**Genetic Variability for Morpho-Physiological Characters in Soybean [*Glycine max* *(L.) Merrill]***

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**ABSTRACT**

In an experiment, fifteen soybean genotypes were evaluated in Randomized Block Design with three replications, to access the genetic variability for yield and its contributing traits during *kharif* 2021 at the research field of Department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MH). The results revealed that, KDS-753 (81.42 cm) recorded highest plant height; leaf area (34.01 dm2) was observed highest in KDS-228. The Chlorophyll stability index (39.12) and RGR (0.0135 g/g/day) were recorded highest in KDS-344 (39.12); while 50% flowering (49.00 DAS) and dry matter production (37.67g) was recorded highest in MAUS-162(49.00 DAS). Days to maturity was recorded highest in AMS-2014-1 (105.33 DAS). Net assimilation rate was recorded highest in MACS-1281 (0.0135g/dm2/day). Least range of GCV and PCV observed for days to maturity (3.443% and 3.962% respectively); while high range of GCV and PCV observed for RGR (37.579% and 45.571% respectively). High range for heritability observed in total dry matter (79.545 %). Genetic advance as a *percent* mean observed higher in total dry matter production (74.481). In the present study the traits, total dry matter and plant height showed high heritability with high genetic advance indicating direct selection for such traits is rewarding in crop improvement.

***key words****:**Soybean, Genetic Variability, Morpho - Physiological Character, Heritability, GAM*

**1. INTRODUCTION**

 The soybean *(Glycine max (L.) Merrill.),* a significant oil-producing crop with global adaptability, is a member of the Fabaceae or Leguminosae family and the subfamily Papilionaceae. In 2021–2022, India produced 13.12 million tons of soybean on 12.18 million hectares of land, yielding 1077 kg of productivity per hectare (*Annon. a* 2021-22*)*. Regretfully, India's soybean productivity (1125 kg ha-1) has not increased significantly in comparison to the global productivity (2148 kg/ha) (*Annon. b* 2020-2029). The absence of a location-specific cultivar in a given area is one of the main obstacles to soybean production. Many variations, including dwarf, medium, and tall types as well as short- and long-day variants, were gathered from various sites in order to determine these genotypes *(Gupta S. K. 2017).* Against the backdrop of information on plant height, leaf area, 50% flowering, dry matter, and their capacity to procreate, the current study was conducted. The foundation of a crop development program is the crop's inherent variability. Variability in crop attributes is classified into two types: genetic and non-genetic. The genetic components of variability that are heritable play the most critical function in plant breeding programs *(Falconer, D.S. 2019)*. The magnitude of crop variation for the yield components, as well as the degree to which this variation is genetically derived and passed on to offspring, can all be understood through organized research that enable the exploitation of variability *(Kumar, V.* 2019). Appropriate genetic metrics, such as genetic coefficient of variation, heritability estimates, and genetic advancements, can be used to quantify variability.

**2. MATERIAL AND METHOD**

A field trial with fifteen different genotypes along with untreated control were carried out in Randomized Block Design with three replications, during *kharif* 2021 at experimental and research field of Department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MH.) for the evaluation of Genetic Variability for morpho-physiological parameters in soybean. The genotypes were sown in a plot size 0.90 x 2.80 m2 with plant spacing 45 x 10 cm. The treatments are illustrated in (Table 1) in order to evaluate genetic variability of different genotypes for various morpho - physiological parameters.

