**Assessment of Soybean (Glycine max L.) Genotypes on the Basis of Biochemical Parameters**

**Abstract**

Soybean (Glycine max L.) is a vital legume crop known for its high protein and oil content. With growing global demand for nutritionally superior and climate-resilient cultivars, the present investigation was undertaken to evaluate different biochemical parameters in soybean genotypes. A total of 92 genotypes were evaluated for five biochemical parameters including total chlorophyll, protein, phenol, moisture and total sugar contents employing standard protocols. Significant genotypic variation was evident for all parameters, highlighting the presence of biochemical diversity within the genotypes. Total chlorophyll content ranged from 41.78 to 54.75 mg/ml, protein from 34.05% to 42.05%, phenol in between 1.02 to 2.58 mg/g, moisture from 3.2% to 5.9%, while total sugar arrayed between 3.05 to 5.98 mg/g. Genotypes such as RVS23-11, NRC253, RVSM2011-35, NRC259 and DLSB40 were recognized as superior on the basis of different biochemical parameters. These biochemical attributes are closely associated with photosynthetic efficiency, nutritional value, stress tolerance and seed storability. The study provides a scientific basis for the selection of elite genotypes for breeding programmes focused on bio-fortification and climate resilience. Future research should emphasize the genetic dissection of these traits through molecular tools and multi-environmental testing to ensure their stability and adaptability under diverse agro-climatic conditions.

**Keywords:** Chlorophyll content, Moisture content, Nutritional quality, Phenol content, Protein content, Soybean (*Glycine max* [L.] Merill), Total sugar

**1. Introduction**

Soybean (Glycine max L. Merrill) is a globally important leguminous crop valued for its high-quality protein, edible oil and diverse industrial and nutritional applications (Mishra et al., 2020; Mishra et al., 2024a). It contains approximately 40% high-quality protein and 20% oil, making it a valuable source of essential amino acids and unsaturated fatty acids, especially linoleic and linolenic acids (Liu, 2016; Mishra et al., 2021a; Mishra et al., 2025a). It is rich in bioactive compounds such as isoflavones, tocopherols, lecithin and phytosterols, which contribute to its health-promoting properties, including cholesterol-lowering, anti-inflammatory and antioxidant effects (Mishra et al., 2021b; Rahman et al., 2024; Mishra et al., 2024b). In addition to being a complete plant-based protein source, it is also a good source of dietary fibre, vitamins like folate, vitamin B1, and vitamin K, and minerals such as calcium, iron, phosphorus and magnesium (Mishra et al., 2021c; Walther et al., 2022). It’s regular inclusion in human diets has been associated with reduced risks of cardiovascular disease, type-2 diabetes and hormone-related cancers (Mishra et al., 2021d; Alahmari, 2024). Due to these nutritional attributes, soybean plays a crucial role in addressing protein-energy malnutrition, especially in vegetarian and low-income populations (Mishra et al., 2021e; Qin et al., 2022). As a multifunctional crop, it contributes significantly to human nutrition, animal feed and soil enrichment through nitrogen fixation (Upadhyay et al., 2020; Sharma et al., 2021; Tripathi et al., 2023; Rajput et al., 2024). With the rising global demand for plant-based proteins and sustainable agricultural practices, enhancing the nutritional profile and adaptability of soybean has become a priority in modern crop improvement programmes (Islam et al., 2022). In India, soybean is predominantly cultivated during the *Kharif* season and has emerged as a leading oilseed crop in central and western agro-climatic zones (Asewar et al., 2022). However, its productivity and quality traits are influenced by both genetic makeup and environmental conditions, including an array of biotic and abiotic stresses aggravated by climate variability (Salgotra & Chauhan, 2023; Mishra et al., 2024c).

Biochemical parameters such as protein content, total sugars, phenolic compounds, chlorophyll content and moisture content are essential indicators of nutritional quality, seed storability, physiological performance and stress resilience in soybean (Silva et al., 2023; Mishra et al., 2025b). These traits are under complex genetic control and show considerable genotypic variation, which can be exploited for breeding programmes targeting nutritional enhancement and climate resilience (Shyam et al., 2019; Rajput et al., 2023; Paliwal et al., 2024; Mishra et al., 2024b; Mishra et al., 2024d). For instance, chlorophyll content directly influences photosynthetic efficiency and biomass production, while phenolic compounds play vital roles in plant defence mechanisms (Dehghani et al., 2022; Li et al., 2024). While protein and sugar content determine the seed’s nutritional and commercial value, and moisture levels influence post-harvest management and storage potential (Ibanez et al., 2020; Bellaloui et al., 2015; Tiwari et al., 2023a; Yadav et al., 2023; Corbineau, 2024).

Despite significant advancements in soybean breeding, there remains a vital need to explore and understand the biochemical diversity within available germplasm to enhance nutritional quality and stress resilience (Vargas-Almendra et al., 2024; Duan et al., 2025). Comprehensive evaluation of key biochemical traits such as protein, chlorophyll, phenol, moisture and sugar content is essential to identify superior genotypes with enhanced functional and adaptive potential. This investigation was undertaken to address this gap by assessing the biochemical variability among soybean genotypes, providing crucial insights that can guide breeding strategies. The identification of promising genotypes with desirable biochemical profiles is fundamental for the development of improved soybean cultivars through biofortification, marker-assisted selection and breeding for climate adaptability, ultimately contributing to sustainable agricultural productivity and food security.

**2. Material & Methods**

**2.1 Experimental material and site**

The present study was conducted during the *Kharif* season of 2023 at the experimental research farm of the Department of Genetics and Plant Breeding, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior, Madhya Pradesh, India.

**2.2 Experimental details**

A total of 92 soybean genotypes were selected as experimental material and acquired from RAK College of Agriculture, Sehore, RVSKVV, Gwalior, Madhya Pradesh, India. The experiment was laid out in a Randomized Block Design (RBD) with two replications. Each plot consisted of three rows, with a row-to-row distance of 30 cm and plant-to-plant spacing of 10 cm. The plot size was maintained at 3.0 m × 1.20 m. Five competitive plants were chosen arbitrarily from each genotype and replication and subjected to biochemical analysis. Biochemical analysis was accomplished at Biochemical Analysis Laboratory, Department of Plant Molecular Biology & Biotechnology, College of Agriculture, RVSKVV, Gwalior, M. P., India.

**2.3 Biochemical analysis**

Biochemical estimations were performed to evaluate total phenol, protein, total chlorophyll, moisture and total sugar contents across all genotypes.

