International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(3): 297-300
www.biochemjournal.com
Received: 08-12-2023
Accepted: 13-01-2024

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Influence of different plant growth regulators on growth parameters (LAI, AGR, CGR, RGR) of soybean (*Glycine max* L.)

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DOI: https://doi.org/10.33545/26174693.2024.v8.i3d.731

Abstract
A field experiment was conducted during the *kharif* 2021 at Cotton Research Station, Junagadh Agricultural University, Junagadh to study the "Effect of plant growth regulators on morpho-physiological, biochemical and yield parameters of soybean (*Glycine max* L.)" The investigation was carried out in Randomized Block Design with three replication. The experiment consisting of eleven treatments *viz*., IAA @ 100 & 150 ppm, GA_3 @ 100 & 150 ppm, Kinetin @ 50 & 75 ppm, Salicylic acid @ 50 & 100 ppm, Brassinosteroid @ 0.1 & 0.25 ppm and control (water spray). Significantly the highest mean of growth character *viz*., AGR, CGR and RGR observed in treatment of GA_3 @ 100 ppm at 40 and 50 DAS and followed by GA_3 @ 150 ppm and IAA @ 100 ppm. The leaf area index (LAI) was increased up to 50 DAS and decreased thereafter due to senescence and ageing of leaves. Significantly the highest mean leaf area index was recorded in treatment GA_3 @ 100 ppm at 60 DAS.

Keywords: Biochemical, GA3, growth, IAA, SA, soybean, yield

Introduction

Soybean (*Glycine max* L.) emerges as a remarkable crop for the 21st Century. Originating from China and classified under the Legumiaceae family with the Papilionaceae sub-family, this legume is a powerhouse of plant protein. Constituting 30% of global vegetable oil and 60% of vegetable protein, soybean seeds boast 40-42% protein and 18-22% oil content. Widely recognized as the economical primary source of dietary protein for many vegetarians, it is often referred to as the "poor man's meat." Additionally, soybean oil is rich in unsaturated fatty acids, containing anti-cholesterol properties beneficial for diabetic patients (Singh *et al*., 1999) [7].

Legumes, including soybeans, play a crucial role in the agricultural economy, symbolizing an impressive source of protein in vegetarian diets and contributing to soil fertility through nitrogen fixation. Pulses, with nearly three times the protein content of cereals, offer a cost-effective solution to address protein malnutrition in humans. In the context of legume crops in the country, soybean holds significance as both an essential oilseed and pulse crop (Sontakey *et al*., 1999) [9].

Growth regulators, as indicated by Senthil *et al*. (2003) [6], influence the morphological characteristics of soybean. These regulators serve as effective instruments for augmenting crop yield, owing to their crucial involvement in diverse physiological and biochemical processes within plants. This involvement leads to a swift alteration in the plant's phenotype during the season, ultimately achieving the desired outcomes. Plant growth regulators contribute to improving the source-sink relationship, promoting the translocation of photo-assimilates, thereby facilitating effective flower formation and fruit development, which, in turn, enhances crop productivity. Furthermore, these regulators have the capacity to enhance physiological efficiency, including photosynthetic ability, and facilitate the efficient partitioning of accumulated substances from source to sink in field crops, as noted by Solamani *et al*. (2001) [8]. It has been reported that soybean's morphological parameters are impacted by the application of growth regulators. Given their significant role in various plant processes, growth regulators serve as valuable tools for boosting agricultural productivity, orchestrating rapid changes in plant phenotype to attain desired results within a single season.

Materials and Methods

The study was conducted at the Cotton Research Station, Junagadh Agricultural University, Junagadh, during the 2021 kharif season. Junagadh is situated in the South Saurashtra Agro-climatic region of Gujarat, with coordinates 21.50 N latitude and 70.50 E longitude, at an altitude of 60 m above mean sea level. The rainy season typically spans from the second half of June to mid-September, with an average rainfall of 1094 mm over the past decade. Periodic partial monsoon failures occur every three to four years in this area, with heavy rainfall concentrated in July and August. The experimental setup followed a Randomized Block Design with three replications. The experimental area measured 35.1 m x 19 m, with gross and net plot sizes of 5.0 m x 2.7 m and 4.0 m x 1.8 m, respectively. The soybean variety utilized in the study was GJS-3 (Gujarat Junagadh Soybean-3), a high-yielding variety developed at Agricultural Research Station, Junagadh Agricultural University, Amreli (Gujarat), and released in 2010-11, specifically suitable for kharif season cultivation.

