J. Farm Sci., 38(4): (457-459) 2025

RESEARCH PAPER

Evaluation of morpho-physiological traits and yield variation in soybean genotypes

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(Received: November, 2023 ; Accepted: November, 2025)

DOI: 10.61475/JFS.2025.v38i4.27

Abstract: A field study was conducted during *kharif*, 2022 at All India Coordinated Research Project on Soybean, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. Variation was observed in morpho-physiological traits for plant height, leaf area index (LAI), Spad chlorophyll meter reading (SCMR) and Yield. The highest plant height was recorded in DSb 40 and lowest was recorded in JS 335. DLSb 5 recorded the highest LAI, SCMR, number of pods per plant and yield. The highest seed yield in DLSb 5 can be attributed to highest LAI, SCMR and more number of pods per plant. The genotype DLSb 1 had lowest pods per plant which gave it a lower yield.

Key words: Morpho-physiological, Soybean, Traits, Variation, Yield

Introduction

Soybean (*Glycine max* (L.) Merrill) is a high value legume crop known for its rich protein (40%) and oil (20%) content, with a complete essential amino acid profile (Dugje *et al*., 2009). Native to East Asia, it's often called the "Miracle crop" and is vital for global food needs. Soybean is the fourth largest field crop globally, supplying over 60% of vegetable oil and protein. Per capita soybean consumption is expected to rise by 17% by 2029 (Anon., 2020), emphasizing the need for increased yields to sustain agriculture and meet demand. In the world, soybean is cultivated in 132.26 m ha area with 426.40 mt production and 2880 kg ha^{-1} productivity. Major producers include Brazil, USA, Argentina, China and India. In India 11.44 m ha area is under soybean cultivation with production and productivity of 12.04 m t and 1052 kg ha^{-1} respectively (Anon., 2022). Key states are Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, Karnataka and Gujarat. The area, production and productivity of soybean in Karnataka are 0.43 m ha, 0.44 m t and 1055 kg ha^{-1} respectively (Anon., 2023). The rapid expansion of soybean cultivation in India aims to address edible vegetable oil shortages. Soybean meal, a byproduct, has crucial uses in both domestic and international food industries. Soybean's exceptional nutritional value, adaptability and yield make it essential for global food security and sustainability (Varsha *et al*., 2020).

Soybean cultivars vary in their physiological and morphological traits which affect their growth and productivity. Productivity is determined by photosynthesis and the accumulation of nutrients in the seeds. The genetic response of a cultivar is influenced by its physiological functions, its adaptation to the environment and how it distributes nutrients. Despite efforts to improve soybean varieties, their yield remains relatively low. Many studies have focused on understanding soybean performance particularly the contribution of different yield components to overall yield (Das *et al*., 1992; Jain *et al*., 2002; Chettri, 2003; Mehta *et al*., 2006).

Material and methods

The present investigation was conducted during *kharif*, 2022. The experiment was conducted in All India Coordinated Research Project on Soybean, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, which is geographically located at 15°26'N latitude and 75°26'E longitude and at an altitude of 678 m above mean sea level (MSL). The experimental material comprised of ten soybean genotypes including three check varieties. Seven soybean genotypes were DSb 38, DSb 39, DSb 40, DLSb 1, DLSb 3, DLSb 4 and DLSb 5. Additionally, three check genotypes, namely DSb 23, DSb 34 and JS 335 were included in the study. The experiment was laid out in a randomized block design (RBD) with three replications. Morpho-physiological traits such as plant height, leaf area index (LAI), Spad chlorophyll meter reading (SCMR) and yield were measured at 30, 60 and 90 DAS.

Results and discussion

Throughout the growth stages, there was a significant difference in plant height among the soybean genotypes. Plant height increased rapidly up to 60 DAS and then remained stable (Table 1). The soybean genotypes DSb 40 (85.79 cm) and DSb 39 (77.11 cm) exhibited the highest plant height, while JS 335 (62.09 cm) and DLSb 4 (66.59 cm) exhibited the lowest plant height. The results of the present investigation are in agreement with earlier reports of a wide range of genetic variability in plant height (Akparobi, 2009). This suggests that the variation in plant height is likely due to the genetic makeup of the different genotypes used in the investigation.

