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Research Article

EFFECT OF FOLIAR APPLICATION OF PLANT GROWTH RETARDANTS ON GROWTH, YIELD AND YIELD ATTRIBUTING PARAMETERS OF SOYBEAN (*Glycine max* L.) MERRILL

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Abstract- Plant growth regulators (PGRS) are known to improve physiological efficiency including photosynthetic ability of plants and offer significant role in realizing higher crop yields. In present study, field experiments were conducted at the Research Farm Dusty Acre, Department of Plant Breeding & Genetics, JNKVV, Jabalpur during kharif 2013. The experiment was laid out in RBD with three replications. The experiment consisted of 7 treatments comprised to different concentration of plant growth retardants *viz*., paclobutrazol (40SC 60ml, 75ml, 90ml and 23SC 105.6ml, 132ml) and Chlormequat chloride (50%SL 500ml). Observation on various growth, yield and yield attributing parameters in soybean were recorded. The leaf area index significantly increased up to 75 DAS and declined steadily towards maturity. The LAI (Leaf Area Index) and LAD (Leaf Area Duration) were found to be maximum in Cycocel (CCC) and were recorded to be lower in PBZ. Among the most important major yield attributing traits *viz;* number of flowers per plant, number of pods per plant, pod length, pod width, pod weight, 100 seed weight, seed yield, biological yield and harvest index were influenced by the foliar application of plant growth retardants

Keywords- Soybean, Plant growth retardants, Yield contributing character, Foliar application.

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Introduction

Soybean (*Glycine max* L.) Merrill) belongs to family "leguminosae", sub-family "papilionaceae" has been called "Golden bean" or "Miracle crop" of the twentieth century. It is one of the most important protein and oilseed crops throughout the world. Its oil is the largest component, highly nutritive and energy legume with 43% of biologically effective protein and 20% of edible oil ranks first among the oil seed crops in India. Almost all essential amino acids particularly glycine, tryptophan, lysine, fatty acid, and vitamins A and D contain a considerate amount of vitamin C. Soybean has been adopted and commercially cultivated in several countries, such as Japan, China, Indonesia, Philippines and Europe. In India, the production of soybean is restricted mainly to Madhya Pradesh, Maharashtra, Rajasthan, Karnataka and Andhra Pradesh. At present, it has been established as a most important oilseed crop of India and Madhya Pradesh (M.P.). Soybean has unprecedented expansion in India by recording 15-20% annual growth rate. It has emerged very fast since early eighties and occupied vital place in agriculture, edible oil economy, foreign exchange and upliftment of socio-economic status of soybean farmers. It contributes around 25% of total edible oil pool of the country. India produces about 8.6 million tons and in M.P. 4.4 million tons of soybean (2014-15). Madhya Pradesh is the soybean bowl of India, contributing 55-60 per cent of country's soybean production. The legume crops are rich in protein and improve human nutrition. These crops improve the soil fertility through the process of nitrogen fixation in the root nodules. The cereal pulses crop intercropping is important for enhancing nutritional food products without causing any loss to the soil structure and health. Soybean is main crop of kharif season, which one or other stage of crop suffers due to excessive moisture stress conditions. The excessive moisture condition occurs due two major reasons: first poor drainage and second heavy and continued rainfall. This situation, adversely affects the crop growth, nutrient availability and ultimately yield. Growth retardants are known to improve the source-sink relationship, translocation of photo-assimilates and thereby photosynthetic ability of the plant and thus play a significant role in realization of high productivity level and higher crop yields. The use of plant growth regulators has therefore been described as the most important tool of the agriculturist to increase crop yields. Plant growth retardants play key role in contributing internal mechanisms of plant growth by interacting with key metabolic processes such as, nucleic acid metabolism and protein synthesis. Growth retardants are known to reduce inter-nodal distance, thereby enhancing source-sink relationship and stimulate the translocation of photo-assimilates to the seeds [1]. Growth regulators exert their influence on foliar transport in a number of ways. These could enhance the absorption by the leaf at the site of application, increase the migration within the leaf and stimulate the transport out of leaf in the acropetal and basipetal direction. The main objectives of this study were to adjudge the effect of foliar application of plant growth retardants on plant Growth, Yield and yield attributing parameters.

