D' the sprouted seeds contain Vit 'C'. It is also source of phosphores and sulphur. Soybean is the cheapest source of protein and hence it is called "poor man's meat" (Mahajan, 1994). Kankal (1996) reported on study of growth functions that, the AGR of dry matter was slow up to 45th day. AGR values showed sharp increasing trend during the period 45 to 60 DAS being grand growth period of soybean crop. Buttery and Buzzel (1972) found some differences between soybean cultivars in growth analysis data revealed that, varietal differences in mean relative growth rate (RGR) was detected within a group of 21 cultivars grown over three years. The varietal differences in RGR were showed to be highly significant. The cultivar x test interaction was not significant for RGR. The

environmental correlations indicated that, those plots with high NAR tended to have high RGR. Kankal (1996) studied soybean in irrigated condition, and the data revealed that, the cultivar MACS-124 showed higher RGR values (0.550 g/g/week) during 45-60 DAS. Thereafter RGR values were decreased with increase in the age of the soybean crop. Pushpa Kumari *et al.* (1993) worked on soybean at Trissure, Kerala and revealed that the comparison of NAR between 40-60 DAS and 60-90 DAS the entries showed increase in NAR under field trial, while rest showed decreasing trend. Jain *et al.* (1996) worked on soybean at Powerkheda, M. P. and observed that NAR of soybean decreased with an increase in crop age. Kankal *et al.* (1996) observed that the mean maximum NAR was 0.501 g/dm²/week during the initial period of 30 to 45 DAS and thereafter it was decreased.

In soybean production low productivity was observed in India than other countries, there may be any physiological reason for low productivity of soybean seed yield. Hence to find out relationship of growth parameters (AGR, RGR, NAR) with the seed yield, the present study was undertaken.

MATERIALS AND METHODS

The present investigations were carried out during *kharif* seasons of the year 2000 and 2003. The details of material used and methods followed are presented in this chapter.

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The experiment was laid out in randomized block design (RBD) with three replications including eight soybean varieties namely V1) JS- 335 ,V2) MACS-58, V3) MACS-124, V4) DS-186, V5) PK-472, V6) PK-1029, V7) Arati and V8) Pooja. The recommended dose of fertilizers was given. The various growth observations were recorded at interval of 30 DAS to harvest. and statistical analysis was carried out by the method suggested by Panse and Sukhatme (1985) . Pooled analysis was done in Department of Statistics, MPKV, Rahuri.

Growth parameters :

Three soybean plants were uprooted at 30, 60, 90 DAS and at harvest of crop and there observations were recorded timely and on the basis of collected data various growth functions were calculated.

Absolute growth rate (g day⁻¹) :

1. Absolute growth rate was calculated by the formula given by Radford (1967).

$$AGR = \frac{W_2 - W_1}{t_2 - t_1}$$

Where, W_2 and W_1 referred to weights of total dry matter g/plant at the time t_2 and t_1 , respectively.

2. Relative growth rate (g g⁻¹ day⁻¹) :

The relative growth rate is an index of the amount of growing material incorporated per unit dry weight of plant per unit time. RGR was calculated by using following formula given by (Briggs *et al.* 1920).

$$RGR = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

Where,

$W_2 - W_1$ is the area total dry matter g per plant at times t_2 and t_1 , respectively.

3. Net assimilation rate (g dm⁻² day⁻¹) :

NAR is an increase in dry weight of plant per unit leaf area per unit time. NAR was calculated by using following formula given by (Greggory, 1926).

$$NAR = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{\log_e L_2 - \log_e L_1}{L_2 - L_1}$$

Where L_1 and L_2 are the leaf areas (dm²) however W_2 and W_1 are the total dry matter gm per plant at the times t_1 and t_2 respectively.

RESULTS AND DISSCUSSION

The present investigation entitled, "Evaluation of growth parameters (AGR, RGR and NAR) in relation to seed yield of soybean." was conducted during the *khariif* season of the year 2000 and 2003 at Instructional Farm, PGI.,

MPKV, Rahuri. The yearwise and pooled data results of Various growth functions were calculated are as 1) AGR 2) RGR 3) NAR the results obtained are presented in Table 1 and 2 .

Growth parameters:

There were sttically significant differences in respect of AGR, RGR and NAR for the period a) 30-60 DAS, b) 60-90 DAS and c) 90 DAS – At harvest are presented in Table 1. It is observed from the pooled mean AGR for the period 30-60 DAS, 60-90 DAS aqnd 90 DAS to harvest was statistically significant among all the varieties.