Leaf area index (LAI) increased from 30 to 60 days after sowing (DAS), peaked during the reproductive stages and declined thereafter. Genotype DLSb 5 had the highest LAI (4.65) followed by DSb-39 (4.23) while DLSb 1 (3.42) and DSb 38 (3.49) had the lowest LAI (Table 2). These results suggest that LAI is a key trait for soybean productivity and the genotype selection may be an effective way to improve yield. There was a positive

Table 1. Mean performance of soybean genotypes for plant height and number of primary branches per plant during *kharif* 2022

Genotype	Plant height (cm)			Number of primary branches per plant
	30 DAS	60 DAS	90 DAS	At harvest
DSb 38	36.40^{ab}	69.27^{bc}	74.93^{b}	3.90^{cd}
DSb 39	35.30^{bc}	73.25^{b}	77.11^{b}	4.90^{ab}
DSb 40	38.90^{a}	80.12^{a}	85.79^{a}	5.10^{a}
DLSb 1	26.68^{fgh}	64.15^{cde}	69.14^{cd}	4.60^{ab}
DLSb 3	25.72^{gh}	68.62^{bc}	73.52^{bc}	4.40^{bc}
DLSb 4	24.11^{h}	60.12^{ef}	66.59^{de}	3.60^{d}
DLSb 5	32.80^{cd}	67.32^{cd}	73.34^{bc}	4.40^{bc}
DSb 34 (C)	31.23^{de}	62.45^{de}	66.87^{d}	4.00^{cd}
DSb 23 (C)	28.73^{ef}	68.58^{bc}	73.19^{bc}	4.60^{ab}
JS 335 (C)	27.32^{fg}	56.52^{f}	62.09^{e}	3.80^{d}
Mean	30.72	67.04	72.26	4.33
S.Em±	0.94	1.82	1.53	0.17
C.D (P=0.05)	2.79	5.42	4.56	0.52

Table 2. Mean performance of soybean genotypes for Leaf area Index at 30, 60, 90 days after sowing (DAS)

Genotype	Leaf Area Index		
	30 DAS	60 DAS	90 DAS
DSb 38	1.87^{e}	3.49^{e}	2.70^{f}
DSb 39	1.94^{cde}	4.23^{b}	3.73^{a}
DSb 40	2.52^{a}	3.69^{de}	2.67^{f}
DLSb 1	1.66^{f}	3.42^{e}	2.92^{e}
DLSb 3	2.13^{bc}	3.87^{cd}	2.90^{e}
DLSb 4	1.93^{de}	3.54^{e}	3.01^{de}
DLSb 5	2.48^{a}	4.65^{a}	3.28^{c}
DSb 34 (C)	2.11^{bcd}	4.09^{bc}	3.13^{cd}
DSb 23 (C)	1.84^{ef}	3.54^{e}	2.96^{de}
JS 335 (C)	2.19^{b}	4.20^{b}	3.53^{b}
Mean	2.06	3.87	3.08
S.Em±	0.06	0.09	0.06
C.D (P=0.05)	0.20	0.29	0.18

Table 3. Mean performance of soybean genotypes for SCMR at 30, 60, 90 days after sowing (DAS)