Total chlorophyll content was measured using the Arnon (1949) acetone extraction method. Fresh leaf samples (250 mg) were ground in 5 ml of 80% acetone, filtered through Whatman No. 1 filter paper, and the volume was made up to 25 ml. Absorbance readings were recorded at 645 nm and 663 nm in spectrophotometer. The concentrations of chlorophyll a, chlorophyll b, and total chlorophyll were calculated using standard equations incorporating the absorbance values, sample weight, and volume of extract. The amount of chlorophyll ‘a’, ’b’ and total are determined using the following formulas as proposed by Arnon (1949) who provided the values of extraction coefficients.

Chlorophyll ‘a’ = [(12.7 X A 663)– (2.69 X A 645)] X V/1000 X w (mgg-1fw)

chlorophyll ‘b’ = [(22.9 X A 645)–( 4.68 X A 663)] X V/ 1000X w ( mgg-1fw)

Total chlorophyll (a+b) = [(20.2 X A 645) + (8.02 X A 663)] X V /1000X w (mgg-1fw)

Where,

A663 = Absorbance values at 663 nm

A645 = Absorbance values at 645 nm

W = Weight of the sample in mg

V = Volume of the solvent used (ml)

Protein content was estimated following the method of Lowry et al. (1951). For this purpose, 25 mg of seed sample was homogenized in 400 µl of 20% trichloroacetic acid and centrifuged at 10,000 rpm for 15 minutes. The supernatant was collected, and 200 µl of 0.1 N NaOH was added, followed by a second centrifugation. Then, 400 µl of supernatant was mixed with reagent C and incubated in the dark for 10 minutes. Subsequently, 0.5 ml of Folin-Ciocalteu reagent was added, and the mixture was kept for 30 minutes before measuring absorbance at 660 nm.

Phenol content was estimated using the method of Swain and Hillis (1959). One gram of oven-dried and powdered seed sample was extracted in 20 ml of 80% ethanol and centrifuged at 10,000 rpm for 15 minutes. One ml of supernatant was mixed with 1.0 ml of Folin’s reagent and 2.0 ml of sodium carbonate, and the volume was made up to 50 ml with distilled water. The intensity of the blue complex was recorded at 650 nm. A standard curve prepared using gallic acid was used to calculate phenol content (mg/g).

The moisture content was estimated by employing the hot air oven method. The initial weight of the seeds was recorded after tagging. Then the sample seeds were put inside the hot air oven for 4-5 hours at 110-120 °C. Once the constant weight was reached the samples were taken out and their weights were again recorded. The moisture content percentage was then calculated by the differences between the initial weight and final weight after drying by using following formulae:

Moisture Content (%) = Initial weight (g) – Final weight (g) X 100

 Initial weight (g)

Total sugar was calculated as per method prearranged by Dubois *et al.* (1956). Total sugar content was determined by crushing 25 mg of seed sample in 1.0 ml of 80% ethanol. The extract was centrifuged at 10,000 rpm for 10 minutes, and the supernatant was dried at 65°C. After redissolving the residue in 1.0 ml of distilled water, the sample was heated at 100°C for 30 minutes, cooled to room temperature, and absorbance was recorded spectrophotometrically.

Experiment was laid out in completely randomized design with two replications. The data were analysed as per method recommended by Snedecor and Cochran (1997).

**3. Results & Discussion**

In the present investigation, five key biochemical parameters *viz*., total chlorophyll content (mg/ml), protein content (%), phenol content (mg/g), moisture content (%) and total sugar content (%) were estimated in ninety-two soybean genotypes and presented in Table 1. Substantial genotypic variability was observed across all parameters, indicating presence of a broad spectrum of biochemical diversity among the tested genotypes.

**3.1 Total Chlorophyll Content (mg/ml)**

Total chlorophyll content exhibited significant variation among the genotypes, arrayed between 41.78 to 54.75 mg/ml, with considerable differences in pigment accumulation. The highest chlorophyll content was recorded in genotypes RVS 23-11 (54.75 mg/ml), followed by NRC84 (53.87 mg/ml), KDS1203 (53.18 mg/ml), KSS 213 (53.18 mg/ml) and NRC 259 (53.25 mg/ml) each exceeding 53.0 mg/ml. In contrast, the lowest chlorophyll content was evident in genotype NRCSL5 (41.78 mg/ml), along with RVS2001-4 (41.87 mg/ml), NRCSL7 (42.05 mg/ml), RVSM 2011-35 (42.04 mg/ml), and RVS 76 (43.01 mg/ml).

Total chlorophyll content, a critical indicator of photosynthetic capacity and plant vigour, varied significantly among the genotypes (Kim et al., 2022). Similar studies have also been conducted by Silva-Perez et al. (2020) and Sharma et al. (2021). The higher chlorophyll content observed in genotypes such as RVS 23-11, NRC 84, and KDS 1203 suggested that genotype have superior photosynthetic efficiency and potential adaptability under optimal and stress conditions (Hossain et al., 2024; Narayana et al., 2024). These findings are in agreement with earlier reports suggesting a positive correlation between chlorophyll content and biomass productivity under both normal and stress environments (Kubar et al., 2021; Acebron et al., 2023; Hossain et al., 2024). The genotypes with lower chlorophyll values may be less efficient in light utilization, thereby impacting overall plant performance (Slattery et al., 2017; Wang et al., 2022).

**3.2 Protein Content (%)**

Protein content ranged between 34.05% to 42.05%, with a mean value of 38.40%, highlighting significant genotypic differences in protein accumulation. The maximum protein content was found in genotypes NRC253 (42.05%), tracked by TS-208 (41.95%), VLS 104 (41.82%), NRC 257 (41.56%) and AMS2021-3 (41.54%) all beyond 41.5%. Conversely, the minimum protein content was investigated in genotypes Pusa Sipani SPS-433 (34.05%), tracked by VLS105 (34.15%), Asb 85 (34.37%), NRCSL 7 (35.28%) and JS 20-69 (35.70%).

Protein content, a major nutritional trait in soybean, also exhibited substantial variation. Genotypes such as NRC253 and TS-208 demonstrated high protein levels, making them potential candidates for protein enrichment in soybean breeding programmes. The wide range of protein content aligns with previous studies conducted by Wei et al. (2021), Aulia et al. (2023) and Mishra et al.(2025b) who also reported similar levels of genotypic variation in soybean cultivars.

**3.3 Phenol Content (mg/g)**

Phenol content displayed substantial genotypic variability, ranging from 1.02 to 2.58 mg/g. The highest phenol accumulation was recorded in genotypes RVSM2011-35 (2.58 mg/g), closely followed by RVSM12-21 (2.57 mg/g), NRC-196 (2.40 mg/g), BAUS124 (2.31 mg/g) and RSC1165 (2.29 mg/g). On the other hand, genotypes NRCSL-8 (1.02 mg/g) demonstrated the lowest phenol content, tracked by SL1311 (1.08 mg/g), TS-156 (1.14 mg/g), NRC257 (1.25 mg/g) and JS 24-26 (1.37 mg/g).

