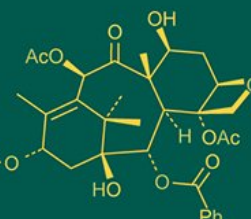
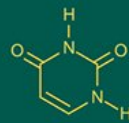


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(9): 918-921
www.biochemjournal.com
Received: 12-07-2026
Accepted: 15-08-2026

Sushma Sahu
M.Sc. (Ag.), Department of
Plant Physiology, Indira
Gandhi Krishi
Vishwavidyalaya (IGKV),
Raipur, Chhattisgarh, India

SP Tiwari
Assistant Professor,
Department of Plant
Physiology, College of
Agriculture, Indira Gandhi
Krishi Vishwavidyalaya
(IGKV), Raipur, Chhattisgarh,
India

Isha Singh Rajput
Ph.D. Scholar, Department of
Plant Physiology, Indira
Gandhi Krishi
Vishwavidyalaya (IGKV),
Raipur, Chhattisgarh, India

Preeti Dewangan
Ph.D. Scholar, Department of
Plant Physiology, Indira
Gandhi Krishi
Vishwavidyalaya (IGKV),
Raipur, Chhattisgarh, India

Corresponding Author:
Sushma Sahu
M.Sc. (Ag.), Department of
Plant Physiology, Indira
Gandhi Krishi
Vishwavidyalaya (IGKV),
Raipur, Chhattisgarh, India

Impact of plant growth stimulant (amino acid + fulvic acid) on morpho-physiological, yield and yield attributes of soybean (*Glycine max* L.)

Sushma Sahu, SP Tiwari, Isha Singh Rajput and Preeti Dewangan

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i9SI.9938>

Abstract

Soybean (*Glycine max* L.) is an important leguminous oilseed crop belonging to the family Fabaceae, with $2n = 40$ chromosomes. This study evaluated the effect of foliar application of Plant Growth Stimulant (PGS) containing amino acid and fulvic acid on morpho-physiological traits, yield attributes and seed quality of soybean under the agro-climatic conditions of Chhattisgarh. A field experiment was conducted during kharif 2025-26 at IGKV, Raipur, using Randomised Block Design (RBD) with three replications and six treatments (Control, 2, 4, 6, 8 and 10 ppm PGS). The PGS was applied at pre-flowering and pre-pod formation stages. Foliar application of PGS improved growth, physiological traits, yield attributes and seed quality. Among the treatments, 6 ppm PGS showed the best overall performance, particularly for SPAD, chlorophyll fluorescence (Fv/Fm), pods per plant, biological yield, seed yield and harvest index. Protein content was highest with 4 ppm, while oil content was maximum with 8 ppm PGS. These findings indicate that foliar application of PGS, particularly at 6 ppm, has potential for improving soybean productivity and seed quality.

Keywords: *Glycine max* L., plant growth stimulant, biostimulant, amino acid, fulvic acid, physiological traits, yield, seed quality

Introduction

Soybean (*Glycine max* L. Merrill) is an important leguminous oilseed crop belonging to the family Fabaceae, with a diploid chromosome number of $2n = 40$. Soybean is one of the most important leguminous oilseed crops in the world owing to its high protein (38–42%) and oil (18–22%) contents, making it an important source of food, feed and industrial raw materials (Liu, 1997; Rongli *et al.*, 2020) [7, 12]. Besides its nutritional and economic importance, soybean contributes significantly to sustainable agriculture through biological nitrogen fixation, which improves soil fertility and reduces dependence on synthetic nitrogen fertilisers (Pandey and Singh, 2019; Teixeira *et al.*, 2018) [11, 14]. However, soybean productivity is frequently constrained by poor nutrient use efficiency, imbalanced fertilisation, environmental stresses and inadequate crop management practices, resulting in yields considerably below the genetic potential of modern cultivars (Rouphael and Colla, 2020; Vishwanatha *et al.*, 2022) [13, 15].

In recent years, plant biostimulants have emerged as an eco-friendly and sustainable approach for improving crop productivity by stimulating natural physiological and biochemical processes without acting solely as nutrient sources (du Jardin, 2015; Calvo *et al.*, 2014; Rouphael and Colla, 2020) [4, 3, 13]. According to the European Biostimulant Industry Council, plant biostimulants enhance nutrient use efficiency, improve tolerance to abiotic stress and promote crop quality through multiple physiological mechanisms (du Jardin, 2015; Rouphael and Colla, 2020) [4, 13]. Among the different categories of biostimulants, amino acid- and fulvic acid-based formulations have received considerable attention because of their ability to improve nutrient uptake, photosynthetic efficiency, chlorophyll synthesis, enzyme activation, and assimilate translocation (Calvo *et al.*, 2014; Teixeira *et al.*, 2018; Baghdadi *et al.*, 2022) [3, 14, 1]. Amino acids function as precursors of proteins, enzymes, phytohormones and chlorophyll, while fulvic acid enhances membrane permeability, nutrient mobility and metabolic activity, collectively promoting plant growth and development (Rouphael and Colla, 2020; Bulgari *et al.*, 2019; Vishwanatha *et al.*, 2022) [13, 2, 15].

