Original Research Article

Evaluation of Growth, Physiological, and Quality Parameters on Seed Yield of Soybean [*Glycine max* (L.) Merrill]

ABSTRACT:

Fifty genotypes of Soybean, including two checks (JS 20-98 and JS 20-34), were evaluated to assess the effect of various growth parameters on the seed yield of soybean cultivars and to determine their variability in protein and oil content as well as the correlation between both qualitative characters and yield parameters. The study was carried out during the *Kharif* season of 2019 at Seed Breeding Farm, Department of Plant Breeding and Genetics, College of Agriculture, JNKVV, Jabalpur, (MP). The experiment was laid out in a randomized complete block design (RCBD), having three replications. In the present studies, the data regarding Leaf area index (LAI), leaf area duration (LAD), Chlorophyll content index (CCI), oil, and protein% showed that there were significant differences among all varieties. The results from these data were analyzed using PCA and correlation analysis. There was a significantly positive correlation of LAI at 30, 45, and 60 DAS with seed yield. There was a significant positive correlation between LAD-1(30-45DAS) and LAD-2(45-60DAS) with seed yield. There was a significantly positive correlation between CCI to seed yield. There was a significantly negative correlation between oil and protein percent with the seed yield of the plant. It was observed that genotype EC 456615 had the highest protein content (41.62%), and genotype EC 389170 had the highest oil content (21.50%) among the studied genotypes.

Keywords: Growth Parameters, Leaf Area Index (LAI), Leaf Area Duration (LAD), Chlorophyll Content Index (CCI), and Seed quality.

INTRODUCTION:

Human and animal health requires soybean meals and oils. Because of its nutritional and economic value and its many applications, soybean farming in Madhya Pradesh has grown. It is the world's most important supplier of vegetable oil (Dashiel, 1993). It's one of India's three most important oilseed crops. The reason for the low performance of soybean may be due to physiological parameters, and thus the study of evaluation of various growth parameters viz. LAI, LAD, and CCI were conducted. The leaf area of soybean is a crucial yield variable controlled by both abiotic (solar radiation and temperature) and biotic (pests and illnesses) variables; consequently, achieving optimal LAI is a first step in reducing soybean yield disparities.

Additionally, the research found that the optimal range for getting the maximum soybean yield was between 3.5 and 4.0 LAI in the early reproductive stage (R1, commencement of flowering) (Fehr *et al*., 1971). Similarly, developing greater nutrition genotypes is another part of crop improvement. Soybean is among the most significant oilseed crops globally in terms of overall output and international commerce, accounting for 25% of global vegetable oil production and nearly two-thirds of protein concentrates for animal feeding. Soybean have brought significant economic benefits to small and marginal farmers as a short-duration, low-input income crop that fetches high prices. It accounts for 40% of overall oilseed output and 25% of total edible oil production. Soybean protein and oil are critical for both children's and adults' health. Soybean is also utilized to make a variety of healthy animal feeds available on the market. The importance of soybean in India's food security cannot be overstated. Farmers and breeders have a problem selecting specific cultivars to cultivate for seed output, oil content, or both. This study aimed to discover a link between soybean oil content and seed yield with physiological factors, i.e., the best leaf area index for achieving maximum production potential in the soybean (*Glycine max* (L.) Merrill). A typical LAI pattern starts with a lag rise early in the season. A fast increase in LAI until a maximum value is attained, followed by a drop in LAI as leaves age and the plant reaches physiological maturity. Because chlorophyll is the primary driver of light absorption and conversion of absorbed light to chemical energy, it is an important (though not the only) element in determining plant photosynthetic potential.

