Indian Res. J. Genet. & Biotech 8(1) : 27 – 37 (2016)

Effect of Foliar Application of Plant Growth Retardants on Biomass Partitioning, Flowering and Productivity of Pigeonpea (*Cajanus Cajan* L. Millsp)

Devendra Kurmi [1], R. K. Samaiya [2], Yogendra Singh[3] and S.K. Dwivedi [4]

[1, 2, 3, 4] ***Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur 482004.***

Abstract

Pigeonpea (*Cajanus Cajan* (L) Millsp.) is an important high protein food crop of family fabaceae. It is a crop of resource poor farmers that provides to them not only quality food and fodder but also fuel food. (4350 Kcal/kg). 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 Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur during kharif 2012-13. The experiment was laid out in RBD with three replications. The treatments were imposed at 60 DAS. Result revealed that all the treatment reduced the plant height and increasing the no. of branches. The minimum plant height was recorded in T3 (paclobutrazol 40 SC 90 ml/ ha.) followed by T9 (control) .The dry weight of leaf, stem and pod increased due to the application of growth retardants. The total dry matter distribution was recorded highest at 120 DAS at harvest. The yield contributing character viz. seed yield per plant, no. of pod per plant, seeds per pod, 100 seed weight and pod length , pod width , increased significantly due to growth retardants among the treatment.

Keywords : Plant growth retardants, Pigeonpea, *cajanus cajan* (**L. Millsp), Yield contributing character , Foliar application, Biomass partitioning.**

Introduction

Pigeonpea is a cross-pollinated (20–70%) species with a diploid number of 2n=2x=22 and genome size of 858 Mbp. According to ICRISAT data since 1976, the area under Pigeonpea has increased by 7%. Pigeonpea is currently being grown on 5.2 million ha in the rainfed areas of Asia, eastern and southern Africa, Latin American and Caribbean countries. In Asia, Pigeonpea is grown in an area of 4.33 million ha with a production of 3.8 million tons India has the largest area (3.38 million ha) followed by Myanmar (580,000 ha), China (150,000 ha) and Nepal (21,360 ha). Pigeonpea is rich in protein (20-22%) particularly sulphur containing amino acids, namely Methionine and cysteine (Singh *et al.*, 1990). Due to its deep root system, Pigeonpea offers less competition to associated crops than some other legumes, and it is often used in intercropping systems with cereals such as millet, sorghum, and maize or with short duration legumes such as cowpea. Pigeonpea also serves as food source as well as therapeutic purposes, especially in most developing countries of Africa, Asia and Latin America (Rao et al, 2002, Domoguen et al, 2010, Udensi et al, 2011a). The economic and therapeutic values notwithstanding, pigeon pea, especially the landraces are faced with under exploitation in term of cultivation, genetic breeding, research and utilization, which obviously might be linked to the preferences of both consumers and breeders to improved varieties (Udensi et al, 2011b).India is the largest producer of Pigeonpea, contributing to around 80% of the world's total production of 3.03 million tons. Pigeonpea ranks sixth in area and production in comparison to other grain legumes such as bean, peas, and chickpeas at global level. It is now widely grown in the Indian subcontinent that accounts for almost 90% of the world's crops. It is a second most important pulse crop of India after chickpea cultivated on 32.5 lakh hectares in arid and semiarid regions and 3 to 3.5 lakh hectares in Madhya Pradesh as Kharif crop. The productivity of Pigeonpea is ranged between 600-700 kg per hectare in India to 700-850 Kg per ha in Madhya Pradesh. The progressive decline in per capita availability of pulses (69 g in 1961 to 30 g in 2002) in India is a matter of great concern. To alleviate protein-energy malnutrition, a minimum, of 50 g pulses

Corresponding authors- e-mail : yogendrasinghbt@gmail.com

Published by the Indian Society of Genetics, Biotechnology Research and Development, Biotech Bhawan 5 E Nikhil Estate, DPS Road, Shastripuram, Agra 282007

Online management by www.isgbrd.co.in

per capita per day is required in addition to other sources of protein such as cereals, milk, meat, eggs etc. To make up this shortfall in supply and unprecedented population growth, about 28 million tons by 2020 and this can be realized only by adopting recent more productive technologies along with aggressive developmental efforts and favorable government policies