 The phenol content is directly associated with the plant’s antioxidant capacity and defence mechanisms (Kumar et al., 2023). Genotypes such as RVSM 2011-35 and RVSM12-21 showed high phenolic concentrations, indicating potential resistance against different biotic and abiotic stressors, as phenolic compounds are known to scavenge reactive oxygen species and contribute to pathogen resistance (Krol-Grzymala & Amarowicz, 2020; Mughal et al., 2024). Hence, these genotypes may be proved valuable in developing cultivars with enhanced functional food properties and stress tolerance.

**3.4 Moisture Content (%)**

Moisture content also exhibited significant variation across genotypes, ranging from 3.2% to 5.9%. The highest moisture content was observed in genotypes NRC259 (5.9%), tracked by NRC-196, DS1510 and JS 24-26 (5.8%), along with a cluster of genotypes including RVS23-11, RVS 12-8, NRCSL-4 and VLS 105 (5.7%). While the lowest moisture levels were found in genotypes DLSB40 and JS20-98 (3.2%), chased by genotypes RVSM 2011-35 (3.4%), RVS 23-10 and RVS 23-13 (3.5%).

 Moisture content is a main determinant of seed storability and post-harvest longevity. High-moisture containing genotypes such as NRC259 and NRC-196 may require specific storage conditions to prevent spoilage, while low-moisture genotypes like DLSB 40 and RVSM 2011-35 may have better storability and are suitable for dryland conditions. The significant variation observed here suggests the importance of considering this parameter in seed handling and distribution systems (Rao et al., 2023; Ramteke et al., 2022; Mishra et al., 2025b).

**3.5 Total Sugar Content (mg/g)**

Total sugar content varied extensively among the genotypes, with values ranging from 3.05 to 5.98 mg/g with a mean worth of 4.42 mg/g. The highest sugar content was recorded in genotypes DLSB 40 (5.98 mg/g), tracked by NRCSL-8 (5.80 mg/g), RVS12-8 (5.72 mg/g), MACS1756 (5.54 mg/g), and Himso1695 (5.42 mg/g). In contrast, the lowest sugar concentrations were evident in genotypes NRC257 (3.05 mg/g), JS335 (3.10 mg/g), JS93-05 (3.15 mg/g), RVS 2001-4 (3.18 mg/g), and JS20-29 (3.18 mg/g).

Total sugar content, which contributes to seed palatability and energy reserves during germination, also demonstrated remarkable variation. Genotypes with high sugar levels, for instance DLSB40 and NRCSL-8, may possess better consumer acceptability and vigour in early seedling stages. On the other hand, low-sugar containing genotypes may be useful where reduced sugar levels are desired for dietary formulations or breeding for low-glycaemic index crops (Jha, 2021; Sharma et al., 2021; Ashoknarayan et al., 2025).

The observed variability in the biochemical parameters among the 92 soybean genotypes indicates existence of a considerable degree of genotypic diversity, which can be effectively utilized for breeding programmes aimed to enhance nutritional quality and stress resilience. Overall, the differential expression of these biochemical parameters across genotypes suggests that targeted selection and multi-trait integration can lead to the development of nutritionally rich, stress-resilient soybean cultivars (Sharma et al., 2023; Mishra et al., 2024b; Mishra et al., 2025b). The identification of elite genotypes with desirable biochemical profiles provides a foundation for marker-assisted selection, genomic-assisted breeding, and bio-fortification strategies (Tiwari et al., 2023b; Yadav et al., 2024a; Mangal et al., 2024). Future studies should focus on multi-environment evaluations and molecular dissection of these traits to better understand their genetic regulation and stability under varying agro-climatic conditions (Rasheed et al., 2022; Asati et al., 2023; Tayade et al., 2023; Abebe et al., 2024; Mishra et al., 2024e; Yadav et al., 2024b).

**Conclusion**

The present investigation revealed significant genotypic variability in important biochemical traits including total chlorophyll, protein, phenol, moisture, and total sugar contents across 92 soybean genotypes. This variation underscores the presence of substantial biochemical diversity within the evaluated genotypes, offering valuable insights for soybean improvement programmes. Genotypes such as RVS 23-11, NRC 253, RVSM 2011-35, NRC 259, and DLSB 40 emerged as superior performers for respective biochemical parameters and may serve as promising candidates for targeted breeding initiatives meant to enhance photosynthetic efficiency, nutritional quality, antioxidant potential, seed storability, and palatability. The observed variability is of particular significance in the context of climate change and increasing biotic and abiotic stress pressures, as traits like higher phenol and chlorophyll content are associated with improved plant resilience. These findings provide a foundation for advanced genetic analyses, including quantitative trait loci (QTL) mapping and marker-assisted selection (MAS), which can accelerate the development of nutritionally enhanced and stress-resilient soybean cultivars. Future research should focus on multi-location trials and the integration of molecular tools to validate the stability and heritability of these traits under diverse agro-climatic conditions.

**Disclaimer (Artificial Intelligence)**

Author(s) hereby declares 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.