Materials and Methods

Location of collection

The specimens of *M. dayanum* were collected from local Lake of Sagar, and were brought to the laboratory of Department of Zoology, Dr. Harisingh Gour University Sagar (MP) under oxygen packing in live condition.

The present study was conducted Research Farm Dusty acre, Department of Plant Breeding and Genetics, JNKVV, Jabalpur (M.P.) during Kharif season of 2013. The Variety under study was JS97-52. The date of Sowing was 25/06/2013

and date of harvest was 07/10/2013 .The seeds of each soybean were sown at the rate of 80 kg/ha by hand dibbling at depth of 4-5 cm in open furrows. Seven treatments were evaluated in Randomized Block Design (RBD) with three replications. The treatments included two plant growth retardants i.e., Paclobutrazol (40SC 60ml, 75ml, 90ml and 23SC 105.6ml, 132ml) and Chlormequate Chloride (50%SL 500ml) with is different foliar concentrations .The concentration of Paclobutrazol were selected after initial evaluation and these concentration were found effective as against the control. The foliar applications were given at the time of vegetative growth stage. The experimental plots were kept weed free by hand weeding and one hoeing was applied after 45 days after planting. Sampling for growth analysis was done at the fixed intervals of 15 days from 20 days after sowing onwards till harvest. Five plants were randomly selected from each treatment and replications for growth analysis. The observations were subdivided into following groups and recorded during the crop season.

Phenological observations

Estimation of leaf area, dry matter production and its partitioning in different plant parts was done at fixed intervals. The leaf area was recorded by using laser area meter (LI-300) whereas, the physiological traits *viz.,* net photosynthesis, PAR absorption, transpiration rate and other physiological processes, were recorded with the help of Infrared Gas Analyser (IRGA model LI-6400). For estimating the dry matter production 5 plants were uprooted from each plot. Dry weight of individual plant part as well as whole plant was recorded accordingly. Chlorophyll content in the 4th leaf of five weeks old plant were determined as chlorophyll index using a non-destructive method using an optical instrument called chlorophyll meter (Apogee, instruments in c, 721w1800N, Logan,(VT84321)USA). (Measure by Chlorophyll content meter Model: CCM 200).

Yield and yield attributing parameters

Plant height, Number of leaves/plant, Number of Branches /plant, Number of flowers /plant, No. of pods / plant, No. of seeds / pod, Pod length (mm), Pod width(mm), Chlorophyll content, RWC% (Relative water content, Seed yield (g/plant & kg/ha), Biological yield (g/ plant & kg/ha), Seed Index (g) and Harvest index (%) morphological yield attributing parameters were quantified at maturity. The mean of plants per replication per treatment was used for further statistical analysis.

Statistical analysis

Analysis of observations was taken on different variables was carried out to know the degree of variation among all the treatments. The pooled data was statistically analyzed using Analysis of variance (ANOVA) through randomized block design [2].

Results and Discussion

Phenological developments

The Effect of plant growth retardants paclobutrazol, chlormequat chloride on Phenological developments of soybean is presented in the [Table-1]. The results revealed that a significant variation was existing among all treatments with regards to their day's requirement for completion of phenophases. The number of days required to attain flower initiation under the influence of various treatment combinations of plant growth retardants paclobutrazol, chlormequat chloride, revealed that the treatments T7 (42.33d) required significantly minimum number of days to flower initiation at par with T4 (42.67d) and T6 (43.00d) whereas, T1 (45.33d) taken maximum number of days to flower initiation. Regarding 50% flowering stage the treatments T7 (47.00d) required significantly minimum days to attained 50% flowering stage, which was at par with T4 (47.33d) and T6 (47.67d) indicating their capability to produce more number of flowers within a short span of time where as T1 (50.00d) taken longest time to attained 50% flowering stage. For pod initiation treatments T7 (50.67d) required significantly minimum number of days to pod initiation at par with T4 (51.33d) and T2/T3/T6 (51.67d) while, T1 (53.33d) had more number of days to attain pod initiation. The number of days required to seed formation, revealed that the treatments T7 (99.00d) required significantly minimum number of days for seed formation, at par with T4/T6 (99.33d) and T3 (99.67d) whereas T1 (101.33d) registered as a treatment which taken more number of days to seed formation. Data noted regarding Phenological development of soybean treatments revealed that influence of paclobutrazol, chlormequat chloride T7 (89.67d) attained physiological maturity within lesser number of days at par with T6 (90.33d) and T4 (90.67d) whereas, T1 (92.00d) registered as a treatment which taken longest span (days) to attain physiological maturity. The similar result has been reported by [3,4].