Plant growth regulators (PGRS) are known to improve physiological efficiency including photosynthetic ability of plants and offer significant role in realizing higher crop yields. The PGRS are also known to enhance the source sink relationship and stimulate the translocation of photo assimilates, thereby increasing the productivity. The growth promoter's viz. NAA, miraculan, cytozyme and triacontanol enhance the fruit set by preventing the flower drop in number of crops. The mechanism involved is through the hormone directed translocation of photo assimilates, counteracting the effects of endogenous growth retardants like ABA and ethylene and also improving the partitioning efficiency. The main objectives of this study were (i) to study the effect of plant growth retardants on flowering and pod setting, (ii) To adjudge the effect of plant growth retardants on biomass production and (iii) its partitioning to compute plant growth analytical parameters as well as investigate the effect of various treatments on morphological yield attributes, seed yield and quality.

Materials And Methods

The present study was conducted Research Farm Dusty acre, Department of Plant Breeding and Genetics, JNKVV, Jabalpur (M.P.) during *Kharif* season of 2012-13. Nine Treatments were evaluated under in R B D with three replications.Tha foliar applications were given at the time of flower and bud initiation. Seed @ 20 kg/ha was sown in all treatments seed was sown in rows by hand methods. The date of sowing was 5th July, 2012.The experimental plots were kept weed free by hand weeding and one hoeing was applied after irrigation at 60 days. Sampling was done at the fixed intervals of 30 days for growth analysis and phonological observations. The sampling was done at 60, 90 and 120 days. Three plants were randomly selected from each treatment per replication for growth analysis and biochemical estimations. The Pigeonpea crop is long duration crop therefore obtain kharif season. Two irrigation were provided first at 80 DAS (Day After Sowing) and second irrigation was given 100 DAS. The observations were subdivided into following groups and recorded during the crop season.

1. Phenological observations: 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 3 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).

2. Growth analytical parameters: Leaf Area Index (LAI), Specific Leaf Area (SLA) and Specific Leaf Weight (SLW) were recorded according to Gardner *et al*. (1985). Leaf Area Duration (LAD) as per Watson (1952), Crop Growth Rate (CGR, Relative Growth Rate (RGR) as per Beadle (1985) and Bio Mass Duration (BMD) were recorded according to standard methods.

3.Physiological parameters : The quantification of the physiological traits *Viz,* photo synthetically active radiation absorption, net photosynthesis, stomata conductance, transpiration rate, intercellular CO_2 concentration, water use efficiency, carboxylation efficiency, quantum use efficiency was carried out by using Infrared Gas Analysor (IRGA) Li Cor-6400 (Licor instruments, USA) as per method suggested by Kannan *et al*. (2007).

4. Yield and yield attributing parameters: Plant height, Number of leaves/plant, Number 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 (Fisher, 1925).

Results And Discussion

1. Phenological developments: The Effect of **plant growth retardants** paclobutrazol, chlormequat chloride on Phenological developments of Pigeonpea is presented in the Table 01**.** 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 T3 (49.33) required minimum number of days to flower initiation at par with T8 (49.67) followed by T2/T5 (50.00) whereas T9 (52.33) taken max. number of days to flower initiation. Regarding 50%

flowering stage the treatments T3 (69.67) required minimum days for reaching 50% flowering stage followed by T1/T5 (70.33) followed by T7 (71.33) indicating their capability to more number of flowers within a short span whereas T9 (72.67) taken longest time to attain 50% flowering stage. For pod initiation treatments T3 (74.67) required minimum number of days to pod initiation followed by T5 (75.33) whereas T9 (77.67) had more number of days to attain pod initiation. The number of days required to seed formation, revealed that the treatments T3 (84.67) required significantly minimum number of days to seed formation followed by T5 (85.33) whereas T9 (88.33) taken more number of days to seed formation. Data noted regarding Phenological development of Pigeonpea treatments revealed that influence of paclobutrazol, chlormequat chloride T3 (135.00) attain physiological maturity within lesser number of days followed by T8 (135.33) while T9 (138.33) registered as a treatment which taken longest span (days) to attain physiological maturity.