1. Mean absolute growth rate (AGR) (g/day) :

- At 30-60 DAS, the significantly highest mean AGR of 0.713 (g/day⁻¹) was recorded in variety Pooja. While the lowest (0.200 g/day⁻¹) was recorded in variety JS-335.
- At 60-90 DAS, the significantly highest mean AGR was observed of variety JS-335 (1.088 g/day) and it was at par with variety DS-186 (1.052) and lowest mean AGR was calculated of variety PK-1029 (0.402 g/day).
- At 90 DAS to harvest, the highest mean AGR was observed in variety Pooja (0.830 g/day) while the lowest mean AGR was observed in variety PK-1029 (0.032 g/day).

Correlation of AGR at 30-60 DAS with seed yield :

The mean AGR had significantly positive correlation with seed yield during the year 2000 (0.788), 2003 (0.777) and pooled data of both the years (0.756), AGR at 60-90 DAS with seed yield the mean AGR at 60-90 DAS had negative correlation with seed yield during the year 2000 (-0.287), 2003 (-0.067) and pooled data of both the years (-0.173).

2. Mean relative growth rate (RGR) :

- At 30-60 DAS, the significantly highest RGR (0.090 g/g/day) was observed in variety Pooja and MACS-58 followed by variety MACS-124 (0.087 g/g/day). While the lowest was seen in variety JS-35 and PK-1029 (0.070 g/g/day each).
- At 60-90 DAS, the significantly highest mean RGR (0.060) (g/g⁻¹/day⁻¹) was observed variety JS-335. However, the RGR (0.018 g/g/day) was observed in variety PK-1029.
- At 90 DAS to harvest, the significantly highest RGR was noticed in variety Arati (0.014 g/g/day) and the lowest was noticed in variety PK-1029 (0.001 g/g/day).

Correlation of RGR with seed yield :

30-60 DAS : The mean RGR had significant positive correlation with seed yield during the year 2000 (0.692), 2003 (0.694) and pooled data of both the years (0.623), 60-90 DAS : The mean RGR had significant negative correlation with seed yield during the year 2000 (-0.704), 2003 (-0.449) and pooled data of both the years (-0.573).

3. Mean net assimilation rate (NAR) :

- At 30-60 DAS, the significantly mean NAR that there

were statistically significant differences among all varieties. The highest pooled mean NAR (0.051 g/dm²/day) was observed of variety Pooja followed by varieties MACS- 58 and Arati (0.049) while lowest was observed in variety JS-335 (0.032 g/dm²/day).

- b) At 60-90 DAS, the significantly lowest NAR was noticed in variety DS-186 (-0.252 g/dm²/day) and the highest NAR was noticed in variety Pooja (0.028 g/dm²/day).
- c) At 90 DAS to harvest, the significantly lowest pooled mean NAR (-0.122 g/dm²/day) was observed of variety DS-186 followed by variety Pooja (-0.117) while the highest mean NAR (-0.007 g/dm²/day) was observed of variety PK-1029.

Correlation of NAR with seed yield :

30-60 DAS : The mean NAR had significant positive correlation with seed yield during the year 2000 (0.623^{**}), 2003 (0.363) and pooled data of both the years (0.401^{*}).

60-90 DAS : The mean NAR had significant negative correlation with seed yield during the year 2000 (-0.847^{**}), 2003 (-0.586^{*}) and pooled data of both the years (-0.703^{*}).

Mean seed yield (q/ha) :

The pooled data of both the years showed that significantly highest seed yield was recorded in variety Pooja (24.045q/ha) lowest seed yield was noted in variety DS-186 (12.518).

The trend of pooled data of mean seed yield (q/ha) was given as below

$$V_8 > V_2 \geq V_3 > V_7 \geq V_5 > V_6 \geq V_1 > V_4$$

In the present studies the pooled data regarding

absolute growth rate (AGR) (Table 1) showed that, there were significant differences among all varieties at 30-60 DAS, 60-90 DAS and 90 DAS to harvest of crop.

The pooled data of AGR (30-60 DAS) showed that, the significantly highest AGR was observed in variety Pooja (0.713 g/day). This variety produced good seed yield hence it can be concluded from the studies that the highest AGR at 30-60 DAS is desirable plant character for getting higher seed yield. Present result agree with Kankal (1996) who stated that, AGR of dry matter was slow up to 45 DAS but afterward AGR of plants sharply increased during the period of 45 to 60 DAS.

The pooled data showed that, there was sudden increase in AGR of all varieties at 60-90 DAS. It is to note that at 90 DAS to harvest of crop pooled mean AGR had shown decrease in AGR values. There must be short interval of 10 days for getting proper AGR values of variety Pooja. The correlation values of AGR during the year 2000, 2003 and pooled data of both the years (Table 2) showed that there was positive correlation between AGR of period 30-60 DAS, 60-90 DAS and 90 DAS to harvest of crop with seed yield (q/ha). From this it is concluded that AGR remains positively associated with seed yield.