**References**

1. Abebe, A. T., Adewumi, A. S., Adebayo, M. A., Shaahu, A., Mushoriwa, H., Alabi, T., Derera, J., Agbona, A., & Chigeza, G. (2024). Genotype x environment interaction and yield stability of soybean (*Glycine max* l.) genotypes in multi-environment trials (METs) in Nigeria. *Heliyon*, 10(19), e38097. <https://doi.org/10.1016/j.heliyon.2024.e38097>
2. Acebron, K., Salvatori, N., Alberti, G., Muller, O., Peressotti, A., Rascher, U., & Matsubara, S. (2023). Elucidating the photosynthetic responses in chlorophyll-deficient soybean (*Glycine max*, L.) leaf. *Journal of Photochemistry and Photobiology*, *13*, 100152. <https://doi.org/10.1016/j.jpap.2022.100152>
3. Alahmari, L. A. (2024). Dietary fiber influence on overall health, with an emphasis on CVD, diabetes, obesity, colon cancer, and inflammation. *Frontiers in Nutrition*, *11*. <https://doi.org/10.3389/fnut.2024.1510564>
4. Arnon, I. (1972). Crop production in dry regions. Leonard Hill, London.
5. Asati, R., Tripathi, M.K., Yadav, R.K., Tripathi, N., Sikarwar, R.S., & Tiwari, P. N. (2024). Investigation of drought stress on chickpea (*Cicer arietinum* L.) genotypes employing various physiological enzymatic and non-enzymatic biochemical parameters. Plants*,* 13(19):2746. <https://doi.org/10.3390/plants13192746>
6. Asewar, B., Jagtap, M., Shinde, G., Mehetre, S., & Pendke, M. (2022). Climate-resilient technologies for enhancing productivity of soybean in India. In *Soybean - Recent Advances in Research and Applications*. IntechOpen. <https://doi.org/10.5772/intechopen.104603>
7. Ashoknarayanan, S., Umarani, R., Vanitha, C., Eevera, T., Djanaguiraman, M., Sudha, P., & Anand, T. (2025). Rapid depletion of total sugars in stored sweet corn seeds limits shelf life. *Plant Science Today*. <https://doi.org/10.14719/pst.6141>
8. Aulia, R., Amanah, H. Z., Lee, H., Kim, M. S., Baek, I., Qin, J., & Cho, B.-K. (2023). Protein and lipid content estimation in soybeans using Raman hyperspectral imaging. *Frontiers in Plant Science*, *14*. <https://doi.org/10.3389/fpls.2023.1167139>
9. Bellaloui, N., Bruns, H. A., Abbas, H. K., Mengistu, A., Fisher, D. K., & Reddy, K. N. (2015). Agricultural practices altered soybean seed protein, oil, fatty acids, sugars, and minerals in the Midsouth USA. *Frontiers in Plant Science*, *6*. <https://doi.org/10.3389/fpls.2015.00031>
10. Corbineau, F. (2024). The Effects of storage conditions on seed deterioration and ageing: How to improve seed longevity. *Seeds*, *3*(1), 56–75. <https://doi.org/10.3390/seeds3010005>
11. Dehghanian, Z., Habibi, K., Dehghanian, M., Aliyar, S., Asgari Lajayer, B., Astatkie, T., Minkina, T., & Keswani, C. (2022). Reinforcing the bulwark: unravelling the efficient applications of plant phenolics and tannins against environmental stresses. *Heliyon*, *8*(3), e09094. <https://doi.org/10.1016/j.heliyon.2022.e09094>
12. Duan, Z., Xu, L., Zhou, G., Zhu, Z., Wang, X., Shen, Y., Ma, X., Tian, Z., & Fang, C. (2025). Unlocking soybean potential: genetic resources and omics for breeding. *Journal of Genetics and Genomics*. <https://doi.org/10.1016/j.jgg.2025.02.004>
13. Dubois, M., Giles, K.A., Hamilton, J.K., Rebers, P.A., & Smith, F. (1956). Colorimetric method for determination of sugars and related substances. *Anal. Chem*. *28*, 350-356.
14. Hossain, Md. S., Khan, Md. A. R., Mahmud, A., Ghosh, U. K., Anik, T. R., Mayer, D., Das, A. K., & Mostofa, M. G. (2024). Differential drought responses of soybean genotypes in relation to photosynthesis and growth-yield attributes. *Plants*, *13*(19), 2765. <https://doi.org/10.3390/plants13192765>
15. Ibáñez, M. A., de Blas, C., Cámara, L., & Mateos, G. G. (2020). Chemical composition, protein quality and nutritive value of commercial soybean meals produced from beans from different countries: A meta-analytical study. *Animal Feed Science and Technology*, *267*, 114531. <https://doi.org/10.1016/j.anifeedsci.2020.114531>
16. Islam, Sohidul M., Muhyidiyn, I., Rafiqul Islam, Md., Kamrul Hasan, Md., Golam Hafeez, A., Moaz Hosen, Md., Saneoka, H., Ueda, A., Liu, L., Naz, M., Barutçular, C., Lone, J., Ammar Raza, M., Kaium Chowdhury, M., el Sabagh, A., & Erman, M. (2022). Soybean and sustainable agriculture for food security. In *Soybean - Recent Advances in Research and Applications*. IntechOpen. <https://doi.org/10.5772/intechopen.104129>
17. Jha, P. (2021). Investigation on the genetic variability of soybean seed sucrose content in germplasm accessions from different countries of origin. *Bioscience Biotechnology Research Communications*, *14*(2), 704–707. <https://doi.org/10.21786/bbrc/14.2.40>
18. Kim, D.-H., Son, S., Jung, J.-Y., Lee, J.-C., & Kim, P.-G. (2022). Photosynthetic characteristics and chlorophyll content of *Cypripedium japonicum* in its natural habitat. *Forest Science and Technology*, *18*(4), 160–171. <https://doi.org/10.1080/21580103.2022.2120544>
19. Król-Grzymała, A., & Amarowicz, R. (2020). Phenolic Compounds of soybean seeds from two European countries and their antioxidant properties. *Molecules*, *25*(9), 2075. <https://doi.org/10.3390/molecules25092075>
20. Kubar, M. S., Shar, A. H., Kubar, K. A., Rind, N. A., Ullah, H., Kalhoro, S. A., Wang, C., Feng, M., Gujar, A., Sun, H., Yang, W., el Enshasy, H., Brestic, M., Zivcak, M., Ondrisik, P., Aljuaid, B. S., El-Shehawi, A. M., & Ansari, M. J. (2021). Optimizing nitrogen supply promotes biomass, physiological characteristics and yield components of soybean (*Glycine max* L. Merr.). *Saudi Journal of Biological Sciences*, *28*(11), 6209–6217. <https://doi.org/10.1016/j.sjbs.2021.06.073>
21. Kumar, K., Debnath, P., Singh, S., & Kumar, N. (2023). An overview of plant phenolics and their involvement in abiotic stress tolerance. *Stresses*, *3*(3), 570–585. <https://doi.org/10.3390/stresses3030040>
22. Li, X., Zhang, W., Niu, D., & Liu, X. (2024). Effects of abiotic stress on chlorophyll metabolism. *Plant Science*, *342*, 112030. <https://doi.org/10.1016/j.plantsci.2024.112030>
23. Liu, K. (2016). Soybean: Overview. In *Reference Module in Food Science*. Elsevier. <https://doi.org/10.1016/B978-0-08-100596-5.00028-7>
24. Lowry, O.H., Rosebrough, N.J., Farr, A.L., & Randall, R.J. (1951). Protein measurement with the folin phenol reagent. *The Journal of Biological Chemistry*.