2. Growth parameters: Leaf Area Index (LAI) differed significantly due to the influence of various treatment of plant growth retardants paclobutrazol, and chlormequat chloride at different crop growth stages (Table 02) At 60 DAS the highest LAI was exhibited by T3 (1.61) at par with T6 (1.55) whereas the minimum LAI was noted in T9 (1.31). At 90 DAS the maximum LAI was exhibited by T3 (2.41) at par with T8 (2.13) whereas the minimum LAI was observed in T9 (1.44). At 120 DAS the maximum LAI was exhibited by T3 (2.33) at par with T8 (2.05) whereas the minimum was observed in T9 (1.40). Leaf Area Duration (LAD) also differed at various crop growth stages (Table 03). At 60-90 DAS Significantly maximum LAD was noted in T3 (593332.65) whereas minimum value was for T9 (413733.60). At 90-120 DAS the highest LAD was noted in T3 (710633.40) and minimum for T9 (427313.00). Regarding Crop Growth Rate (CGR) at 60-90 DAS ssignificantly highest CGR was noted in T3 (3.74) while T9 (1.78) observed as a treatment with least CGR .At 90-120 DAS significantly maximum CGR was noted in T6 (13.37) while T9 (10.00) noted as a treatment with lowest CGR (Table 03).Relative Growth Rate (RGR) variation is summarized in Table 03**.** At 60-90 DAS maximum RGR was exhibited by T3 (0.0021) while minimum was noted in T9 (0.0010). At 90-120 DAS maximum RGR was exhibited by T3/T6 (0.0063) while minimum observed in T2 (0.0040). Specific Leaf Area (SLA) differed significantly as summarized in table 04 . At 60-90 DAS maximum SLA was noted in T3 (23.60) while T9 (16.50) obtained as a treatment with least SLA. At 90-120 DAS the highest SLA T3 (27.63) at par with T6 (27.42) while T1 (16.76) observed as a treatment with lowest SLA. Specific Leaf Weight (SLW) varied significantly due to the influence of various treatment combinations at different crop growth stages (Table 04). At 60-90 DAS highest SLW was exhibited by T3 (0.0963) and T7 (0.0831) while T1 (0.0619) noted as a treatment with least SLW. At 90-120 DAS the maximum SLW was for T3 (0.0898) whereas minimum SLW was observed in T1 (0.0549). Biomass Duration (BMD) of various crop growth stages is summarized in Table 04. At 60-90 DAS ssignificantly highest BMD was exhibited by T3 (69.40) while T1 (48.40) noted as a treatment with least BMD. At 90-120 DAS maximum value of BMD was recorded for n T3 (75.40) and least for T1 (53.80).

3. Physiological parameters: There existed significant variability was observed due to the various treatments for different physiological traits under investigations (Table 05). Chlorophyll content in leaf differed significantly among various treatments under paclobutrazol, chlormequat chloride. At 60 DAS the maximum chlorophyll index was noted in T5 (53.03) and least for T2 (48.51). At 90 DAS maximum Chlorophyll was estimated in T8 (57.36) while the least was for T9 (53.09). At 120 DAS maximum amd minimum values were for T3 (47.59) and T9 (43.26) respectively . The Relative water content (%) among various treatments under paclobutrazol, chlormequat chloride are summarized in Table 05. At 60 DAS the maximum RWC was noted in T3 (82.86) and on the contrary, T9 (71.48) noted as a treatment with lowest RWC. At 90 DAS maximum RWC was estimated for T3 (84.23) and least for T9 (71.43). At 120 DAS the max. and min. values were for T3 (70.98) and T9 (56.97) respectively . Effect of plant growth retardants paclobutrazol, and chlormequat chloride on Net Photosynthesis, PAR, Stomata conductance and Transpiration in Pigeonpea is summarized in Table No. 06. Maximum net photosynthesis was noted in T3 (15.30) while minimum value for the same was recorded in T9 (11.80). T3 (1185.00) had significantly highest values for PAR followed by T6 (1174.33) and T4 (1164.67) while lowest value for the same was recorded in T9 (1102.00). For stomatal conductance significantly maximum stomatal conductance was observed in T3 (0.439) while minimum value for the same was observed in T9 (0.225). Transpiration rate was highest for T3 (4.83) and least for T9 (3.18). Effect of plant growth retardants paclobutrazol and chlormequat chloride on Intercellular CO_2 concentration, Carboxylation efficiency, Water use efficiency and Quantum use efficiency in Pigeonpea is summarized in Table 07. For Intercellular CO_2 concentration Significantly maximum intercellular CO_2 concentration was noted in T5 (278.00) followed by T6 (274.00) at par with T4 (272.00) while minimum value for the same was observed in T9 (251.00). Regarding