The pooled data in regards to mean RGR (Table 1) showed that, there were significant differences among all varieties at 30-60 DAS, 60-90 DAS and 90 DAS to harvest of crop. These results are confirmatory with results of Buttery and Buzzel (1972) noted significant differences among 21 varieties in respect of RGR over three years. The pooled data showed that the highest RGR was noted at 30-60 DAS and it declined from 60-90 DAS to harvest of crop.

RGR expressed the dry weight increased in a unit time interval in relation to initial dry weight. The pooled data showed that the high yielding varieties Pooja, MACS-124 and MACS-58 had higher RGR at 30-60 DAS than rest of

Table 1 : Pooled data of Mean absolute growth rate (AGR) g/day, Mean relative growth rate (RGR) g.g⁻¹.day⁻¹, Mean net assimilation rate (NAR) g. dm⁻².day⁻¹ and Seed yield for the *khariif* season (2000 and 2003)

S. No.	Treatment	Mean absolute growth rate (AGR) (g/day ⁻¹)			Mean relative growth rate(RGR) (g.g ⁻¹ .day ⁻¹)			Mean net assimilation rate (NAR) (g. dm ⁻² .day ⁻¹)			Seed yield (q/ha)
		30 DAS-60 DAS	60 DAS-90 DAS	90 DAS-Harvest	30 DAS-60 DAS	60 DAS-90 DAS	90 DAS-Harvest	30 DAS-60 DAS	60 DAS-90 DAS	90 DAS-Harvest	
1	V ₁ -JS-335	0.200	1.088 [*]	0.272	0.070	0.060 [*]	0.007	0.032	-0.208	-0.095 [*]	14.600
2	V ₂ -MACS-58	0.665 [*]	0.865	0.252	0.090 [*]	0.028	0.004	0.049 [*]	-0.045	-0.058	22.618
3	V ₃ -MACS-124	0.648 [*]	0.938	0.222	0.087 [*]	0.028	0.003	0.048	-0.045	-0.035	21.847
4	V ₄ -DS-186	0.320	1.052 [*]	0.335	0.080	0.050	0.007	0.042	-0.252 [*]	-0.122 [*]	12.518
5	V ₅ -PK-472	0.470	0.820	0.256	0.080	0.030	0.005	0.045	-0.053	-0.053	19.213
6	V ₆ -PK-1029	0.452	0.402	0.032	0.070	0.018	0.001	0.045	-0.030	-0.007	15.810
7	V ₇ - Arati	0.528	0.715	0.613	0.085	0.028	0.014 [*]	0.049 [*]	-0.043	-0.100 [*]	20.203
8	V ₈ - Pooja	0.713 [*]	0.715	0.630 [*]	0.090 [*]	0.020	0.010	0.051 [*]	-0.028	-0.117 [*]	24.045 [*]
	Mean	0.500	0.824	0.351	0.081	0.033	0.006	0.045	-0.088	-0.073	18.857
	S. E. ±	0.031	0.048	0.070	0.001	0.003	0.001	0.005	0.005	0.016	0.422
	C. D. at 5 %	0.088	0.139	0.203	0.003	0.009	0.003	0.015	0.014	0.048	1.223

*Significant over rest of all varieties

all varieties. These results are confirmatory with Kankal (1996), who noted that, the variety MACS-124 had highest RGR of (0.550 g/g/week) during 45-60 DAS thereafter RGR values were decreased with increase in age of crop. The correlation data of RGR with seed yield of the year 2000, 2003 and pooled data of both the years revealed that, there was positive correlation between RGR at 30-60 DAS and 90 DAS to harvest of crop. The net assimilation rate (NAR)

However, Izumiyama *et al.* (1995) reported that, there were no significant differences in NAR during *kharif* and dry season. In present investigation it is observed that, there was decrease in NAR with increase in crop age this result is an agreement with Jain *et al.* (1996) noted that, there was decrease in NAR with increase in crop growth. Similar results are noted by Kankal (1996) who noted that, mean NAR was found maximum in varieties during 30-45 DAS

Table 2 : The yearwise and pooled data of correlation analysis of soybean yield (q/ha) with growth parameters (AGR,RGR and NAR).

S. No	Plant character		'r' values of		
			2000	2003	Pooled data
1	AGR	30-60 DAS	0.788**	0.777**	0.756**
		60-90 DAS	-0.287*	-0.067	-0.173
		90 DAS-harvest	0.394**	0.487**	0.423**
2	RGR	30-60 DAS	0.692**	0.694**	0.623**
		60-90 DAS	-0.704**	-0.449**	-0.573**
3	NAR	30-60 DAS	0.623**	0.363**	0.401**
		60-90 DAS	-0.847**	-0.586**	-0.703**

'r' values', *Significance at 5 % (0.284), ** Significance at 1 % (0.358)

is a measure of average efficiency of leaves of plant. NAR is measure of source of activity. NAR depends upon light interception on leaf area and CO₂ assimilation.