Table-1 *Effect of plant growth retardants paclobutrazol, chlormequat chloride on phenological developments of Soybean*

Treatment detail	Days to flower initiation	Days to 50 % flowering	Days to pod initiation	Days to seed formation	Days to physiological maturity
T_1-Control (No foliar spray)	45.33	50.00	53.33	92.00	101.33
T_2-Paclobutrazol 40SC @60ml/ha	44.33	48.33	51.67	91.33	100.33
T_3-Paclobutrazol 40SC @75ml/ha	43.67	48.33	51.33	91.00	99.67
T_4-Paclobutrazol 40SC @90ml/ha	42.67	47.33	51.33	90.67	99.33
T_5-Paclobutrazol 23SC @105.6ml/ha	44.67	49.33	52.67	91.67	101.00
T6 -Paclobutrazol 23SC@132ml/ha	43.00	47.67	51.00	90.33	99.33
T_7-Chlormequat Chloride 50%SL 500ml/ha	42.33	47.00	50.67	89.67	99.00
Mean	**43.71**	**48.29**	**51.71**	**90.95**	**100.00**
SEm±	**0.38**	**0.29**	**0.30**	**0.36**	**0.30**
CD at 5%	**1.17**	**0.90**	**0.91**	**1.11**	**0.94**

Growth parameters

Leaf Area Index (LAI) differed significantly due to the influence of various treatments of plant growth retardants paclobutrazol, and chlormequat chloride at different crop growth stages [Table-2]. At 30 DAS the Significantly maximum LAI was exhibited by T5 (1.28) closely at par with T2 (1.25), T3(1.24) and T1 (1.22) whereas, significantly minimum LAI was estimated in T7 (1.17). At 45 DAS T7 revealed significantly highest LAI (2.10) which was at par with T5 (2.00), followed by T1 (1.99) and least LAI was noted in T4 (1.78). At 60 DAS the highest LAI was exhibited by T7 (3.30) followed by T1 (2.73) at par with T5 (2.59) and T2 (2.51) whereas the minimum LAI was noted in T4 (2.38). At 60 DAS the maximum LAI was exhibited by T7 (3.30) followed by T1 (2.73) at par with T5 (2.59) and T2 (2.51) while, minimum LAI was recorded in T4 (2.38).At 75 DAS Significantly maximum LAI value was reported under T7(4.19) followed byT1 (3.82) and T5(3.40) at par with T2 (3.37) while, lowest LAI was estimated in T4 (2.98). At 90 DAS T7 had significantly the highest value (3.21) for LAI followed by T1 (2.77) and T3 (2.52) while, least value of LAI was observed under T6 (2.30). The similar results have been reported by [5].

Physiological traits

The physiological traits differed significantly due to various soybean treatments under foliar spray of plant growth retardants paclobutrazol (PBZ) and chlormequat chloride (CCC) at various crop growth stages [Table-3] in soybean. Net photosynthesis (μmol/m2/sec) under foliar spray of plant growth retardants maximum net photosynthesis was recorded in T3 (17.10) followed by T7 (15.80) and T4 (14.10) while lowest was recorded in T1 (11.70). Water Use Efficiency (mol mol-1) was observed in T3 (5.33), which was followed by T7 (4.36) at par with T2 (4.00) and T4 (3.62) while significantly minimum value of WUE was noted under T1 (3.05). Air temperature (0c) T1 (4.63) had significantly maximum for air temperature over other treatments, which was at par with T6 (33.24) and T4 (33.07) followed by T5 (31.80) whereas, significantly minimum valve was