Several studies have demonstrated that foliar application of amino acid-based biostimulants significantly improves plant height, leaf area, chlorophyll content, photosynthetic efficiency, flowering behaviour, yield attributes and seed quality in field crops (Kocira *et al.*, 2018; Melo *et al.*, 2024; Han *et al.*, 2024) [6, 9, 5]. Likewise, humic and fulvic substances have been reported to enhance nutrient acquisition, root growth, carbon assimilation and dry matter accumulation, resulting in increased crop productivity and improved seed quality (Teixeira *et al.*, 2018; Baghdadi *et al.*, 2022) [14, 1]. Despite the growing use of plant biostimulants, information on the optimum concentration of Plant Growth Stimulant (PGS) for improving morpho-physiological traits, yield attributes and seed quality of soybean under the agro-climatic conditions of Chhattisgarh remains limited. Therefore, the present investigation was undertaken to evaluate the effect of different concentrations of foliar-applied Plant Growth Stimulant (PGS) on morpho-physiological traits, yield attributes, seed yield and seed quality of soybean.

2. Material and methods

2.1 Plant material and experimental conditions

The present investigation, entitled “Impact of biostimulant on morpho-physiological Traits, yield and yield attributes of Soybean (*Glycine max* L.)” was conducted during the kharif season of 2025-26 at the, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh, India. The experiment was laid out in a Randomised Block Design (RBD) with three replications comprising six treatments: T₁ (Control), T₂ (PGS @ 2 ppm), T₃ (PGS @ 4 ppm), T₄ (PGS @ 6 ppm), T₅ (PGS @ 8 ppm) and T₆ (PGS @ 10 ppm). The soybean variety RSC-1040 was sown on 08 July 2025, following the recommended package of practices. Plant Growth Stimulant (PGS), an amino acid- and fulvic acid-based biostimulant, was applied as a foliar spray at the pre-flowering and pre-pod formation stages according to the respective treatment concentrations, whereas distilled water was sprayed in the control treatment. All agronomic and plant protection practices were kept uniform for all treatments throughout the experimental period.

2.2 Morpho-physiological parameters

Morphological observations, including plant height, number of leaves and number of branches per plant, were recorded at the specified crop growth stages. Physiological parameters comprising SPAD chlorophyll index, chlorophyll fluorescence (Fv/Fm), specific leaf area (SLA) and specific leaf weight (SLW) were measured following standard procedures. Phenological observations, including days to first flowering, days to 50% flowering and days to pod initiation, were also recorded during the crop growth period.

2.3 Yield and yield attributes

At physiological maturity, observations on pods per plant, pod length, number of seeds per pod, 100-seed weight, seed yield per plant, biological yield and harvest index were recorded following standard procedures. The recorded observations were used to evaluate the effect of different concentrations of Plant Growth Stimulant on soybean productivity.

2.4 Statistical analysis

The experimental data were subjected to analysis of variance (ANOVA) appropriate for the Randomised Block Design (RBD). Treatment means were compared using the Critical Difference (CD) test at the 5% level of significance, wherever the F-test indicated significant treatment effects.