25. Mangal, V., Verma, L. K., Singh, S. K., Saxena, K., Roy, A., Karn, A., Rohit, R., Kashyap, S., Bhatt, A., & Sood, S. (2024). Triumphs of genomic-assisted breeding in crop improvement. *Heliyon*, *10*(15), e35513. <https://doi.org/10.1016/j.heliyon.2024.e35513>
26. Mishra N, Tripathi MK, Tiwari S, Tripathi N, Trivedi HK. (2020). Morphological and molecular screening of soybean genotypes against yellow mosaic virus disease. *Legume Research*. <https://doi.org/10.18805/LR-4240>
27. Mishra, N., Tripathi, M.K., Tiwari, S., Tripathi, N., Sapre, S. & Ahuja, A. *et al*. (2021a). Cell suspension culture and *in vitro* screening for drought tolerance in soybean using poly-ethylene glycol. *Plants*.; 10;10(3):517. <https://doi.org/10.3390/plants10030517>
28. Mishra, N., Tripathi, M.K., Tiwari, S., Tripathi, N., Gupta, N., Sharma, A., & Solanki1 R.S. (2021b). Evaluation of diversity among soybean genotypes *via* yield attributing traits and SSR molecular markers. *Current Journal of Applied Science and Technology*, *40*, 21: 9-24.
29. Mishra, N., Tripathi, M.K., Tripathi, N., Tiwari, S., Gupta, N., & Sharma, A. (2021c). Validation of drought tolerance gene-linked microsatellite markers and their efficiency for diversity assessment in a set of soybean genotypes. *Current Journal of Applied Science and Technology*. *30*,48–57. <https://doi.org/10.9734/cjast/2021/v40i2531515>
30. Mishra N, Tripathi MK, Tripathi N, Tiwari S, Gupta N, Sharma A, *et al*. (2021d). Changes in biochemical and antioxidant enzymes activities play significant role in drought tolerance in soybean. *Int. J Agric. Technol. 17*,1425-46. 41.
31. Mishra, N., Tripathi, M.K., Tiwari, S., Tripathi, N., Gupta, N., & Sharma, A. (2021e). Morphological and physiological performance of Indian soybean [*Glycine max* (L.) Merrill] genotypes in respect to drought. *Legume Res Int. J*. LR-4550.
32. Mishra, R., Tripathi, M.K., Sikarwar, R.S., Singh, Y., & Tripathi, N. (2024a). Soybean (*Glycine max* L. Merrill): A multipurpose legume shaping our world. *Plant Cell Biotechnology and Molecular Biology*. 15;25(3–4):17–37. <https://doi.org/10.56557/pcbmb/2024/v25i3-48643>
33. Mishra, R., Tripathi, M., Tripathi, N., Singh, J. & Tiwari S. (2024b). Nutritional and anti-nutritional factors in soybean. *Acta Scientific Agriculture*. 3: 8(11):46–63. <https://doi.org/10.31080/ASAG.2024.08.1432>
34. Mishra, R., Tripathi, M.K., Shrivastava, M.K., & Amrate, P.K. (2024c). Genetic diversity in crop improvement: A cornerstone for sustainable agriculture and global food security. In: Tripathi MK, Tripathi N, editors. *Advances in Plant Biotechnology*. Cornous Publications LLP; p. 1–21. [https://doi.org/https://doi.org/10.37446/volbook032024/1-21](https://doi.org/https%3A//doi.org/10.37446/volbook032024/1-21)
35. Mishra, R., Tripathi, M.K., Tripathi, N., Singh, J., Yadav, P.K. & Sikarwar, R.S. *et al.* (2024d). Breeding for major genes against drought stress in soybean. In: Tripathi MK, Tripathi N, editors. *Advances in Plant Biotechnology*. Cornous Publications LLP, Puducherry, India. p. 22–68. [https://doi.org/https://doi.org/10.37446/volbook032024/22-68](https://doi.org/https%3A//doi.org/10.37446/volbook032024/22-68)
36. Mishra, R., Tripathi, M. K., Shrivastava, M. K., Amrate, P. K., Singh, J., & Singh, Y. (2024e). From conventional to modern plant breeding: How far have we come? In M. K. Tripathi & R. Mishra (Eds.), *Recent Advances in Plant Breeding* (Vol. 1, pp. 1–20). Cornous Publications LLP. <https://doi.org/10.37446/volbook102024/1-20>
37. Mishra, R., Shrivastava, M.K., Amrate, P.K., Sharma, S., Singh, Y., Tripathi, & M.K. (2025a). Phenotypic diversity and trait analysis of soybean recombinant inbred lines. *Plant Cell Biotechnology and Molecular Biology*. May 17;26(7–8):32–52. <https://doi.org/10.56557/pcbmb/2025/v26i7-89345>
38. Mishra, R., Shrivastava, M.K., Tripathi, M.K., Amrate, P.K., Singh, Y. & Solanki R. *et al*. (2025b). Unravelling soybean yield potential: Exploring trait synergy, impact pathways, multidimensional patterns and biochemical insights. *Plant Science Today*. <https://doi.org/10.14719/pst.6401>
39. Mughal, A., Jabeen, N., Ashraf, K., Sultan, K., Farhan, M., Hussain, M. I., Deng, G., Alsudays, I. M., Saleh, M. A., Tariq, S., & Zaman, Q. uz. (2024). Exploring the role of caffeic acid in mitigating abiotic stresses in plants: A review. *Plant Stress*, *12*, 100487. <https://doi.org/10.1016/j.stress.2024.100487>
40. Narayana, Kodadinne N., Wijewardana, C., Alsajri, F. A., Reddy, K. R., Stetina, S. R., & Bheemanahalli, R. (2024). Resilience of soybean genotypes to drought stress during the early vegetative stage. *Scientific Reports*, *14*(1), 17365. <https://doi.org/10.1038/s41598-024-67930-w>
41. Paliwal, S., Tripathi, M.K., Sikarwar, R.S., Yadav, R.K., & Sonaniya, P. (2024). Evaluation of biochemical parameters in linseed (*Linum usitatissimum*).  *International Journal of Advanced Biochemistry Research*. *8*(4), 260.DOI: 10.33545/26174693.2024.v8.i4d.947
42. Qin, P., Wang, T., & Luo, Y. (2022). A review on plant-based proteins from soybean: Health benefits and soy product development. *Journal of Agriculture and Food Research*, *7*, 100265. <https://doi.org/10.1016/j.jafr.2021.100265>
43. Rahman, U., Younas, Z., Ahmad, I., Yousaf, T., Latif, R., Rubab, U., Hassan, H., Shafi, U., & Mashwani, Z.-R. (2024). Enhancing health and therapeutic potential: innovations in the medicinal and pharmaceutical properties of soy bioactive compounds. *Frontiers in Pharmacology*, *15*. <https://doi.org/10.3389/fphar.2024.1397872>
44. Rajput, A., Ali Panhwar, Q., & Babar, H. (2024). *Role of Leguminous Crops by Enhancing Soil Fertility and Plant Nutrition*. <https://doi.org/10.5772/intechopen.1006827>
45. Rajput, S., Jain, S., Tiwari, S., Barela, A., Chauhan, S., Tiwari, P.N., Gupta, N., Sikarwar, R.S., Tripathi, N., & Tripathi, M.K. (2023). Biochemical characterization of chickpea (*Cicer arietinum* L.) genotypes. *Plant Cell Biotechnol. & Mol. Biol*. *24 (3-4)*, 1-9. 10.56557/PCBMB/2023/v24i3-48239.
46. Ramtekey, V., Cherukuri, S., Kumar, S., V., S. K., Sheoran, S., K., U. B., K., B. N., Kumar, S., Singh, A. N., & Singh, H. V. (2022). Seed longevity in legumes: Deeper insights into mechanisms and molecular perspectives. *Frontiers in Plant Science*, *13*. <https://doi.org/10.3389/fpls.2022.918206>