The data of NAR Table 1 showed that, at 30-60 DAS high yielding varieties had higher NAR during 2000 and 2003. The pooled data (Table 1) revealed that, at 30-60 DAS the high yielded varieties had significantly highest NAR Pooja (0.051), MACS-58 (0.049) and MACS-124 (0.048 g/dm²/day⁻¹) respectively than other varieties studied. NAR was reduced after 30-60 DAS. The net assimilation rate was found to be reduced from 60 days onwards till harvest during the year 2000 and 2003. The pooled data showed that at 60-90 DAS the short durational variety DS-186 had significantly lowest (-0.252 g/dm²/day) NAR than other varieties. It was followed by second short durational variety JS-335 (-0.208 g/dm².day⁻¹). Pookpakdi (1983) observed that, NAR ranged from 68 to 73 g.m².week⁻¹ at 25-42 DAP thereafter it dropped at 42-68 DAP. A significant decrease found at 68 DAP. A reduction in NAR at reproductive stage indicated a decrease in photosynthetic activity of leaves. Phenomenon partly due to the senescence of lower leaves.

The pooled data showed that, there was linear decrease in NAR from 60 DAS must be due to decrease in photosynthetic activity of lower leaves and senescence of lower leaves or it may be due to excessive canopy development. This conclusion is confirmatory with result of Bisht and Chandel (1989) and Pushpakumari *et al.* (1993). The pooled data at 90 DAS to harvest showed that, the varieties DS-186 (-0.122), Arati (-0.100), Pooja (-0.117) and JS-335 (-0.095) g/dm²/day had significantly lowest NAR over other varieties. These results are confirmatory with Sharma and Sharma (1993) who noted highest NAR of variety JS-335 during *kharif* season.

thereafter it decreases. However, Pushpakumari *et al.* (1993) noticed that, soybean entries showed increase in NAR under field trial while comparing NAR between 40-60 DAS and 60-90 DAS.

The correlation data of year 2000, 2003 and pooled data (Table 2) revealed that there was positive correlation of NAR at 30-60 DAS with seed yield. However, there was negative correlation at 60-90 DAS and 90 DAS to harvest of crop. These results are confirmatory with conclusions of Nirmalakumari and Balsubramanian (1989).

It is observed from pooled data that, the variety Pooja had significantly highest seed yield of 24.045 q/ha over rest of all varieties studied. It might be due to better performance in respect of following plant characters. 1) Pooja had highest AGR 0.713 g/day at 30 DAS 2) Pooja had highest RGR at 30 DAS (0.090 g/g⁻¹/day⁻¹) 3) Pooja had highest NAR at 30 DAS 0.051 g/m²/day.

It can be concluded from data that, the variety Pooja had the significantly highest seed yield of (24.373 q/ha) during the year 2000 (23.717 q/ha) during the year 2003 (23.717 q/ha) and pooled data of both the year (24.045 q/ha). It is also concluded from these studies that, the Pooja soybean variety was found to be suitable for cultivation over the seasons in Ahmednagar jurisdiction. However, there is further need to confirm these results to arrive at final recommendation.

1. The data of year 2000, 2003 and pooled data of both the year showed that the absolute growth rate increased up to 60 DAS thereafter it reduced but in soybean variety Pooja it increased at 90 DAS to harvest as its total dry matter production was higher during this period. There was significant positive correlation between AGR at 30-60 DAS and 90 DAS

to harvest with seed yield.

- 2.. RGR was noticed highest at 30-60 DAS during the year 2000, 2003 and pooled data of both the years. The pooled data showed that the high yielded varieties had significantly the highest RGR Pooja (0.090 g/g/day), MACS-58 (0.090 g/g/day), MACS-124 (0.087 g/g/day) at 30 DAS and it reduced with an increase in age of crop. The RGR at 30-60 DAS showed significant positive correlation with seed yield.
3. Significantly the highest NAR was noticed at 30-60 DAS during the year 2000, 2003 and pooled data of both the years thereafter it decreases with an increase in age of crop. There was significantly positive correlation of NAR at 30-60 DAS with seed yield and negative correlation at 60-90 DAS.
4. There was significant positive correlation between AGR at 30-60 DAS and 90 DAS to harvest with seed yield. The RGR at 30-60 DAS showed significant positive correlation with seed yield. There was significantly positive correlation of NAR at 30-60 DAS with seed yield and negative correlation at 60-90 DAS.

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