

PHYSIOLOGICAL EFFICIENCY AND SEED YIELD OF SESAME AS INFLUENCED BY DIFFERENT PLANT GROWTH REGULATOR

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ABSTRACT

Sesame (*Sesamum indicum* L.) is an important oilseed crop cultivated in India since ages during kharif season. Excessive vegetative growth is observed under favourable environment and optimal moisture conditions, which resulted in lower capsule formation, reduced seed yield due to poor source to sink partitioning of photosynthates resulting in low yield and poor harvest index of the crop. A field experiment was conducted during the *Kharif* season of 2025 at the Research Farm of the ICAR All India Coordinated Research Project (Sesame and Niger) Unit, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV) to identify environmentally acceptable and practically affordable plant growth regulator that can modify plant growth suitably through growth retardants, stress-mitigating compounds and potassium nutrition to improve assimilate production, partitioning and reproductive efficiency in sesame by improving the physiological efficiency of the crop to increase productivity of sesame. The experiment was laid out in a randomized block design (RBD) with three replications and eleven treatments comprising a control, salicylic acid, paclobutrazol, mepiquat chloride, chlormequat chloride and potassium chloride (KCl), applied either as a single spray at 60 days after sowing (DAS) or as split sprays at 45 and 60 DAS. Each foliar treatment was applied at a spray volume of 300 L ha⁻¹. The treatments included salicylic acid at 200 ppm at 60 DAS and 100 ppm at 45 and 60 DAS; paclobutrazol, mepiquat chloride and chlormequat chloride at 200 ppm at 60 DAS and 100 ppm at 45 and 60 DAS; and KCl at 2% at 60 DAS and at 45 and 60 DAS. Observations were recorded on plant growth attributes, physiological parameters, yield attributes and seed yield. Among the treatments, chlormequat chloride @ 200 ppm applied at 60 DAS (T8) consistently outperformed other treatments, combining the highest Leaf Area Index (3.18) at 60 DAS, Leaf Area Duration 53.55 m² days during 30–60 DAS and 64.20 m² days during 60DAS –maturity, Crop Growth Rate of 9.55 g m² day⁻¹ at 30–60 DAS and 19.90 g m² day⁻¹ during 60DAS – maturity, Net Assimilation Rate during 30–60 DAS varied from 6.67 g m² day⁻¹ (T4) to 7.32 g m² day⁻¹ (T3), however it varied significantly during 60 DAS - maturity and maximum NAR (9.78 g m² day⁻¹) was recorded under treatment T1, Light Transmission Ratio varied from 30.68 to 34.19%, energy interception varied from 65.81 to 69.32% while chlorophyll content varied between 46.93 (T1) and 55.72 (T8). These improvements in physiological and yield attributes were reflected in the highest seed yield of 692.03 kg ha⁻¹, HI 32.44% and oil content 47.67% was recorded in T8, whereas higher biological yield 2514.34 kg ha⁻¹, was recorded under treatment T2. Application of PGRs significantly influenced seed yield and oil content in sesame. Among the treatments, Chlormequat chloride @ 200 ppm at 60 DAS @ 300 L ha⁻¹(T8) proved to be most effective in improving seed yield, partitioning efficiency, and seed quality and found most effective for enhancing crop productivity.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the oldest cultivated oilseed crops and is valued for its high-quality edible oil, nutritional composition and diverse industrial uses. Sesame seed contains about 45–55% oil, with a favourable proportion of unsaturated fatty acids, and is also an important source of protein, antioxidants, minerals and bioactive compounds. Despite its economic and nutritional importance, sesame productivity remains relatively low compared with its genetic potential. Low and unstable yields are associated with several factors, including indeterminate growth habit, excessive vegetative growth, asynchronous flowering and maturity, poor assimilate partitioning, lodging, capsule shattering and sensitivity to environmental stresses. Plant growth and productivity are governed by a complex interaction between genetic potential, environmental conditions and endogenous plant hormones. Plant growth regulators (PGRs) are biologically active compounds that, even at relatively low concentrations, can modify physiological and biochemical processes such as cell division, cell elongation, photosynthesis, assimilate translocation, reproductive development and senescence.

Exogenous application of growth-promoting or growth-retarding regulators can therefore alter plant architecture and improve the balance between vegetative and reproductive growth. Compounds such as salicylic acid, paclobutrazol, mepiquat chloride and chlormequat chloride have been reported to influence crop growth, canopy development, photosynthetic efficiency and yield attributes in different crops.

In sesame, excessive vegetative growth may result in inefficient utilization of assimilates and resources, whereas appropriate modification of plant architecture may enhance light interception, photosynthetic activity and assimilate partitioning towards developing capsules and seeds. Salicylic acid may enhance physiological efficiency by influencing photosynthesis, antioxidant defence and stress tolerance, while growth retardants such as paclobutrazol, mepiquat chloride and chlormequat chloride may restrict excessive vegetative growth and promote reproductive development. However, the response of sesame to PGRs is highly dependent on the type of regulator, concentration, time and method of application, as well as prevailing environmental conditions. Information on the comparative effects of different PGRs and application schedules on physiological efficiency and seed productivity of sesame remains relatively limited.