observed in T1/T2/T7 (31.50). Canopy temperature (°c) under foliar spray of plant growth retardants significantly highest canopy temperature was recorded under T4 (34.04), which was at par with T5 (33.92) followed by T2 (33.74) however, significantly minimum value was recorded under T1 (32.49). Regarding Transpiration rate (m mol/m2/sec), T1 (4.63) had significantly higher transpiration rate over other treatments, which was followed by T6 (4.24) and T7 (3.63) while, significantly least value was recorded in T4 (3.13) [Table-4]. Regarding Stomatal conductance (mol/m2/sec) significantly maximum value was noted in T3 (0.27) followed by T6/T7 (0.24) and T4 (0.21) however, significantly minimum value was observed under T1 (0.16).

Table-2 *Influence of plant growth retardants on Leaf Area Index (LAI) at different growth stages in soybean*

Treatment detail	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T_1-Control (No foliar spray)	1.22	1.99	2.73	3.82	2.77
T_2-Paclobutrazol 40SC @60ml/ha	1.25	1.96	2.51	3.37	2.49
T_3-Paclobutrazol 40SC @75ml/ha	1.24	1.92	2.47	3.18	2.52
T_4-Paclobutrazol 40SC @90ml/ha	1.19	1.78	2.38	2.98	2.31
T_5-Paclobutrazol 23SC @105.6ml/ha	1.28	2.00	2.59	3.4	2.46
T6 -Paclobutrazol 23SC@132ml/ha	1.19	1.82	2.42	3.00	2.30
T_7-Chlormequat Chloride 50%SL 500ml/ha	1.17	2.10	3.30	4.19	3.21
Mean	**1.22**	**1.94**	**2.63**	**3.42**	**2.58**
SEm±	**0.02**	**0.022**	**0.044**	**0.054**	**0.043**
CD at 5%	**0.062**	**0.067**	**0.137**	**0.166**	**0.133**

Table-3 *Influence of plant growth retardants on Net photosynthesis, Water use efficiency, Air temperature and Canopy temperature in soybean*

Treatment detail	Net photosynthesis (mmol/m²/s)	Water use efficiency (mmol/mol)	Air Temp (0c)	Canopy Temperature (0c)
T1-Control (No foliar spray)	11.7	3.05	31.5	32.49
T_2-Paclobutrazol 40SC @60ml/ha	12.5	4	31.5	32.53
T_3-Paclobutrazol 40SC @75ml/ha	17.1	5.33	33.67	34.04
T_4-Paclobutrazol 40SC @90ml/ha	14.1	3.62	33.07	33.34
T_5-Paclobutrazol 23SC @105.6ml/ha	13	4.13	31.8	33.92
T6 -Paclobutrazol 23SC@132ml/ha	13.6	3.21	33.24	33.74
T_7-Chlormequat Chloride 50%SL 500ml/ha	15.8	4.36	31.5	32.54
Mean	**13.97**	**3.96**	**32.39**	**33.23**
SEm±	**0.06**	**0.07**	**0.24**	**0.04**
CD at 5%	**0.18**	**0.21**	**0.73**	**0.12**