MATERIALS AND METHODS:

The experiment was conducted at the Seed Breeding Farm, Department of Plant Breeding and Genetics, College of Agriculture, JNKVV, Jabalpur, during the *Kharif* season of 2019 (M.P.). The annual rainfall of the experimental area is around 1200-1400mm, with most of it falling between June and September. Fifty genotypes were utilized in the study, including two control varieties (JS 20-98 and JS 20-34) acquired from the All India Coordinated Research Project on

Soybean, Department of Plant Breeding and Genetics, JNKVV, Jabalpur, and the Indian Institute of Soybean Research, Indore (M.P.). A Randomized Complete Block Design was used to plan the experiment. To guarantee optimal germination and decrease weed infestation, the field was prepared using manual tillage. The rows were 40cm wide and the plants were 7cm apart. The plot was 1.2m x 3m in size. At 30, 45, and 60 days after sowing, the different growth observations (LAI and LAD) were recorded. OP-Stat software was used to conduct the statistical analysis. The leaf area index was computed using leaf area per plant data collected at 30, 45, and 60 days. The LAI was determined using Watson's (1947) formula.

$$LAI = \frac{\text{Total leaf area}}{\text{Land area}} \qquad LAI = \frac{(LA_2 + LA_1)}{2/p}$$

Where,

LA_1 and LA_2 represent leaf area during two consecutive intervals and 'P' ground area.

The size and persistence of leaf area or leafiness during the crop growth phase are expressed by leaf area duration. It is connected to yield and indicates the magnitude of the seasonal integral of light interaction (Watson, 1952).

The LAD was calculated in the following way:

$$LAD = \frac{(LA_2 + LA_1)}{2} \times (t_2 - t_1) \text{ (cm}^2 \text{ days)}$$

Where,

LA_1 and LA_2 represent the leaf area at two successive time intervals (t_1 and t_2).

Chlorophyll Content Index (CCI), measured in grams of chlorophyll per unit ground area, was determined in the fourth leaf of a five-week-old plant using a non-destructive procedure including a chlorophyll meter (Model: CCM 200 Made in the USA). The protein content of each sample was determined using a standard micro-Kjeldahl digestion and distillation method. The AOAC method was used to determine the fat content of the sample (1984). Correlation coefficients were determined using the software OP-stat to assess the degree of association between features and yield and yield components. The goal of principle component analysis is to find a limited number of linear combinations (principal components) of a collection of variables that preserve a lot of the original information. A limited number of main components is frequently used to substitute the original variables, create graphical representations, and do regression analysis, cluster analysis, and factor analysis, among other things. As a result, this study may be viewed as an attempt to demonstrate the nearly linear dependencies between variables. The obtained values were compared to Fisher and Yates's (1963) tabulated values at t-2 d.f. at two levels of probability, namely 5%, and 1%, to assess the significance of correlation coefficients.

RESULTS AND DISCUSSION:

Principal Component Analysis, or PCA, is a dimensionality-reduction approach for reducing the dimensionality of big data sets by converting a large collection of variables into a smaller one that retains the majority of the information in the large set. Table (i) shows the Eigen-values, percent variance, and cumulative Eigen-values in the current study. Only two of the nine principal components (PCs) had an Eigen-value greater than 1.00 and indicated roughly 74.60 percent diversity among the attributes investigated.

Table: (i) Eigen values of Correlation Matrix

	PC1	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC7**	**PC8**	**PC9**
Eigen values	**5.326**	**1.391**	**0.757**	0.547	0.369	0.297	0.185	0.070	0.058
Proportion	0.592	0.155	0.084	0.061	0.041	0.033	0.021	0.008	0.006
Cumulative Proportion	0.592	0.746	0.830	0.891	0.932	0.965	0.986	0.994	1.000

As a result, the relevance of these two main components was given significant consideration for further explanation. PC1 exhibited the most variability (59.20 percent), followed by PC2 (15.30 percent). As a result, choosing lines for characters in PC1 and PC2 may be beneficial. AGS 48 (genotype no.47) had the highest PC score in PC1 of the 50 genotypes studied, indicating that this genotype has a high value of traits such as LAI, LAD, and CCI (as shown in table (ii)). AGS 76 (genotype 44) had the highest PC score in PC2 and was mostly associated with LAD and CCI (shown in table (ii)). El-Hashash (2016), Manav *et al*. (2017), Dubey *et al*. (2018), and Liying (2018) reported similar results (2018).