Therefore, systematic evaluation of suitable PGRs and their application strategies is essential for developing an efficient crop-management technology for sesame. The present study was undertaken to assess the influence of different plant growth regulators on growth, physiological efficiency, yield attributes and seed yield of sesame, and to identify suitable PGR treatments for improving assimilate utilization and reproductive productivity of the crop.

MATERIAL AND METHODS:

The field experiment was conducted during the *Kharif* season of 2025 at the Research Farm of the ICAR All India Coordinated Research Project (Sesame and Niger) Unit, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV). The experimental site had a fairly uniform topography and was characterized by the occurrence of localized weeds commonly prevalent in the area. Geographically, Jabalpur is located at 23° 90' N latitude and 79° 58' E longitude and at an altitude nearly of 411.78 m above mean sea level as per the classification of the National Agricultural Research Project (NARP), New Delhi, Jabalpur comes under the "Kymore Plateau and Satpura Hills" agro-climatic zone. The average annual rainfall of Jabalpur region is approximately 1350 mm, primarily received during mid-June to the end of September.

The soils of the experimental area were sandy clay loam texture with proper drainage, gentle slope. The soil reaction varied from neutral to slightly alkaline, with an optimum pH of 7.3, low in organic carbon content, moderate in available nitrogen, phosphorus and potassium, with optimum electrical conductivity. The experiment was laid out in a randomized block design (RBD) with three replications and eleven treatments comprising a Control (T1), Salicylic acid @ 200 ppm at 60 DAS @ 300 L ha⁻¹(T2), Salicylic acid @ 100 ppm at 45 & 60 DAS @ 300 L ha⁻¹(T3), Paclobutrazol @ 200 ppm at 60 DAS @ 300 L ha⁻¹(T4), Paclobutrazol @ 100 ppm at 45 & 60 DAS @ 300 L ha⁻¹(T5), Mepiquat chloride @ 200 ppm at 60 DAS @ 300 L ha⁻¹(T6), Mepiquat chloride @ 100 ppm at 45 & 60 DAS @ 300 L ha⁻¹(T7), Chlormequat chloride @ 200 ppm at 60 DAS @ 300 L ha⁻¹(T8), Chlormequat chloride @ 100 ppm at 45 & 60 DAS @ 300 L ha⁻¹(T9), KCL @ 2% at 60 DAS @ 300 L ha⁻¹(T10) and KCL @ 2% at 45 & 60 DAS @ 300 L ha⁻¹(T11). Observations were recorded on important physiological plant growth attributes having substantial influence on seed and oil yield.

RESULTS AND DISCUSSION

The analysis of canopy development and growth dynamics revealed significant differences among treatments. Leaf Area Index (LAI) at 60 DAS varied from 2.68 (T5) to 3.18 (T8). The higher LAI values were recorded in T8, T6, and T4, indicating superior canopy expansion and greater potential for light interception (table1). In contrast, T5 exhibited the lowest LAI, reflecting restricted leaf development under the influence of treatments on canopy architecture. The Leaf Area Duration (LAD) ranged between 45.67 m² days (T5) and 53.55 m² days (T8) during 30–60 DAS and 55.57 m² days (T5) and 64.20 m² days (T8) during 60–maturity. Treatments T8, T6, and T4 consistently maintained higher LAD values, suggesting prolonged photosynthetic activity and sustained assimilate production during the critical growth phase suggesting that these treatments significantly enhanced leaf longevity and functional duration, which are vital for biomass accumulation. Crop Growth Rate (CGR) also showed significant variation, ranging from 8.34 g m² day⁻¹ (T2) to 9.55 g m² day⁻¹ (T8) at 30–60 DAS and 15.61 g m² day⁻¹ (T2) to 19.90 g m² day⁻¹ (T8) at 60DAS - maturity, implying that growth efficiency per unit area significantly enhanced across treatments due to changes in canopy traits (Table 1).

Table 1: Effect of different PGR treatments on Leaf Area Index, Leaf Area Duration and Crop Growth Rate.

Treatments	Leaf Area Index (LAI)	Leaf Area Duration (LAD) (m ² days)			Crop Growth Rate (CGR) (g m ² day ⁻¹)	
	At 60 DAS	At 30 -60	At 30-60 DAS		At 30-60 DAS	At 30 -60 DAS

		DAS m ² days			m ² days
T1	2.90	49.30	59.30	8.65	19.00
T2	2.95	49.79	58.52	8.34	15.61
T3	2.94	49.90	61.40	9.16	18.14
T4	3.10	52.25	59.79	8.59	17.19
T5	2.68	45.67	55.57	8.35	15.68
T6	3.13	52.80	63.91	8.84	18.51
T7	2.84	47.84	57.92	8.40	17.64
T8	3.18	53.55	64.20	9.55	19.90
T9	2.88	48.94	58.20	8.39	15.80
T10	2.98	50.51	60.41	8.82	18.55
T11	2.80	47.99	59.45	8.84	19.02
SEM	0.06	0.94	0.98	0.15	0.38
CD at 5%	0.18	2.76	2.88	0.44	1.11