Corboxylation efficiency T3 (0.0565) had significantly highest values for corboxylation efficiency followed by T6 (0.0529) and T8 (0.0505) while lowest value for the same was noted in T9 (0.0470). Water use efficiency was Significantly maximum water use efficiency was noted in T3 (3.71) followed by T4 (3.45) at par with T1 (3.39) while minimum value for the same was noted in T9 (2.98). While Quantum use efficiency was Significantly highest quantum use efficiency was noted in T3 (0.0129) at par with T6 (0.0123) and T8 (0.0120) while lowest value for the same was noted in T9 (0.0107) under paclobutrazol, chlormequat chloride growth retardants.

4. Morph physiological yield attributing parameters: These parameters at maturity stage are summarized in **table 08.** Plant height varied significantly .The minimum plant height was observed in T3 (117.13) while T9 (141.76) observed as a treatment with maximum plant height. Regarding Number of branches per plant maximum number of branches per plant was obtained in T3 (10.77) while T9 (7.11) noted as a treatment with least number of branches per plant. While studying No. of flowers (per plant) maximum No. of flowers was observed in T3 (467.27) while T9 (222.67) recorded as a treatment with least No. of flowers. The maximum number of pods per plant was obtained in T3 (337.33) and T9 (150.11) was observed as a treatment with least number of pods per plant. The maximum number of seed per pod was expressed in T3 (5.22) and minimum in T9 (3.77).Effect of Plant growth retardant's paclobutrazol and chlormequatchlorides on Morph physiological yield attributing parameter at maturity stage are summarized in Table No.09. Maximum filled pod per plant were obtained in T3 (346.73) while T9 (162.33) observed as a treatment with least filled pod. Significantly maximum Unfilled pod was obtained in T9 (30.30) and T3 (22.83) recorded as a treatment with least Unfilled pod. The maximum pod length was obtained in T3 (5.41) while T9 (4.83) having pod length. Significantly maximum pod width was obtained in T3 (2.77) while T9 (2.34) recorded as a treatment with least pod width. Effect of plant growth retardants paclobutrazol and chlormequat chloride on Morph physiological yield attributing parameter at maturity stage is summarized in Table No. 10. 100 seed wt. varied significantly. It was maximum in T3 (8.60) and min. in T4 (7.13) Maximum biological yield was estimated in T3 (94.43) while min in T5 (70.39).Highest harvest index was observed in T5 (33.33) while poorest harvest index was noted in T9 (19.59). Grain yield was highest for T3 (24.83) lowest was observed in T9 (18.15). Effect of plant growth retardants paclobutrazol and chlormequat chloride on Nitrogen, Protein and Carbohydrate in seed of Pigeonpea is summarized in Table No.11. T3 (3.85) expressed significantly highest N content (%) while lowest N content was observed in T9 (3.05). The protein content was highest in T3 (24.08 and lowest in T9 (19.08). Carbohydrate Content was highest in T3 (62.57) while lowest in T9 (57.40).