Table: (ii) Loadings (Eigen-vectors) of Correlation Matrix

	PC1	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC7**	**PC8**	**PC9**
LAI 30DAS	0.205	**-0.561**	**-0.457**	**0.392**	**0.488**	0.132	-0.127	-0.049	-0.079
LAI 45DAS	**0.279**	**-0.422**	-0.313	**-0.491**	**-0.392**	**-0.494**	-0.087	-0.004	-0.009
LAI 60DAS	**0.383**	-0.077	-0.085	-0.210	-0.136	**0.533**	**0.693**	0.044	-0.110
LAD1	**0.371**	0.219	0.180	0.114	**0.364**	**-0.539**	0.279	**0.347**	**-0.383**
LAD2	**0.411**	0.121	0.107	0.069	0.187	-0.192	0.148	**-0.375**	**0.753**
CCI	**0.329**	0.125	-0.077	**0.673**	**-0.635**	-0.019	-0.096	0.033	-0.062
OIL %	-0.040	**-0.640**	**0.732**	0.140	-0.099	-0.016	0.080	0.112	0.068
PROTEIN %	**-0.396**	-0.074	-0.303	0.170	-0.067	-0.163	**0.372**	**0.587**	**0.450**
YIELD	**0.400**	0.088	0.093	-0.204	0.070	**0.317**	**-0.493**	**0.613**	0.239

LAI (30 and 45 days) showed a positive correlation with LAD, CCI, and yield per plant and negative with oil% and Protein% (shown in table (iii)). Also, LAD showed a positive correlation with CCI and yield per plant and negative with oil% and protein%. CCI Showed a positive correlation with yield per plant and negative with oil% and protein%, oil% and protein% showed a negative correlation with LAI, LAD, CCI, and seed yield per plant. Similar results were obtained by adetokunbo *et al*. (2019).

Table: iii Pearson Correlation Matrix

	LAI-30DAS	**LAI-45DAS**	**LAI-60DAS**	**LAD-1**	**LAD-2**	**CCI**	**OIL %**	**PROTEIN %**	**YIELD**
LAI30	1.000	0.549**	0.442**	0.234^{NS}	0.351*	0.319*	0.212^{NS}	-0.264^{NS}	0.325*
LAI45	0.549**	1.000	0.622**	0.373**	0.494**	0.349*	0.120^{NS}	-0.493**	0.528**
LAI60	0.442**	0.622**	1.000	0.645**	0.783**	0.602**	-0.064^{NS}	-0.776**	0.809**
LAD1	0.234^{NS}	0.373**	0.645**	1.000	0.905**	0.635**	-0.172^{NS}	-0.796**	0.762**
LAD2	0.351*	0.494**	0.783**	0.905**	1.000	0.710**	-0.134^{NS}	-0.878**	0.858**
CCI	0.319*	0.349*	0.602**	0.635**	0.710**	1.000	-0.150^{NS}	-0.616**	0.626**
OIL%	0.212^{NS}	0.120^{NS}	-0.064^{NS}	-0.172^{NS}	-0.134^{NS}	-0.150^{NS}	1.000	0.010^{NS}	-0.134^{NS}

PROTEIN%	-0.264^{NS}	-0.493**	-0.776**	-0.796**	-0.878**	-0.616**	0.010^{NS}	1.000	-0.913**
YIELD	0.325*	0.528**	0.809**	0.762**	0.858**	0.626**	-0.134^{NS}	-0.913**	1.000

Where, LAD-1 means LAD at 30-45 DAS and LAD-2 means 45-60 DAS

CONCLUSION:

The genotypes AGS 48 and AGS 76 were identified as prospective lines using principal component analysis. Based on correlation analysis, it is proposed that LAI, LAD, and CCI be given special attention to enhance seed yield. As a result, indirect selection based on these features will be particularly efficient in increasing seed production.

In conclusion, these lines should be exploited in future breeding projects to generate more versatile, trait-specific soybean varieties.

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