[Table-4] Carboxylation efficiency [µmol m-2 s-1(µmol mol-1)-1] Under foliar spray of plant growth retardants significantly maximum carboxylation efficiency was recorded in T3 (0.07) other value was followed by T7 (0.06) and T5 (0.05) however, significantly least carboxylation efficiency was recorded under T1/T6/T2 (0.04) [Table-4]. Significantly highest quantum efficiency was noted under T7 (0.06) value, which was at par with T2 (0.05) and T1/T5 (0.04) whereas, lowest was observed in T6 (0.02) [Table-4]. Regarding Mesophyll efficiency (µmol mol-1(mol/m2/sec)-1) T3 (1596.90) had significantly higher for mesophyll efficiency over other treatments, which was followed by T2 (1460.70) at par with T7 (1436.08). Significantly lowest value was observed under T1 (1153.08) for mesophyll efficiency [Table-5]. CO2 concentration (µmol mol-1) was highest in T3 (314.33), which was at par with T7 (308.00) followed by T4 (296.67) whereas, significantly least value was noted in T1 (247.67) [Table-5]. Regarding Relative Water Content (RWC %) T7 (73.05) had significantly maximum RWC over other treatments, which was followed by T3 (72.41) and T5 (71.24) while, significantly lowest value was noted in T4 (69.77) [Table-5]. Chlorophyll Content Index (CCI %) is summarized in [Table-5]. At 40 DAS significantly highest chlorophyll content index was exhibited by T3 (18.09), which was at par with T1 (18.04) and T2 (17.01) whereas, T7 (15.08) showed the lowest chlorophyll content index as compared to others. At 70 DAS T7 (21.16) had significantly maximum values for chlorophyll content index over other treatments which was at par with T3 (20.80) and T2 (19.57) however, minimum was recorded under T1 (16.81). The similar result has been reported by [6, 7].

Table-4 *Influence of plant growth retardants on Transpiration rate, Stomatal conductance, Carboxylation efficiency and Quantum efficiency in soybean*

Treatment detail	Transpiration rate (mmol/m²/s)	Stomatal conductance (mol/m²/s)	Carboxylation efficiency [mmol m-2 s-1 (mmol mol-1)-1]	Quantum efficiency
T_1-Control (No foliar spray)	4.63	0.16	0.04	0.04
T_2-Paclobutrazol 40SC @60ml/ha	3.23	0.20	0.04	0.05
T_3-Paclobutrazol 40SC @75ml/ha	3.21	0.27	0.07	0.03
T_4-Paclobutrazol 40SC @90ml/ha	3.13	0.21	0.05	0.03
T_5-Paclobutrazol 23SC @105.6ml/ha	3.15	0.19	0.05	0.04
T6 -Paclobutrazol 23SC@132ml/ha	4.24	0.24	0.04	0.02
T_7-Chlormequat Chloride 50%SL 500ml/ha	3.63	0.24	0.06	0.06
Mean	**3.6**	**0.22**	**0.05**	**0.04**
SEm±	**0.06**	**0.004**	**0.001**	**0.03**
CD at 5%	**0.19**	**0.01**	**0.002**	**0.09**

Morph physiological yield attributing parameters

The morphological attributes differed significantly due to various foliar sprays of plant growth retardants PBZ and CCC [Table-6] in soybean. Plant height (cm) was varied significantly at P<0.05 maturity under foliar spray of plant growth retardants at maturity in soybean. Significantly maximum plant height was recorded under T1 (38.44) which was at par with T5 (37.66) followed by T2 (37.15) while, T4 (34.91) had least plant height. No. of leaves per plant was influenced significantly due to foliar spray of plant growth retardants in soybean. Significantly higher no. of leaves was observed in T7 (32.56) followed by T1 (31.01) and T6 (30.91) whereas, minimum no. of leaves was noted under T4 (29.44). Number of branches per plant was varied significantly due to foliar spray of plant growth retardants at maturity in soybean. Significantly maximum number of branches per plant was obtained in T3 (7.10) followed by T7 (6.50), it was at par with T6 (5.83). T1 (4.93) had lowest number of branches per plant. Number of nodes per plant

was influenced significantly due to foliar spray treatments at maturity of plant growth retardants in soybean. Significantly highest number of nodes per plant was expressed in T1 (14.34) followed by T2 (13.75), the later was at par withT3 (13.28).The minimum number of nodes was observed under T4 (12.73). Number of flowers per plant varied significantly due to foliar spray of plant growth retardants. In soybean significantly maximum number of flowers per plant was recorded in T3 (51.04), it was at par with T7 (50.05) and T4 (48.87) while, T1 (45.01) had least number of flowers per plant. Number of pods per plant was significantly influenced due to foliar spray of plant growth retardants in soybean. Significantly higher number of pods were obtained under T3 (40.94) which were at par with T7 (39.63) and T6 (38.73) while, T1 (34.91) produced minimum number of pods in soybean.