The experimental design included a total of eleven treatments, replicated three times, employing a Randomized Block Design. Treatments consisted of IAA (Indole-3-acetic acid) at 100 & 150 ppm, GA3 (Gibberellic acid) at 100 & 150 ppm, Kinetin at 50 & 75 ppm, Salicylic acid at 50 & 100 ppm, Brassinosteroid at 0.1 & 0.25 ppm, and a control (water spray). Observations were recorded at 50, 60, 70 Days After Sowing (DAS), and at harvest for each treatment and replication. Parameters such as Leaf Area Index (LAI), Absolute Growth Rate (AGR), Relative Growth Rate (RGR), and Crop Growth Rate (CGR) were measured using a destructive method. Pre-harvest observations included tagged plant data, with three tagged plants selected from each plot to assess different growth parameters. An analysis of variance was conducted to determine the significance of differences between treatments for all the observed characteristics, following the methodology suggested by Panse and Sukhatme (1954) [4].

Crop growth parameters

Different crop growth parameters are leaf area index (LAI), absolute growth rate (AGR), Crop growth rate (CGR), Relative growth rate (RGR).

Leaf area index (LAI)

The Leaf Area Index (LAI) was determined by dividing the overall leaf area by the respective ground area, following the approach recommended by Watson (1952) [10] at 50, 60, and 70 Days After Sowing (DAS), as well as at the time of harvest.

$$\text{Leaf area index} = \frac{\text{Leaf area}}{\text{Ground area}}$$

Absolute growth rate (AGR)

It represents the rate of dry matter production per unit time (g day^{-1}) and was g day^{-1}.

$$AGR = \frac{(W_2 - W_1)}{(t_2 - t_1)}$$

In this context, W_1 and W_2 denote the dry matter at earlier and subsequent stages, while t_1 and t_2 indicate the respective time periods during which the measurements for W_1 and W_2 were taken.

Crop growth rate (CGR)

Using the overall dry matter of the plant, the Crop Growth Rate (CGR) was computed using the formula provided by Watson (1952) [10], expressed as g m^{-2} day^{-1}.

$$CGR = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{1}{A}$$

In this equation, W_1 and W_2 refer to the dry matter at earlier and subsequent stages, while t_1 and t_2 represent the respective time periods during which W_1 and W_2 were measured. GA denotes the ground area.

Relative growth rate (RGR)

It denotes the rate at which the dry weight increases per unit of existing dry weight and is specified as g g^{-1} day^{-1} (Blackman, 1919) [11].

$$RGR = \frac{(\log_e W_2 - \log_e W_1)}{(t_2 - t_1)}$$

In this context, W1 and W2 represent the dry weight (in grams) at times t1 and t2, respectively, and the logarithm used is the natural logarithm.

Result and Discussion

Leaf area index

All the treatments were effective to increase LAI over control at all the growth stages. At 50, 60, 70 DAS and at harvest significantly higher leaf area index (2.80, 4.92, 3.43, 2.45) was observed in T_3 (GA_3 @ 100 ppm). Significantly higher mean leaf area index observed in treatment T_3 (3.40), which was followed by T_4 (3.29), T_2 (3.19) T_7 (3.03), T_2 (2.95) and T_8 (2.81), while control T_{11} (2.12) recorded the lowest leaf area index. The leaf area index increased up to 50 DAS and decreased thereafter 70 DAS this is due to senescence of leaves. The visible limitation of leaf senescence is notable during the critical grain filling phase. The application of growth regulators has the potential to mitigate chlorophyll degradation and protease activity. This, in turn, enhances the synthesis of soluble proteins and photosynthetic enzymes, leading to an extended assimilatory surface area for an extended period, as observed by Faldu *et al*. (2018) [2]. Among the various treatments, GA3 was identified as more effective compared to others, and it exhibited similar efficacy to IAA. This aligns with findings from Sarkar *et al*. (2002) [5] in soybean.