Pigeonpea (*Cajanus cajan* (L.) Millsp) is widely grown as a pulse crop in many parts of the Indian subcontinent (Bokhari & Ashraf, 1990). It is largely eaten in the form of split pulse as dal, while its tender green pod constitute a very favorite vegetable. It is often grown for green manure or for cover crop. It is one of the most important pulse crops of india, which accounts for 90 per cent of the world production , occupying an area of 3047 m ha with a production of 2.7 m tons and the national average yield is 797 kg/ha. The lower productivity in Pigeonpea is attributed to factor like improper partitioning of photo assimilate toward production structures and lower pod set persent which resulted in to lower harvest index (HI). To achieve optimum vegetative growth and to affect better translocation of photo assimilates in to developing sinks, the use of plant growth retardants, which regulate the plant growth and finally alter the plant architecture appears to an excellent approach. Moreover growth retardants play a significant role in modifying growth and flowering of Pigeonpea .Plant growth retardants change both morphology and physiology of crop. The effect of growth retardants vary with the plant species ,variety, concentration used frequency of application and various other factors which influence the uptake and translocation of the chemical. Plant growth retardants are also capable of redistribution of photo- assimilates into different organs of the plant and thereby bring about better source –sink relationship and yield improvement. The final pattern of development and behaviour to each individual plant is the result of a complex interplay between genetic, hormonal and environmental factors. when growth regulator are used in appropriate concentration influence the plant architecture in a typical fashion and improve the yield potential. It is inferred that both the phenological stages viz. flower initiation and pod initiation are early due to use of plant growth retardants application. Similar reports have been mode by Garai and Datta (2003) in green gram. Kalpana *et al.* (2003) reported that genotype produce higher seed yield also showed higher value for Pn. The use of less water to achieve high yield is a measure object of the modern agriculture (Richards, 2001). Many researcher have documented similar results on the exogenous applications of PGRs to different crop Plants (Tahsinet al., 2006, ullah et al., 2007, Radhakrishnan et al., 2008, Muhammad et al., 2009).

Table 01: Effect of plant growth retardants paclobutrazol, chlormequat chloride on phenological developments of Pigeonpea

Treatment	Day to flower initiation	Days to 50% flowering	Day to pod initiation	Day to seed formation	Days to physiological maturity
T_1	50.33	70.33	75.67	85.67	135.67
T_2	50.00	71.67	76.00	86.00	136.00
T_3	49.33	69.67	74.67	84.67	135.00
T_4	51.00	71.67	75.67	87.00	136.33
T_5	50.00	70.33	75.33	85.33	136.00
T_6	51.33	72.33	76.67	87.33	135.67
T_7	51.33	71.33	75.67	86.00	136.67
T8	49.67	72.00	75.67	86.33	135.33
T9	52.33	72.67	77.67	88.33	138.33
Mean	**50.59**	**71.33**	**75.89**	**86.30**	**136.11**
SEm±	**0.45**	**0.35**	**0.38**	**0.29**	**0.25**
CD at 5%	**1.35**	**1.04**	**1.15**	**0.86**	**0.76**

Table 02: Effect of plant growth retardants paclobutrazol, and chlormequat chloride on LAI at different growth stage of Pigeonpea.

Treatments	LAI at DAS		
	60 DAS	90 DAS	120 DAS
T_1	1.39	2.07	2.02
T_2	1.41	1.81	1.77
T_3	1.61	2.41	2.33
T_4	1.45	2.1	2.03
T_5	1.38	2.06	2.01
T_6	1.55	1.95	1.9
T_7	1.37	1.96	1.89
T8	1.39	2.13	2.05
T9	1.31	1.44	1.4
Mean	**1.43**	**1.99**	**1.93**
SEm±	**0.05**	**0.07**	**0.07**
CD at 5%	**0.14**	**0.22**	**0.21**

Table 03: Effect of plant growth retardants paclobutrazol and chlormequat chloride on LAD CGR and RGR at different growth stage of Pigeonpea

Treatments	LAD (m^2.day) at DAS		CGR (g/m^2 of ground area/day) at DAS		RGR (g/g/day) at DAS	
	60-90	90-120	60-90	90-120	60-90	90-120
T_1	518874.65	613519.95	2.10	10.20	0.0013	0.0057
T_2	482917.95	537329.75	3.30	10.19	0.0014	0.0040
T_3	593332.65	710633.40	3.74	12.88	0.0021	0.0063
T_4	532285.00	619545.10	2.99	11.13	0.0015	0.0051
T_5	516170.95	610047.90	3.10	10.45	0.0014	0.0042
T_6	533708.20	577331.70	3.58	13.37	0.0020	0.0063
T_7	499691.25	577933.20	3.08	11.88	0.0016	0.0052
T8	528295.40	627636.55	3.22	11.04	0.0016	0.0048
T9	413733.60	427313.00	1.78	10.00	0.0010	0.0052
Mean	**513223.29**	**589032.28**	**2.99**	**11.24**	**0.002**	**0.005**
S.Em±	**12880.52**	**21413.30**	**0.35**	**1.27**	**0.0003**	**0.0007**
CD at 5%	**38617.50**	**64199.91**	**1.06**	**3.81**	**0.0008**	**0.0020**