3. Result and Discussion

Foliar application of Plant Growth Stimulant (PGS) significantly influenced the growth, physiological and yield-related traits of soybean. Plant height at 30 DAS was maximum under PGS @ 4 ppm (T₃) (40.48 cm), followed by T₆ (34.25 cm), while the minimum was recorded under T₄ (30.47 cm). At 45 DAS, the maximum plant height was observed under T₃ (47.23 cm), followed by T₆ (42.56 cm), and the minimum under T₁ (36.40 cm). At 60 DAS, maximum plant height was recorded under T₆ (69.93 cm), followed by T₅ (61.80 cm), whereas the minimum was observed in T₁ (46.31 cm). Number of leaves per plant was maximum under T₄ (25.33), followed by T₃ (24.33), while the minimum was recorded under T₂ (18.67). Number of branches per plant at 60 DAS was maximum under T₄ (6.47), followed by T₅ (6.26), and minimum under T₁ (5.00). Specific leaf weight (SLW) was maximum under T₄ (0.0053), followed by T₂ (0.0049), whereas the minimum was recorded under T₆ (0.0041). SPAD value was maximum under T₄ (50.10), followed by T₅ (45.20), while the minimum was recorded under T₁ (32.72). Chlorophyll fluorescence (Fv/Fm) was maximum under T₅ (0.82), followed by T₄ (0.81), and minimum under T₁ (0.68). Among yield attributes, pods per plant were maximum under T₄ (76.33), followed by T₃ (65.60), while minimum was recorded under T₁ (47.13). Pod length was maximum under T₄ (3.93 cm), followed by T₅ (3.60 cm), and minimum under T₁ (2.70 cm). Seeds per pod were maximum under T₄ (2.65), followed by T₅ (2.59), whereas minimum was recorded under T₁ (2.11). The maximum 100-seed weight was recorded under T₃ (14.60 g), followed by T₅ (14.10 g), while the minimum was under T₁ (12.63 g). Biological yield was maximum under T₄ (33.33 g plant⁻¹), followed by T₅ (31.87 g plant⁻¹), and minimum under T₁ (28.22 g plant⁻¹). Seed yield was maximum under T₄ (10.23 g plant⁻¹), followed by T₅ (9.37 g plant⁻¹), whereas minimum was recorded under T₁ (7.14 g plant⁻¹). Harvest index was maximum under T₄ (31.53%), followed by T₅ (29.13%), while minimum was observed under T₁ (25.11%).

The improvement in plant height, leaves and branches following PGS application may be attributed to enhanced nutrient uptake, chlorophyll synthesis and metabolic activity, resulting in better vegetative growth and biomass accumulation (Calvo *et al.*, 2014; du Jardin, 2015; Teixeira *et al.*, 2018) [3, 4, 14]. The higher SLW, SPAD and Fv/Fm values under PGS treatments indicate improved photosynthetic efficiency and dry matter accumulation, possibly due to enhanced physiological activity and better light interception (Rouphael and Colla, 2020; Baghdadi *et al.*, 2022; Han *et al.*, 2024) [13, 1, 5]. The increase in pods per plant, pod length, seeds per pod, biological yield, seed yield and harvest index may be associated with improved photosynthetic efficiency, nutrient utilization and effective translocation of assimilates towards developing reproductive organs (Teixeira *et al.*, 2018; Kocira *et al.*, 2018; Han *et al.*, 2024) [14, 6, 5]. The higher 100-seed weight under PGS treatment suggests improved seed filling due to greater

assimilate availability during the reproductive stage (Baghdadi *et al.*, 2022; Kocira *et al.*, 2018) ^[1, 6]. Overall, the superior performance of PGS @ 6 ppm for most growth, physiological and yield traits indicates that this concentration provided optimum physiological stimulation for improving soybean productivity under the experimental conditions (Rouphael and Colla, 2020; Vishwanatha *et al.*, 2022) ^[13, 15].

Table 1: Effect of plant growth stimulant on morpho-physiological parameters

Treatment	PH (cm)			NLPP	NBPP		SLA	SLW	SPAD value		CF
	30 DAS	45 DAS	60 DAS		45 DAS	60 DAS			Flowering stage	Pod formation stage	
T ₁	31.49	36.4	46.31	19.00	4.87	5.00	224.5	0.0047	32.72	36.83	0.68
T ₂	31.85	38.66	50.53	18.67	5.2	5.30	229.6	0.0049	39.53	40.72	0.71
T ₃	40.48	47.23	58.57	24.33	5.75	5.97	221.3	0.0047	41.37	48.50	0.76
T ₄	30.47	40.86	53.85	25.33	5.67	6.47	194.8	0.0053	50.10	49.54	0.81
T ₅	31.96	42.43	61.80	20.00	5.93	6.26	214.7	0.0043	45.20	47.97	0.82
T ₆	34.25	42.56	69.93	23.33	5.5	5.85	238.4	0.0041	44.83	43.69	0.76
SEm (±)	2.48	1.08	2.36	1.22	0.11	0.12	137.1	0.007	1.51	2.29	0.02
CD at %	NS	3.41	7.42	3.85	0.35	0.36	NS	NS	4.77	7.21	0.06

Table 2: Effect of plant growth stimulant on morpho-physiological parameters

Treatment	NPPP	PL	NSPP	Test Weight	BYPP	SYPP	HI (%)
T ₁	47.13	2.70	2.11	12.63	28.22	7.14	25.11
T ₂	56.27	3.33	2.24	12.97	29.37	7.75	26.70
T ₃	65.60	3.43	2.43	14.6	30.30	8.43	27.77
T ₄	76.33	3.93	2.65	13.8	33.33	10.23	31.53
T ₅	58.53	3.60	2.59	14.1	31.87	9.37	29.13
T ₆	61.80	3.05	2.53	13.90	31.33	8.77	28.53
SEm (±)	4.64	0.16	0.05	0.33	0.15	0.11	0.52
CD at %	14.63	0.52	3.48	1.03	0.48	0.35	1.63