The differences in Net Assimilation Rate (NAR) during 30–60 DAS were statistically non-significant, indicating uniform assimilation efficiency across treatments. The NAR varied from 6.67 g m² day⁻¹ (T4) to 7.32 g m² day⁻¹ (T3), however it varied significantly during 60 DAS - maturity and maximum NAR (9.78 g m² day⁻¹) was recorded under treatment T1, while minimum (NAR) was recorded in treatment T₂ (8.19 g m² day⁻¹) indicating higher assimilation efficiency. The effect of different plant growth regulator treatments on light transmission Ratio (LTR) exhibited non-significant differences and it varied from 30.68 to 34.19% suggesting that canopy architecture could not influence light penetration in different treatments. Among different treatments T₅ (34.19%) recorded maximum (LTR), while minimum (LTR) was recorded in treatment T₈ (30.68%). The effect of different plant growth regulator treatments on energy interception exhibited non-significant differences and it varied from 65.81 to 69.32% indicating comparable canopy efficiency in capturing solar energy. Among all treatments T₈ (69.32%) recorded maximum energy interception, while minimum energy interception was recorded in treatment T₅ (65.81%) (table 2). Significant differences for chlorophyll content were observed among different treatments and it varied between 46.93 (T1) and 55.72 (T8). Treatments T8, T6, T11, and T5 recorded higher SPAD values, while T1 and T9 showed the lowest values indicating significant effect of treatments on leaf greenness and photosynthetic potential. T8 emerged as a promising treatment, combining high chlorophyll content and favorable LTR with competitive NAR. T5 and T7 excelled in energy interception, while T3 showed superior assimilation efficiency. Overall, canopy traits (LTR and energy interception) and biochemical attributes (chlorophyll content) jointly determined productivity potential, with T8 proved to be the most balanced treatment in terms of canopy openness, pigment concentration, and assimilation efficiency, positioning it as the most effective treatment for maximizing crop productivity.

Table 2: Effect of different PGR treatments on Net Assimilation Rate, Light Transmitting Ratio, Energy Interception and Chlorophyll content

Treatments	Net Assimilation Rate (g m ² day ⁻¹)		Light Transmitting Ratio (LTR)	Energy Interception (%)	Chlorophyll content (SPAD)
	At 30-60 DAS	At 60 DAS - maturity			
T1	6.94	9.78	31.77	68.23	46.93
T2	6.72	8.19	32.97	67.03	54.42
T3	7.32	8.99	30.88	69.12	52.90
T4	6.67	8.90	32.78	67.22	50.22
T5	7.19	8.58	34.19	65.81	53.94

T6	6.78	8.84	32.03	67.97	55.42
T7	7.13	9.30	34.02	65.98	49.66
T8	7.17	9.48	30.68	69.32	55.72
T9	6.87	8.30	33.62	66.83	48.03
T10	6.93	9.39	34.07	65.93	54.22
T11	7.17	9.72	31.95	68.05	55.07
SEM	0.25	0.22	1.30	1.66	2.02
CD at 5%	NS	0.64	NS	NS	5.95

The differences were statistically significant, indicating that PGR treatments had a marked influence on seed yield. Seed yield ranged from 511.86 (T1) to 692.03 (T8). The highest yield was recorded in T8 (692.03), followed by T2 (677.31) and T9 (654.44). The lowest yield was observed in T1 (511.86) (table 3). Biological yield varied between 1928.40 (T4) and 2514.34 (T2) however the differences could not attain the level of significance, suggesting that PGR treatments did not significantly affect total biomass production. HI indicates the partitioning efficiency of assimilates into seeds; it ranged from 23.99% (T1) to 32.44% (T8). Treatments T8, T4, and T6 recorded higher HI values, while T1 showed the lowest. Significant differences in oil content were observed indicating treatment effects on seed quality. The oil content in the seed varied between 45.85% (T1) and 47.67% (T8). Treatments T8, T4, and T5 recorded higher oil percentages, while T1 and T6 showed lower values (**Table 3**). Application of PGRs significantly influenced seed yield and oil content, while biological yield and harvest index remained statistically unaffected. Among the treatments, T8 proved most effective, offering a balanced improvement in yield, partitioning efficiency, and seed quality, thereby proved to be most suitable for enhancing crop productivity.

Table 3: Influence of different PGR treatments on seed yield, biological yield, and Harvest index

Treatments	Seed yield (kg ha⁻¹)	Biological yield (kg ha⁻¹)	Harvest index (HI) (%)	OIL content (%)
T1	511.86	2131.86	23.99	45.85
T2	677.31	2514.34	27.65	46.60
T3	621.30	2081.24	30.81	46.27
T4	581.01	1928.40	32.28	47.27
T5	615.72	2285.92	28.50	46.93
T6	637.50	2088.19	32.21	45.94
T7	601.38	2008.85	30.18	46.80
T8	692.03	2149.05	32.44	47.67
T9	654.44	2376.19	27.88	46.20
T10	556.01	1999.53	27.81	46.01
T11	579.02	2119.85	27.87	45.93
SEM	22.19	250.15	3.00	0.30
CD at 5%	65.45	NS	NS	0.88

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