47. Rao, P. J. M., Pallavi, M., Bharathi, Y., Priya, P. B., Sujatha, P., & Prabhavathi, K. (2023). Insights into mechanisms of seed longevity in soybean: a review. *Frontiers in Plant Science*, *14*. <https://doi.org/10.3389/fpls.2023.1206318>
48. Rasheed, A., Mahmood, A., Maqbool, R., Albaqami, M., Sher, A., Sattar, A., Bakhsh, G., Nawaz, M., Hassan, M. U., Al-Yahyai, R., Aamer, M., Li, H., & Wu, Z. (2022). Key insights to develop drought-resilient soybean: A review. *Journal of King Saud University - Science*, *34*(5), 102089. <https://doi.org/10.1016/j.jksus.2022.102089>
49. Salgotra, R. K., & Chauhan, B. S. (2023). Genetic Diversity, Conservation, and Utilization of Plant Genetic Resources. *Genes*, *14*(1), 174. <https://doi.org/10.3390/genes14010174>
50. Sharma, A., Tripathi, M. K., Tiwari, S., Gupta, N., Tripathi, N., & Mishra, N. (2021). Evaluation of Soybean (*Glycine max* L.) Genotypes on the basis of biochemical contents and anti-oxidant enzyme activities. *Legume Research* <https://doi.org/10.18805/LR-4678>
51. Sharma, A., Mishra, N., Tripathi, N., Nehra, S., Singh, J., & Tiwari S. *et al*. (2023). Qualitative trait based variability among soybean genotypes. *Acta Scientific Agriculture*. 1;02–13. <https://doi.org/10.31080/ASAG.2023.07.1212>
52. Shyam, C., & Tripathi, M,K. (2019). Biochemical studies in Indian mustard (*Brassica juncea* L.) czern and coss for fatty acid profiling. *International Journal of Chemical Studies*. *97(4),*338-343.
53. Silva-Pérez, V., de Faveri, J., Molero, G., Deery, D. M., Condon, A. G., Reynolds, M. P., Evans, J. R., & Furbank, R. T. (2020). Genetic variation for photosynthetic capacity and efficiency in spring wheat. *Journal of Experimental Botany*, *71*(7), 2299–2311. <https://doi.org/10.1093/jxb/erz439>
54. Silva, M. F. da, Soares, J. M., Xavier, W. A., Silva, F. C. dos S., Silva, F. L. da, & Silva, L. J. da. (2023). The role of the biochemical composition of soybean seeds in the tolerance to deterioration under natural and artificial aging. *Heliyon*, *9*(12), e21628. <https://doi.org/10.1016/j.heliyon.2023.e21628>
55. Slattery, R. A., VanLoocke, A., Bernacchi, C. J., Zhu, X.-G., & Ort, D. R. (2017). Photosynthesis, light use efficiency, and yield of reduced-chlorophyll soybean mutants in field conditions. *Frontiers in Plant Science*, *8*, <https://doi.org/10.3389/fpls.2017.00549>
56. Snedecor, G., & Cochran, W.G. Statistical Methods. (1997). VI Ed. Oxford IBH Pub. Co. Delhi.
57. Swain, T. & Hillis, W.E. (1959). The phenolic constituents of *Prunus domestica*. I.-The quantitative analysis of phenolic constituents. *Journal of the Science of Food and Agriculture*,10,63-68.<http://dx.doi.org/10.1002/jsfa.2740100110>
58. Tayade, R., Imran, M., Ghimire, A., Khan, W., Nabi, R. B. S., & Kim, Y. (2023). Molecular, genetic, and genomic basis of seed size and yield characteristics in soybean. *Frontiers in Plant Science*, *14*, <https://doi.org/10.3389/fpls.2023.1195210>
59. Tiwari, P.N., Tiwari, S., Sapre, S., Babbar, A., Tripathi, N., Tiwari, S., & Tripathi, M. K. (2023a). Screening and selection of drought-tolerant high-yielding chickpea genotypes based on physio-biochemical selection indices and yield trials. *Life*. *13,* 1405.
60. Tiwari, P.N., Tiwari, S., Sapre, S., Tripathi, N., Payasi, D.K., Singh, M., Thakur, S., Sharma, M., Tiwari, S., & Tripathi, M.K. (2023b). Prioritization of physio-biochemical selection indices and yield-attributing traits toward the acquisition of drought tolerance in chickpea (*Cicer arietinum* L.). *Plants* *12,* 3175. https://doi.org/ 10.3390/plants12183175
61. Tripathi, M.K., Tripathi, N., Tiwari, S., Mishra, N., Sharma, A., & Tiwari, S, *et al*. (2023). Identification of Indian soybean (*Glycine max* [L.] Merr.) genotypes for drought tolerance and genetic diversity analysis using SSR markers. *Scientist*, *3(3)*, 31-46.
62. Upadhyay, S., Singh, A.K., Tripathi, M.K., Tiwari, S., & Tripathi, N. (2020). Validation of simple sequence repeats markers for charcoal rot and Rhizoctonia root rot resistance in soybean genotypes. *I.J.A.B.R.* *10(2),*137-144.
63. Vargas-Almendra, A., Ruiz-Medrano, R., Núñez-Muñoz, L. A., Ramírez-Pool, J. A., Calderón-Pérez, B., & Xoconostle-Cázares, B. (2024). Advances in soybean genetic improvement. *Plants*, *13*(*21*), 3073. <https://doi.org/10.3390/plants13213073>
64. Walther, B., Guggisberg, D., Badertscher, R., Egger, L., Portmann, R., Dubois, S., Haldimann, M., Kopf-Bolanz, K., Rhyn, P., Zoller, O., Veraguth, R., & Rezzi, S. (2022). Comparison of nutritional composition between plant-based drinks and cow’s milk. *Frontiers in Nutrition*, *9*. <https://doi.org/10.3389/fnut.2022.988707>
65. Wang, G., Zeng, F., Song, P., Sun, B., Wang, Q., & Wang, J. (2022). Effects of reduced chlorophyll content on photosystem functions and photosynthetic electron transport rate in rice leaves. *Journal of Plant Physiology*, *272*, 153669. <https://doi.org/10.1016/j.jplph.2022.153669>
66. Wei, X., Li, S., Zhu, S., Zheng, W., Zhou, S., Wu, W., & Xie, Z. (2021). Quantitative analysis of soybean protein content by terahertz spectroscopy and chemometrics. *Chemometrics and Intelligent Laboratory Systems*, 208, 104199. <https://doi.org/10.1016/j.chemolab.2020.104199>
67. Yadav, P.K., Tripathi, M.K., Tiwari, S., Chauhan, S., Tripathi, N., & Sikarwar, R.S. *et al*. (2023). Biochemical characterization of parental inbred lines and hybrids of maize (*Zea mays* L.) under different irrigation conditions. *International Journal of Plant & Soil Science*, *35(18),*1743-1762.
68. Yadav, R.K., Tripathi, M.K., Tiwari, S., Asati, R., Tripathi, N., & Sikarwar, R.S. (2024a). Estimation of biochemical parameters in chickpea (*Cicer arietinum* L.) genotypes. *Legume Research*. DOI: 10.18805/LR -5327.
69. Yadav, P.K., Tripathi, M.K., Tripathi, N., Sikarwar, R.S., & Yadav, S.K. (2024b). [Biochemical characterization of maize (*Zea mays* L.) genotypes under different irrigation circumstances](https://www.researchgate.net/profile/Manoj-Tripathi-10/publication/383658980_Advances_in_Biotechnology_Bioscience/links/66d59d75f84dd1716c78fa1e/Advances-in-Biotechnology-Bioscience.pdf#page=139). *In book Advances in Biotechnology & Bioscience*, *16*,133-165.