Conclusion

The present investigation demonstrated that foliar application of Plant Growth Stimulant (PGS) containing amino acid and fulvic acid can effectively improve the growth, physiological performance, yield attributes and productivity of soybean under the agro-climatic conditions of Chhattisgarh. Among the evaluated treatments, PGS @ 6 ppm (T₄) showed the most consistent and superior performance, recording higher number of leaves and branches, SPAD chlorophyll index, chlorophyll fluorescence, pods per plant, pod length, seeds per pod, biological yield, seed yield and harvest index. PGS @ 4 ppm performed better for plant height at earlier growth stages and 100-seed weight, while higher concentrations also improved several physiological and yield traits. The findings indicate that an optimum concentration of PGS can enhance photosynthetic efficiency, assimilate production and reproductive development, ultimately contributing to greater soybean productivity. Therefore, foliar application of PGS @ 6 ppm at pre-flowering and pre-pod formation stages may be considered a promising approach for improving soybean growth, yield and physiological performance under similar agro-climatic conditions.

References

1. Baghdadadi A, Della Lucia MC, Borella M, Bertoldo G, Ravi S, Zegada-Lizarazu W, Chiodi C, Pagani E, Hermans C, Stevanato P, Nardi S, Monti A, Mangione F. A dual-omics approach for profiling plant responses to biostimulant applications under controlled and field conditions. *Front Plant Sci.* 2022;13:983772.

2. Bulgari R, Franzoni G, Ferrante A. Biostimulants Application in Horticultural Crops under Abiotic Stress Conditions. *Agronomy.* 2019;9(6):306.

3. Calvo P, Nelson L, Kloepper JW. Agricultural uses of plant biostimulants. *Plant Soil.* 2014;383(1–2):3–41.

4. du Jardin P. Plant biostimulants: Definition, concept, main categories and regulation. *Sci Hortic.* 2015;196:3–14.

5. Han Ş, Sönmez İ, Qureshi M, Güden B, Gangurde SS, Yol E. The effects of foliar amino acid and Zn applications on agronomic traits and Zn biofortification in soybean (*Glycine max* L.). *Front Plant Sci.* 2024;15:1382397.

6. Kocira S, Szparaga A, Kocira A, Czerwińska E, Wójtowicz A, Bronowicka-Mielniczuk U, Koszel M, Findura P. Modeling biometric traits, yield and nutritional and antioxidant properties of seeds of three soybean cultivars through the application of biostimulant containing seaweed and amino acids. *Front Plant Sci.* 2018;9:388.

7. Liu K. Soybeans: Chemistry, Technology, and Utilization. New York: Chapman & Hall; 1997.

8. Manu SM, Halagalimath SP, Biradar BD, Chandranath HT. Effect of nutrient management on chlorophyll content (SPAD value) and productivity of soybean (*Glycine max* L.). *Int J Chem Stud.* 2020;8(1):1979–1981.

9. Melo SM, Figueiredo CC, Ramos MLG, Rocha OCB, Aguiar ER, Oliveira AD. Effects of foliar application of amino acid-based biostimulants on growth and yield of soybean. *Agron J.* 2024;116(2):451–462.

10. Moe S, Girdthai T. Relationships of soybean (*Glycine max* L. Merrill) accessions based on physiological and agro-morphological traits. *Int J Chem Environ Biol Sci.* 2013;1(2):375–379.

11. Pandey AK, Singh AK. Effect of drought stress on physiological traits of soybean. *Legume Res.* 2019;42:522–528.

12. Rongli H, Yang Z, Yuan S, Zhou X. Research status of soybean symbiosis nitrogen fixation. *Oil Crop Sci.* 2020;5(1):6–10.
13. Rouphael Y, Colla G. Biostimulants in agriculture. *Front Plant Sci.* 2020;11:40.
14. Teixeira WF, Fagan EB, Soares LH, Soares JN, Reichardt K, Dourado Neto D. Seed and foliar application of amino acids improve variables of nitrogen metabolism and productivity in soybean crop. *Front Plant Sci.* 2018;9:396.
15. Vishwanatha S, Ramarao R, Shwetha BN, Koppalkar BG, Ashoka N, Ananda N, Umesh MR, Vinaykumar M, Naik VS. Response of blackgram (*Vigna mungo* L.) and soybean (*Glycine max* L.) to novel biostimulants in North Eastern Dry Zone of Karnataka. *Legume Res.* 2022;45(9):1130–1136.