Genotype	SCMR Values		
	30DAS	60DAS	90DAS
DSb 38	30.07^{e}	40.01^{cd}	36.45^{cd}
DSb 39	31.21^{de}	45.59^{ab}	44.17^{a}
DSb 40	34.71^{c}	43.69^{a-d}	20.00^{e}
DLSb 1	28.79^{ef}	39.45^{d}	42.35^{ab}
DLSb 3	32.82^{cd}	47.07^{ab}	41.87^{abc}
DLSb 4	26.93^{f}	42.55^{bcd}	38.49^{bcd}
DLSb 5	41.67^{a}	48.96^{a}	38.07^{bcd}
DSb 34 (C)	38.33^{b}	45.33^{abc}	33.67^{d}
DSb 23 (C)	37.53^{b}	44.44^{a-d}	46.71^{a}
JS 335 (C)	33.06^{cd}	44.74^{a-d}	42.61^{ab}
Mean	33.51	44.18	38.43
S.Em±	0.81	1.81	1.86
C.D (P=0.05)	2.42	5.40	5.54

correlation between LAI and seed yield (Tijani *et al*., 2000). The decrease in LAI towards maturity is due to a lesser number of leaves caused by the senescence of older leaves. At 90 DAS, DSb 40 had minimum LAI as it reached senescence stage earlier.

Significantly different SCMR values were observed throughout the growth period among the soybean genotypes.

Table 4. Mean performance of soybean genotypes for pods plant^{-1} and yield

Genotype	Pods Plant^{-1}	Yield (q ha^{-1})
DSb 38	47.07^{cd}	22.08^{de}
DSb 39	47.93^{bcd}	26.69^{a-d}
DSb 40	55.20^{abc}	27.68^{abc}
DLSb 1	44.07^{d}	18.83^{e}
DLSb 3	55.33^{abc}	28.68^{abc}
DLSb 4	45.47^{d}	23.76^{cde}
DLSb 5	63.20^{a}	31.21^{a}
DSb 34 (C)	57.27^{ab}	29.34^{ab}
DSb 23 (C)	52.40^{bcd}	26.78^{a-d}
JS 335 (C)	51.67^{bcd}	25.12^{bcd}
Mean	51.96	26.01
S.Em±	3.14	1.68
C.D P=(0.05)	9.35	4.99

The SCMR values decreased from 60 DAS to maturity in all genotypes (Table 3). The maximum SCMR value was recorded at 60 DAS in genotype DLSb 5 (48.96), while the minimum was recorded in DLSb 1 (39.45). At 90 DAS, the variety DSb 40 showed the minimum SCMR value as it reached the senescence stage earlier than the other varieties. Chlorophyll content varies with the nitrogen content in plants, as nitrogen is an essential element in chlorophyll formation (Ghosh *et al*., 2000). Genotypes with higher SCMR values tend to have higher yields and seed quality.

The data on number of pods per plant is presented in Table 4, reveals a variation among soybean genotypes. Notably, the genotype DLSb 5 recorded the highest number of pods per plant (63.20), while the lowest count was observed in genotype DLSb 1 (44.07) which was on par with DLSb 4 (45.47). The number of pods per plant is a major contributor to grain yield. Oz *et al*. (2009) observed significant positive correlation between seed yield and the number of pods per plant.

The data on seed yield of the soybean genotypes is presented in Table 4. It has shown that the seed yield among the genotypes varied significantly. The highest seed yield was recorded by the genotype DLSb 5 (31.21 q ha^{-1}) followed by DSb 34 (29.34 q ha^{-1}) and the lowest seed yield was obtained from the genotype DLSb 1 (18.83 q ha^{-1}). The highest seed yield in DLSb 5 can be attributed to highest LAI, SCMR, more number of pods per plant and number of seeds per pod. The genotype DLSb 1 had lowest pods per plant and seeds per pod, which gave it a lower yield. This is because pods per plant and seeds per pod are positively correlated with yield.

Conclusion

In India the studies on soybean has not gained much importance. The present study was intended to understand the performance of the soybean genotypes with respect to their morphological, physiological and the relationship among these traits as well as their relationship with yield and quality aspects. The present study revealed that the genotype DLSb 5 was found best with respect to yield but their seed quality is moderate. The genotypes DSb 40 and DLSb 4 were found to have good quality but yielding ability is moderate. Hence, these genotypes could be used for further developing genotypes with high yield and better quality traits.

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