Absolute growth rate (g day^{-1})

At 50, 60, 70 DAS and at harvest significantly higher absolute growth rate (AGR) (0.29 g day^{-1}, 0.42 g day^{-1}, 0.36 g day^{-1}, 0.26 g day^{-1}) was observed in T_3 (GA_3 @ 100 ppm). The Absolute Growth Rate (AGR) serves as a straightforward indicator of plant growth, quantifying the alteration in size or the increase in size per unit of time. Absolute growth rate gives absolute values of biomass between two intervals. In present GA_3 @ 100 and 150 ppm and IAA @ 100 ppm was found most effective compared to other similar result was found by Hamoda (2021) [3] in soybean.

Crop growth rate (g m^{-2} day^{-1})

The data related to crop growth rate exhibited statistical significance across all stages. The application of GA_3 at 100 ppm resulted in a significantly higher crop growth rate, recording values of 11.48 g m^{-2} day^{-1}, 19.10 g m^{-2} day^{-1}, 3.25 g m^{-2} day^{-1}, and 2.14 g m^{-2} day^{-1} at 50, 60, 70 Days after Sowing (DAS), and at harvest, respectively. Notably, the crop growth rate (CGR) peaked at 50-60 DAS in treatment T_3, attributed to an increased duration of sunlight conducive to photosynthetic activity. This coincided with higher temperatures recorded in standard weeks 32 and 35. Subsequently, CGR exhibited a steady increase during the pod development phase, followed by the initiation of the pod maturity phase.

Relative growth rate (g g^{-1} day^{-1}): As the crop growth progressed, there was a noticeable decline in the Relative Growth Rate (RGR), as evidenced by this investigation. This decline signifies an increase in dry matter per unit of existing dry matter over time. The reduced RGR in the later stages of the crop can be attributed to a decrease in the rate of dry matter production. The application of growth regulators is hypothesized to enhance photosynthetic efficiency by increasing leaf thickness, retaining more chlorophyll content, and facilitating the efficient translocation of photosynthates. This, in turn, could contribute to an increase in the relative growth rate of plants.

All the treatments exhibited significant differences in RGR values, displaying higher RGR at 50-60 Days After Sowing (DAS), which subsequently decreased after 60 DAS. Notably, treatment T_3 (GA3 @ 100 ppm) recorded significantly higher RGR values, with measurements of 0.0499 g g-1 day-1, 0.0676 g g-1 day-1, 0.0407 g g-1 day-1, and 0.0194 g g-1 day-1 at 50, 60, 70 DAS, and at harvest, respectively.

Table 1: Effect of plant growth regulators on leaf area index of soybean (*Glycine max* L.)

	Treatments	**Leaf area index (LAI)**				
	at 40 and 50 DAS	**50 DAS**	**60 DAS**	**70 DAS**	**At harvest**	**Mean**
T_1	IAA @ 100 ppm	2.51	4.74	3.33	2.19	3.19
T_2	IAA @ 150 ppm	2.43	4.25	3.20	1.91	2.95
T_3	GA_3 @ 100 ppm	2.80	4.92	3.43	2.45	3.40
T_4	GA_3 @ 150 ppm	2.77	4.79	3.37	2.24	3.29
T_5	Kinetin @ 50 ppm	2.28	4.15	2.71	1.26	2.60
T_6	Kinetin @ 75 ppm	2.42	4.16	3.03	1.21	2.71
T_7	Salicylic acid @ 50 ppm	2.44	4.37	3.27	2.06	3.03
T_8	Salicylic acid @ 100 ppm	2.42	4.19	3.06	1.55	2.81
T_9	Brassinosteroid @ 0.1 ppm	2.30	4.16	2.83	1.35	2.67
T_{10}	Brassinosteroid @ 0.25 ppm	2.19	3.82	2.55	1.21	2.44
T_{11}	Control (Water spray)	1.94	3.09	2.31	1.14	2.12
	S.Em±	0.12	0.22	0.16	0.18	
	C.D. at 5%	0.36	0.67	0.48	0.54	
	C.V. %	8.43	9.13	9.47	10.23	

Table 2: Effect of plant growth regulators on absolute growth rate (g day^{-1}) of soybean (*Glycine max* L.)