**Table 1. Treatment details**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sr. No** | **Treat.** | **Name of Variety/ genotype** | **Developed by** | **Year** | **Special Character** |
|
| 1 | V1 | AMS-1001(PDKV Yellow gold) | Dr. PDKV Akola | 2018 | Moderately tolerant to stem fly, girdle beetle, resistant to charcoal rot and yellow mosaic virus. *(Annon. c)* |
|
| 2 | V2 | AMS- MB-5-18 (PDKV Suvarna soya) | Dr. PDKV Akola | 2019 | Resistant to charcoal rot, girdle beetle and stem fly. *(Annon. c)* |
|
| 3 | V3 | AMS-100-39(PDKV Amba) | Dr. PDKV Akola | 2021 | Moderately tolerant to root/stem rot, girdle beetle and stem fly. *(Annon. c)* |
|
| 4 | V4 | AMS-2014-1(PDKV Purva) | Dr. PDKV Akola | 2020 | Resistant to major diseases *viz.* root rot and yellow mosaic virus and pest *viz.* Stem fly and girdle beetle. *(Annon. c)* |
|
| 5 | V5 | JS-97-52 | Dr. PDKV Akola | 2008 | Resistant to yellow mosaic virus, root rot, charcoal rot, tolerant to stem fly and girdle beetle. *(Annon. c)* |
| 6 | V6 | NRC-86 | IISR Indore | 2015 | Tolerant to girdle beetle and stem fly*(Annon. d)* |
| 7 | V7 | MAUS-162 | VNMKV Parbhani | 2014 | Tolerant to major pest and diseases. *(Annon. e)* |
| 8 | V8 | MAUS-612 | VNMKV Parbhani | 2016 | Tolerant to pod shattering, tolerant to major pest, diseases and moisture stress. *(Annon. e)* |
| 9 | V9 | KDS-726(Phule Sangam) | MPKV Rahuri | 2016 | Resistant to rust, moderately resistant to charcoal rot *(Annon. f)* |
|
| 10 | V10 | KDS-344(Phule Agrani) | MPKV Rahuri | 2015 | Tolerant to rust disease *(Annon. f)* |
|
| 11 | V11 | KDS-753(Phule Kimaya) | MPKV Rahuri | 2017 | Rust resistant *(Annon. f)* |
|
| 12 | V12 | KDS-228(Phule Kalyani) | MPKV Rahuri | 2006 | Moderately resistant to charcoal rot and rust *(Annon. f)* |
|
| 13 | V13 | KDS-992 | MPKV Rahuri | 2021 | Tolerant to water logging, major pest and diseases *(Annon. f)* |
| 14 | V14 | MACS-1188 | Agarkar Research Institute, Pune | 2013 | Tolerant to bacterial leaf blight, charcoal rot and stem fly *(Annon. g)* |
| 15 | V15 | MACS-1281 | Agarkar Research Institute, Pune | 2016 | Resistant to pod shattering and tolerant to drought *(Annon. g)* |

**3. RESULTS AND DISCUSSION**

 A wide range of variability was observed for most of the characters. The estimates of phenotypic coefficients of variation were higher than that of genotypic coefficients of variation for all characters under study. The high magnitude of GCV value for morphological and physiological traits was observed for RGR (37.579%), Total Dry Matter (36.238%), NAR (21.575%). Moderate range of GCV observed for Plant Height (12.862%) and Leaf Area (12.593%). Least range of GCV observed for days to maturity (3.443%). The high magnitude of PCV value for morphological and physiological traits was observed for RGR (45.571%), Total Dry Matter (36.321%), NAR (30.565%). Moderate range of PCV observed for Leaf Area (15.615%) and Plant Height (14.459%). Least range of PCV observed for days to maturity (3.962%). The high magnitude of heritability was observed in Total Dry Matter (79.545%) and Plant Height (79.13%); while least range observed in NAR (49.82%). The high magnitude for genetic advances observed for plant height (15.85) and DM production (15.68). Least range for genetic advances observed for NAR (0.003) and RGR (0.006). The high magnitude for genetic advance (GA) for *per cent* mean was observed for DM production (74.48%) and RGR (63.83%); while Least range observed for days to maturity (6.16%).

* 1. **Analysis of Variance**

 It was performed as per the methodology suggested by Panse and Sukhatme (1954).

The statistical model used for the design will be:

 Yijk = µ + Vij + Bk + eijk

Where,

 YijK= Performance of ijth treatment in kth block, µ = general mean, Vij= the effect of the ijth treatment

 Bk= block effect, eijk = the environmental effect.