**Table 1: Mean performance, range and coefficient of variation of different biochemical parameters of soybean genotypes**

| **S. No.** | **Genotypes** | **Total Chlorophyll Content (mg/ml)** | **Protein Content (%)** | **Phenol Content (mg/g)** | **Moisture Content** | **Total Sugar Content (mg/g)** |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | RVS 23-1 | 48.72 | 37.52 | 2.21 | 5.40 | 5.21 |
| 2 | RVS 23-2 | 51.17 | 38.70 | 2.36 | 5.40 | 5.05 |
| 3 | RVS 23-3 | 46.54 | 37.12 | 2.02 | 3.80 | 5.24 |
| 4 | RVS 23-4 | 49.82 | 39.05 | 2.16 | 4.70 | 4.86 |
| 5 | RVS 23-5 | 42.31 | 35.78 | 1.56 | 5.40 | 5.15 |
| 6 | RVS 23-6 | 45.71 | 36.52 | 1.78 | 4.40 | 4.54 |
| 7 | RVS 23-7 | 53.64 | 38.18 | 1.64 | 5.50 | 4.02 |
| 8 | RVS 23-8 | 52.18 | 37.61 | 1.82 | 4.80 | 3.96 |
| 9 | RVS 23-9 | 43.52 | 35.82 | 2.15 | 4.70 | 4.28 |
| 10 | RVS 23-10 | 46.81 | 40.12 | 2.04 | 3.50 | 5.12 |
| 11 | RVS 23-11 | 54.75 | 36.75 | 1.81 | 5.70 | 5.25 |
| 12 | RVS 23-12 | 48.64 | 39.81 | 1.65 | 5.10 | 3.85 |
| 13 | RVS 23-13 | 47.82 | 38.64 | 2.12 | 3.50 | 5.06 |
| 14 | RVS 23-14 | 49.15 | 39.12 | 1.89 | 3.60 | 5.17 |
| 15 | RVS 23-15 | 46.71 | 37.68 | 2.08 | 4.80 | 5.20 |
| 16 | RVS 23-16 | 53.24 | 37.51 | 1.92 | 5.40 | 3.88 |
| 17 | RVS 23-17 | 51.58 | 35.89 | 1.84 | 5.10 | 4.65 |
| 18 | RVS 23-18 | 49.71 | 38.44 | 2.01 | 4.90 | 3.75 |
| 19 | RVS 23-19 | 48.67 | 36.78 | 2.15 | 5.50 | 4.72 |
| 20 | RVS 23-20 | 53.87 | 37.81 | 1.96 | 5.20 | 5.15 |
| 21 | RVS 23-21 | 48.27 | 35.96 | 2.11 | 5.40 | 4.54 |
| 22 | RVS 23-22 | 49.81 | 40.08 | 1.98 | 5.60 | 5.04 |
| 23 | RVS 23-23 | 51.02 | 38.69 | 2.17 | 4.80 | 3.56 |
| 24 | RVS 23-24 | 47.45 | 38.81 | 2.19 | 4.90 | 3.84 |
| 25 | RVS 23-25 | 49.28 | 36.92 | 2.05 | 5.40 | 5.01 |
| 26 | RVS 23-26 | 46.71 | 37.65 | 2.09 | 5.50 | 4.49 |
| 27 | RVSM 35 | 49.18 | 36.81 | 1.72 | 4.70 | 5.18 |
| 28 | JS 20-34 | 48.65 | 39.81 | 1.65 | 5.40 | 4.45 |
| 29 | JS 93-05 | 51.18 | 40.50 | 2.21 | 5.20 | 3.15 |
| 30 | JS 95-60 | 48.42 | 38.50 | 1.98 | 4.40 | 5.20 |
| 31 | JS 335 | 52.45 | 35.61 | 2.18 | 4.60 | 3.10 |
| 32 | JS 20-116 | 52.39 | 36.52 | 1.84 | 5.20 | 3.82 |
| 33 | JS 20-69 | 49.86 | 35.70 | 1.45 | 5.40 | 3.65 |
| 34 | JS 20-98 | 52.62 | 40.91 | 1.68 | 3.40 | 3.70 |
| 35 | RVS 76 | 43.01 | 38.04 | 2.01 | 5.50 | 3.28 |
| 36 | RVS 2001-4 | 41.87 | 37.80 | 1.56 | 3.90 | 3.18 |
| 37 | Raj Soya 24 | 52.75 | 39.65 | 2.12 | 4.60 | 4.27 |
| 38 | Raj Soya 18 | 49.96 | 38.72 | 2.21 | 3.60 | 4.56 |
| 39 | JS 20-29 | 53.68 | 37.86 | 1.56 | 4.70 | 3.18 |
| 40 | VLS 104 | 49.56 | 41.82 | 1.85 | 5.20 | 4.45 |
| 41 | NRCSL 5 | 41.78 | 38.74 | 1.54 | 5.50 | 5.24 |
| 42 | JS 24-26 | 52.17 | 40.13 | 1.37 | 5.80 | 3.57 |
| 43 | NRCSL 7 | 42.05 | 35.28 | 1.76 | 5.60 | 4.12 |
| 44 | SKAUS 3 | 50.74 | 36.54 | 2.18 | 5.50 | 5.00 |
| 45 | RVS 12-8 | 45.07 | 39.57 | 1.64 | 5.70 | 5.72 |
| 46 | KDS 1203 | 53.18 | 38.61 | 1.78 | 5.40 | 3.25 |
| 47 | NRC 253 | 48.71 | 42.05 | 1.92 | 3.80 | 4.34 |