Table-5 *Influence of plant growth retardants on Mesophyll efficiency, CO2 concentration, Relative water content and Chlorophyll content index in soybean*

Treatment detail	Mesophyll Efficiency (mmol/mol (mol m-2 s-1)-1)	CO_2 concentration (mmol mol^{-1})	Relative water content (%)	Chlorophyll content Index (g/m2)	
				At 40 Days	At 75 Days
T_1-Control (No foliar spray)	1153.08	247.67	69.77	18.04	16.81
T_2-Paclobutrazol 40SC @60ml/ha	1460.70	289.67	71.18	17.01	19.57
T_3-Paclobutrazol 40SC @75ml/ha	1596.90	314.33	72.41	18.09	20.8
T_4-Paclobutrazol 40SC @90ml/ha	1162.92	296.67	70.54	16.63	18.63
T_5-Paclobutrazol 23SC @105.6ml/ha	1596.90	254.67	71.24	16.32	19.46
T6 -Paclobutrazol 23SC@132ml/ha	1264.45	277.00	70.91	15.85	18.23
T_7-Chlormequat Chloride 50%SL 500ml/ha	1436.08	308.00	73.05	15.08	21.16
Mean	1338.75	284.00	71.30	16.72	19.24
SEm±	35.65	2.66	0.08	0.73	0.65
CD at 5%	109.87	8.2.	0.25	2.24	2.02

Table-6 *Influence of plant growth retardants on morphological and yield attribute in soybean*

Treatment detail	Plant height (cm)	No. of leaves/ plant	No. of branches /plant	Total No. of nodes /plant	No. of flowers /plant	No. of pods /plant
T_1-Control (No foliar spray)	38.44	31.01	4.93	14.34	45.01	34.91
T_2-Paclobutrazol 40SC @60ml/ha.	37.15	29.72	5.00	13.75	46.91	36.85
T_3-Paclobutrazol 40SC @75ml/ha	36.71	30.76	7.10	13.22	51.04	40.94
T_4-Paclobutrazol 40SC @90ml/ha.	34.91	29.44	5.70	12.73	48.87	38.44
T_5-Paclobutrazol 23SC @105.6ml/ha.	37.66	30.16	5.27	13.28	47.71	37.97
T6 -Paclobutrazol 23SC@132ml/ha	35.55	30.91	5.83	12.81	48.54	38.73
T_7-Chlormequat Chloride 50%SL 500ml/ha.	36.49	32.56	6.50	13.14	50.05	39.63
Mean	36.7	30.65	5.75	13.32	48.30	38.21
SEm±	0.15	0.30	0.02	0.016	1.24	0.62
CD at 5%	1.19	0.926	0.45	0.391	3.42	2.43

The yield attributes differed significantly due to various foliar sprays of plant growth retardants PBZ and CCC at maturity stage [Table-7] in soybean. Pod length was not varied significantly due to foliar spray of plant growth retardants in soybean. Highest pod length was observed under T3 (3.10), which was at par with T5 (3.01) and T7 (2.99) whereas, minimum pod length was noted in T1 (2.87). Pod width (cm) was not differed significantly due to the foliar spray treatments of plant growth retardants PBZ and CCC in soybean. Maximum pod width was produced by T3 (0.78) at par with T5 (0.77) and T6 (0.76) while, lowest pod width was recorded in T2 (0.70). Pod weight was not influenced significantly due to foliar spray of plant growth retardants in soybean. Higher pod weight was noted in T3 (2.92), which was at par with T7 (2.79) and T6 (2.63) whereas, minimum pod weight was observed under T1 (2.87) in soybean. 100 seeds weight (g) was varied significantly due to foliar spray of plant growth retardants in soybean. Significantly maximum Number of 100 seeds weight was estimated under T3 (8.28), which was at par with T7 (8.26) and T2 (7.91) while, least number of 100 seeds weight was noted in T1 (6.98). Seed yield (q/ha) was influenced significantly due to foliar spray treatment of plant growth retardants PBZ and CCC in soybean. Significantly highest seed yield was produced by T3 (7.30) followed by T7 (6.98) and T6 (6.58) however, lowest seed yield was recorded under T1 (6.03). Significant variations was observed for biological yield (q/ha) in soybean due to foliar application of plant growth retardants. Significantly maximum biological yield was reported under treatment T3 (22.05) followed by T7 (21.30) and T6 (20.39), the minimum biological yield was observed in T1 (19.08) treatment. Harvest Index (%) was varied significantly due to various foliar spray treatments plant growth retardants PBZ and CCC in soybean. Significantly highest harvest index was observed under treatment T3 (33.12) which was at par with T7 (32.76) and T6 (32.43) while, lowest harvest index was noted in T1 (31.59). The similar findings have been reported by [8, 9, 10 and 11].