**Table 2.** Analysis of Variance

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sources of variation** | **df** | **Plant height (cm)** | **Leaf area****(dm2)** | **Chlorophyll stability index** | **50% flowering** | **Days to maturity** | **Dry matter****(g)** | **RGR****(g/g/day)** | **NAR****(g/dm2/day)** |
| Replications | 2 | 9.885 | 7.721 | 1.345 | 0.1556 | 5.089 | 0.555 | 7.419 | 1.111 |
| Treatments | 14 | 244.231\* | 44.331\* | 6.924\* | 29.460\* | 39.213\* | 47.329\* | 3.845\* | 1.749\* |
| Error | 28 | 19.739 | 6.700 | 1.784 | 1.060 | 3.827 | 0.183 | 5.214 | 4.406 |

* 1. **Range**

In present study of all fifteen (15) genotypes showed significant variability among six (6) traits, variability in range has observed, plant height ranged from KDS-753 (81.42 cm) to MAUS-162 (53.58 cm), leaf area ranged from JS-97-52 (21.83 dm2) to KDS-228 (34.01 dm2), dry matter ranged from KDS-228 (10.1 g) to MAUS-162 (34.67 g), relative growth rate ranged from AMS-2014 (0.0039 g/g/day) to KDS-228 (0.0154 g/g/day), net assimilation rate ranged from JS-97-52, NRC-86 (0.0061 g/dm2/day) to MACS-1281 (0.0135 g/dm2/day) days to maturity ranged from KDS-344 (93.67 DAS) to AMS-2014-1 (105.33 DAS), Similar findings confirmed with Hossain *et al.* (2004), Krisnawati and Adie (2019), Sahoo, S. K. *et al.* (2025) reported high range of variability.

* 1. **Genotypic and Phenotypic coefficient of variation**

 In the present investigation the phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the characters has been reported by Bangar *et al*. (2003), Sureshrao *et al*. (2014), Jandong *et al*. (2020)

 The high magnitude of GCV, PCV value for physiological traits was observed for relative growth rate, dry matter production, relative growth rate, net assimilation rate. Similar findings were reported by Datt *et al*. (2011), Kumar *et al.* (2007)

 Least range of GCV and PCV observed for days to maturity. Similar findings were reported by Verma (2019), Neelima *et al*. (2018).

**3.4 Heritability and Genetic advance**

 In selection programme the success depends primarily upon the magnitude of heritable variability. The high magnitude for genetic advances observed for plant height (15.85), dry matter production (15.68). This results also reported by Hossain *et al.* (2004), Sureshrao *et al.* (2014), Koraddi and Basavaraja (2019).

 The high magnitude for genetic advance for percent mean observed for dry matter production (74.48%), relative growth rate (63.83%), plant height (23.45%), Similar findings were reported by Sureshrao *et al.* (2014), Koraddi and Basavaraja (2019).

 High heritability and high genetic advance in percent of mean of these traits showed that these traits were under the control of additive gene and selection or the improvement of these traits could be effective.

**Table 3. Range, Mean and Estimate of Genetic Parameters**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **Characters** | **Range** | **Mean** | **GCV%** | **PCV%** | **h2 (BS)** | **Genetic Advance** | **GAM** |
| 1 | Plant Height | 53.58 - 81.42 | 67.255 | 12.862 | 14.459 | 79.13 | 15.851 | 23.57 |
| 2 | Leaf Area | 21.83 - 34.01 | 28.12 | 12.593 | 15.615 | 65.03 | 5.883 | 20.92 |
| 3 | Total Dry Matter | 10.1- 34.67 | 26.98 | 36.238 | 36.321 | 79.545 | 15.684 | 74.481 |
| 4 | RGR | 0.0039 - 0.0154 | 0.00886 | 37.579 | 45.571 | 67.99 | 0.006 | 63.83 |
| 5 | NAR | 0.0061 - 0.0135 | 0.0097 | 21.575 | 30.565 | 49.82 | 0.003 | 31.37 |
| 6 | Days to Maturity | 93.67 - 105.33 | 99.7556 | 3.443 | 3.962 | 75.50 | 6.148 | 6.163 |

**4. CONCLUSION**

 The analysis of variance found significant for all the characters. Highest value of GCV (37.579%) and PCV (45.571%) observed in RGR. High heritability (h2) (79.545%) found in total dry matter. Genetic advance (15.851%) found highest in plant height. Genetic advance as percent mean (74.481%) found highest in total dry matter. High heritability coupled with low genetic advance as *percent* mean was observed in days to maturity indicates influence of non-additive effects in expression of such character. The investigated work may be recommended for continued use in breeding programs based on the findings from mean value, genotypic coefficient of variation, phenotypic coefficient of variation, heritability, and genetic advancement. During crop improvement, the genotypes with strong genetic progress and high heritability for the majority of essential traits will be used for direct selection of those traits.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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