| 48 | MACS 1756 | 50.54 | 37.50 | 2.01 | 5.60 | 5.54 |
| 49 | Lok Soya 2 | 48.92 | 38.62 | 1.40 | 4.80 | 4.02 |
| 50 | AMS 2021-3 | 47.45 | 41.54 | 1.62 | 4.40 | 3.45 |
| 51 | Himso 1695 | 49.18 | 37.76 | 2.10 | 4.80 | 5.42 |
| 52 | TS-156 | 51.62 | 38.04 | 1.14 | 4.90 | 4.25 |
| 53 | NRCSL-8 | 44.51 | 39.06 | 1.02 | 5.60 | 5.80 |
| 54 | JS 24-34 | 47.86 | 41.59 | 1.84 | 4.70 | 4.12 |
| 55 | RSC 10-52 | 48.52 | 38.07 | 1.40 | 5.40 | 3.35 |
| 56 | DS 1510 | 47.35 | 40.35 | 2.25 | 5.80 | 4.42 |
| 57 | KSS 213 | 53.18 | 39.67 | 2.21 | 4.90 | 4.28 |
| 58 | MAUS 824 | 46.18 | 37.98 | 2.14 | 5.60 | 5.25 |
| 59 | NRC 254 | 45.62 | 41.72 | 1.61 | 5.30 | 4.05 |
| 60 | AMS 2021-4  | 46.05 | 40.97 | 2.05 | 5.40 | 4.65 |
| 61 | Himso1696 | 50.27 | 37.79 | 2.24 | 5.60 | 4.80 |
| 62 | DS 1529 | 48.65 | 38.17 | 2.01 | 4.90 | 4.54 |
| 63 | KDS 1188 | 45.84 | 37.45 | 1.81 | 4.70 | 3.48 |
| 64 | MACS 1745 | 53.05 | 39.42 | 2.02 | 5.50 | 3.35 |
| 65 | NRC 255 | 50.25 | 39.91 | 1.75 | 3.80 | 3.84 |
| 66 | Asb 93 | 48.92 | 38.17 | 2.14 | 4.80 | 4.51 |
| 67 | VLS 105 | 49.65 | 34.15 | 2.05 | 5.70 | 3.26 |
| 68 | NRCSL 4 | 52.05 | 38.44 | 1.98 | 5.70 | 5.19 |
| 69 | NRC 257  | 46.27 | 41.56 | 1.25 | 5.30 | 3.05 |
| 70 | MAUS 814 | 51.25 | 40.14 | 2.01 | 4.90 | 5.15 |
| 71 | SL 1311 | 48.08 | 39.55 | 1.08 | 5.40 | 5.24 |
| 72 | Asb 85 | 47.75 | 34.37 | 1.40 | 4.00 | 5.20 |
| 73 | PS 1693 | 49.05 | 39.46 | 2.18 | 4.80 | 3.49 |
| 74 | NRC 256 | 47.62 | 36.65 | 1.87 | 4.90 | 5.21 |
| 75 | RSC 1165 | 53.05 | 35.05 | 2.29 | 5.20 | 4.84 |
| 76 | BAUS 124 | 51.87 | 37.81 | 2.31 | 5.40 | 3.19 |
| 77 | DLSB 40 | 49.54 | 35.25 | 2.17 | 3.20 | 5.98 |
| 78 | NRC 258 | 46.25 | 40.05 | 2.12 | 5.80 | 3.48 |
| 79 | Pusa Sipani BS-9 | 48.17 | 38.76 | 2.04 | 4.90 | 4.56 |
| 80 | PS 1696 | 49.15 | 39.46 | 2.28 | 4.80 | 5.22 |
| 81 | CAUMS 3 | 51.62 | 37.25 | 2.18 | 5.20 | 4.51 |
| 82 | AUKS 212 | 48.71 | 38.65 | 2.04 | 5.10 | 4.25 |
| 83 | RVSM 12-21 | 50.87 | 39.05 | 2.57 | 5.60 | 4.45 |
| 84 | NRC 259 | 53.25 | 39.88 | 2.10 | 5.90 | 5.05 |
| 85 | AS 34 | 44.72 | 40.02 | 2.26 | 5.60 | 5.15 |
| 86 | RVSM 2011-35 | 42.04 | 39.82 | 2.58 | 3.40 | 3.45 |
| 87 | RSC 1172 | 51.05 | 37.52 | 2.24 | 4.90 | 3.45 |
| 88 | AS 55 | 47.28 | 36.48 | 1.72 | 5.40 | 4.98 |
| 89 | TS-208 | 49.15 | 41.95 | 1.88 | 4.90 | 4.56 |
| 90 | NRC-260 | 50.06 | 40.52 | 2.08 | 5.60 | 3.95 |
| 91 | NRC-196 | 48.70 | 41.44 | 2.40 | 5.80 | 4.85 |
| 92 | Pusa Sipani SPS-433 | 49.05 | 34.05 | 2.34 | 5.40 | 5.02 |
| **Mean** | **48.98** | **38.40** | **1.94** | **5.01** | **4.42** |
| **Minimum** | **41.78** | **34.05** | **1.02** | **3.20** | **3.05** |
| **Maximum** | **54.75** | **42.05** | **2.58** | **5.90** | **5.98** |
| **C.V.** | **1.38** | **1.34** | **2.79** | **1.26** | **1.28** |
| **S.E.** | **0.55** | **0.45** | **0.49** | **0.34** | **0.36** |
| **CD0.05** | **1.53** | **1.36** | **1.38** | **1.25** | **1.29** |