	Treatments	**Absolute growth rate (g day^{-1})**				
	at 40 and 50 DAS	**50 DAS**	**60 DAS**	**70 DAS**	**At harvest**	**Mean**
T_1	IAA @ 100 ppm	0.26	0.40	0.33	0.24	0.31
T_2	IAA @ 150 ppm	0.23	0.36	0.31	0.20	0.28
T_3	GA_3 @ 100 ppm	0.29	0.42	0.36	0.26	0.33
T_4	GA_3 @ 150 ppm	0.28	0.41	0.34	0.25	0.32
T_5	Kinetin @ 50 ppm	0.21	0.32	0.29	0.18	0.25
T_6	Kinetin @ 75 ppm	0.19	0.32	0.28	0.16	0.24
T_7	Salicylic acid @ 50 ppm	0.25	0.37	0.32	0.21	0.29
T_8	Salicylic acid @ 100 ppm	0.24	0.33	0.30	0.19	0.27
T_9	Brassinosteroid @ 0.1 ppm	0.22	0.33	0.29	0.17	0.25
T_{10}	Brassinosteroid @ 0.25 ppm	0.18	0.30	0.26	0.15	0.22
T_{11}	Control (Water spray)	0.16	0.26	0.23	0.14	0.20
	S.Em±	0.010	0.018	0.016	0.012	
	C.D. at 5%	0.030	0.053	0.046	0.034	
	C.V. %	7.82	9.01	9.10	10.11	

Table 3: Effect of plant growth regulators on crop growth rate (g m^{-2} day^{-1}) of soybean (*Glycine max* L.)

	Treatments	Crop growth rate (g m^{-2} day^{-1})				
	at 40 and 50 DAS	50 DAS	60 DAS	70 DAS	At harvest	Mean
T_1	IAA @ 100 ppm	11.08	18.31	3.10	1.97	8.61
T_2	IAA @ 150 ppm	9.37	16.21	2.62	1.73	7.48
T_3	GA_3 @ 100 ppm	11.48	19.10	3.25	2.14	8.99
T_4	GA_3 @ 150 ppm	11.29	18.58	3.12	2.01	8.75
T_5	Kinetin @ 50 ppm	8.34	15.21	2.33	1.52	6.85
T_6	Kinetin @ 75 ppm	7.56	14.40	2.29	1.49	6.44
T_7	Salicylic acid @ 50 ppm	10.44	17.66	2.80	1.80	8.18
T_8	Salicylic acid @ 100 ppm	9.82	16.80	2.42	1.74	7.70
T_9	Brassinosteroid @ 0.1 ppm	8.58	15.66	2.54	1.50	7.07
T_{10}	Brassinosteroid @ 0.25 ppm	7.34	13.55	2.27	1.45	6.15
T_{11}	Control (Water spray)	5.30	11.10	1.99	1.26	4.92
	S.Em±	0.45	0.84	0.14	0.098	
	C.D. at 5%	1.35	2.48	0.40	0.29	
	C.V. %	8.67	9.06	9.12	9.96	

Table 4: Effect of plant growth regulators on relative growth rate (g g^{-1} day^{-1}) of soybean (*Glycine max* L.)