Table-7 *Influence of plant growth retardants on yield attributes in soybean*

Treatment detail	Pod length (cm)	Pod width (cm)	Pod weight (g)/plant	100 seed weight (g)	Seed Yield (q/ha)	Biological Yield (q/ha)	Harvest Index (%)
T1-Control (No foliar spray)	2.87	0.73	2.41	6.98	6.03	19.08	31.59
T_2-Paclobutrazol 40SC @60ml/ha.	2.89	0.70	2.49	7.91	6.23	19.11	32.60
T_3-Paclobutrazol 40SC @75ml/ha	3.10	0.78	2.92	8.28	7.30	22.05	33.12
T_4-Paclobutrazol 40SC @90ml/ha.	2.90	0.73	2.58	7.19	6.45	19.90	32.43
T_5-Paclobutrazol 23SC @105.6ml/ha.	3.01	0.77	2.54	7.89	6.34	19.73	32.12
T6 -Paclobutrazol 23SC@132ml/ha	2.98	0.76	2.63	7.87	6.58	20.39	32.26
T_7-Chlormequat Chloride 50%SL 500ml/ha.	2.99	0.74	2.79	8.16	6.98	21.30	32.76
Mean	**2.96**	**0.75**	**2.62**	**7.75**	**6.56**	**20.22**	**32.41**
SEm±	**0.060**	**0.020**	**0.001**	**0.280**	**0.003**	**0.011**	**0.110**
CD at 5%	**0.190**	**0.060**	**0.068**	**0.860**	**0.168**	**0.318**	**1.010**

Application of growth retardants to the developing sink was shown to increase the transport of photosynthates from leaf to the developing sink. However, growth retardants *viz.*, paclobutrazol and cycocel were more beneficial in terms of the translocation of photo-assimilates towards developing reproductive parts compared to growth promoter kinetin and the control. Plant growth retardants are known to change the growth and development pattern of crop plants by altering

many physiological and biochemical processes and thereby increasing the yield of crops. Paclobutrazol (PBZ) and chlormequat chloride (CCC) is a plant growth retardant, used in the present investigation are known antagonist of the plant hormone gibberellin. It acts by inhibiting gibberellin biosynthesis, reducing intermodal growth to give stouter stems enhanced root growth, causing early fruit set and increasing seed set in plants. Hence, there is vast scope for improving the productivity potential of soybean by using different means particularly, the use of plant growth retardants *viz;* paclobutrazol (PBZ) and chlormequat chloride (CCC). Plant growth retardants modify plant organs differentially and influence the source sink relationship and improve yield potential. Such substances are therefore, potentially useful in agriculture, because suitable concentrations applied at appropriate time and stage will increase the yield either by altering dry mater distribution in the plant or by regulating growth [12].

It is concluded from the present investigation that plant growth retardants especially paclobutrazol 40 SC@75ml/ha may be proved as potent plant growth retardant to enhance the different phenological, physiological, morphological, yield component and yield of soybean due to better partitioning and efficient translocation mechanism of photo-assimilates towards the sink.

Conflict of Interest: None declared

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