	Treatments	Relative growth rate (g g^{-1} day^{-1})				
	at 40 and 50 DAS	50 DAS	60 DAS	70 DAS	At harvest	Mean
T_1	IAA @ 100 ppm	0.0483	0.0673	0.0337	0.0190	0.0421
T_2	IAA @ 150 ppm	0.0469	0.0609	0.0322	0.0150	0.0388
T_3	GA_3 @ 100 ppm	0.0499	0.0676	0.0407	0.0194	0.0444
T_4	GA_3 @ 150 ppm	0.0489	0.0674	0.0343	0.0191	0.0424
T_5	Kinetin @ 50 ppm	0.0406	0.0556	0.0309	0.0137	0.0352
T_6	Kinetin @ 75 ppm	0.0396	0.0549	0.0303	0.0124	0.0343
T_7	Salicylic acid @ 50 ppm	0.0479	0.0662	0.0330	0.0167	0.0410
T_8	Salicylic acid @ 100 ppm	0.0473	0.0656	0.0320	0.0144	0.0398
T_9	Brassinosteroid @ 0.1 ppm	0.0409	0.0566	0.0314	0.0131	0.0355
T_{10}	Brassinosteroid @ 0.25 ppm	0.0389	0.0529	0.0303	0.0130	0.0338
T_{11}	Control (Water spray)	0.0339	0.0472	0.0196	0.0117	0.0281
	S.Em±	0.002	0.0033	0.001	0.00084	
	C.D. at 5%	0.006	0.0099	0.005	0.0024	
	C.V. %	9.12	9.74	10.44	9.57	

Conclusion

The leaf area index started with a low value during the initial stage of crop growth, peaked at 60 Days After Sowing (DAS), and then declined towards crop maturity due to senescence in the reproductive phase. This pattern provides valuable insights into the plant's photosynthetic capacity. Treatment T_3 (GA3 @ 100 ppm) exhibited a significantly higher leaf area index (3.40), comparable to T_4 (GA3 @ 150 ppm). Notably, treatment T_3 (GA3 @ 100 ppm) displayed significantly elevated mean values for Absolute Growth Rate (AGR) at 0.33 g day^{-1}, Crop Growth Rate (CGR) at 8.99 g m^{-1} day^{-1}, Relative Growth Rate (RGR) at 0.044 g g^{-1} day^{-1}, and Leaf Area Index (LAI). This higher-yielding treatment demonstrated a substantial increase in crucial growth parameters, including AGR, CGR, RGR, and LAI, compared to the control.

References

1. Anonymous. Annual progress report kharif maize 2018. AICRP on maize, Directorate of Maize Research, Pusa Campus, New Delhi 110 012, India; c2018. p. 835.
2. Faldu TA, Kataria GK, Singh CK, Paghadal CB. Influence of plant growth regulators on morphological and physiological parameters of groundnut (*Arachis hypogaea* L.) cv. GJG-9. J Pharmacogn Phytochem. 2018;7(3):2341-2344.
3. Hamoda AM. Effect of sowing dates and gibberellin foliar application on growth of soybean. Ann Agric Sci. 2021;59(1):9-16.
4. Panse VG, Sukhatme PV. Statistical methods for agriculture workers. ICAR, New Delhi; c1954. p. 147-156.
5. Sarkar PK, Haque MS, Karim MA. Effects of GA3 and IAA and their frequency of application on morphology, yield contributing characters and yield of soybean. J Agron. 2002;1(4):119-122.
6. Senthil A, Pathmanaban G, Srinivasan PS. Effect of bioregulators on some physiological and biochemical parameters of soybean (*Glycine max* L.). Legume Res India. 2003;26:54-56.
7. Singh I, Phil PS. Correlation and path coefficient analysis in soybean. Legume Res. 1999;22(1):67-68.
8. Solomani A, Sivakumar C, Anbumani S, Suresh T, Arumugam K. Role of plant growth regulators on rice production. Agric Rev. 2001;23:33-40.
9. Sontakey PY, Nair B, Pillewan SS, Deotale RD, Manupure P. Effect of steroids on growth and yield of soybean. J Soils Crops. 1999;9(2):231-237.
10. Watson DJ. The physiological basis of variation in yield. Advances in agronomy. 1952 Jan 1;4:101-145.
11. Blackman VH. The compound interest law and plant growth. Annals of botany. 1919 Jul 1;33(131):353-360.