Table 04: Effect of plant growth retardants paclobutrazol and chlormequat chloride on SLA , SLW and BMD at different growth stage of Pigeonpea

Treatments	SLA (m^2/g) at DAS		SLW (g/m^2) at DAS		BMD (g/m^2 of ground area/day) at DAS	
	60-90	90-120	60-90	90-120	60-90	90-120
T_1	15.22	**90-120**	0.0619	**90-120**	48.4	53.8
T_2	20.03	16.76	0.0739	0.0549	68.6	65.0
T_3	23.60	21.58	0.0963	0.0707	69.4	75.4
T_4	21.67	27.63	0.0675	0.0898	53.2	60.2
T_5	16.73	24.80	0.0872	0.0610	58.6	74.4
T_6	23.32	19.72	0.0635	0.0764	55.4	63.0
T_7	17.99	27.42	0.0831	0.0553	62.2	68.8
T8	18.26	20.75	0.0823	0.0743	64.8	70.4
T9	16.50	21.62	0.0906	0.0722	55.2	61.0
Mean	**19.26**	17.01	**0.08**	0.0885	**59.6**	**65.0**
S.Em±.	**1.23**	**21.92**	**0.0048**	**0.07**	**34.84**	**31.98**
CD at 5%	**3.68**	**1.51**	**0.0145**	**0.0044**	**10.1**	**95.98**

Table 05: Effect of plant growth retardants paclobutrazol, and chlormequat chloride on chlorophyll content and Relative water content in leaf of Pigeonpea

Treatments	Chlorophyll content in leaf g/m^2			Relative water content (%)		
	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS
T_1	50.07	54.46	47.45	78.12	72.10	65.13
T_2	48.51	55.51	46.33	75.28	65.08	61.40
T_3	51.52	53.23	47.59	82.86	84.23	70.98
T_4	50.15	55.47	45.91	72.49	82.72	70.47
T_5	53.03	55.45	46.31	76.73	79.38	69.92
T_6	50.23	55.05	44.67	78.92	81.85	68.30
T_7	50.54	54.52	46.57	74.21	73.67	64.25
T8	52.98	57.36	45.81	73.35	77.30	66.10
T9	51.66	53.09	43.26	71.48	71.43	56.97
Mean	**50.97**	**54.90**	**45.99**	**76.50**	**77.04**	**65.95**
S.Em±.	**0.45**	**0.41**	**0.47**	**0.59**	**0.71**	**1.06**
CD at 5%	**1.35**	**1.24**	**1.42**	**1.76**	**2.12**	**3.17**

Table 06: Effect of plant growth retardants paclobutrazol, and chlormequat chloride on Net Photosynthesis, PAR, Stomata conductance and Transpiration in Pigeonpea.

Treatments	Net Photosynthesis µmol/m^2/s	PAR µmol /m^2/s	Stomatal conductance	Transpiration mmol/m^2/s
T_1	12.60	1125.00	0.245	3.71
T_2	13.00	1139.67	0.285	3.95
T_3	15.30	1185.00	0.439	4.83
T_4	13.42	1164.67	0.385	4.41
T_5	13.40	1151.67	0.315	4.31
T_6	14.50	1174.33	0.415	4.62
T_7	12.10	1110.00	0.270	3.51
T8	13.23	1107.00	0.320	4.45
T9	11.80	1102.00	0.225	3.18
Mean	**13.26**	**1139.93**	**0.322**	**4.11**
SEm±	**0.10**	**2.48**	**0.004**	**0.02**
CD at 5%	**0.31**	**7.43**	**0.011**	**0.06**

Table 07. Effect of plant growth retardents paclobutrazol and chlormequat chloride on Intercellular CO_2 concentration, Corboxylation efficiency, Water use efficiency and Quantum use efficiency in Pigeonpea.

Treatments	Intercellular CO_2 concentration	Corboxylation efficiency	Water use efficiency	Quantum use efficiency
T_1	265.00	0.0475	3.39	0.0112
T_2	269.00	0.0483	3.29	0.0114
T_3	271.00	0.0565	3.71	0.0129
T_4	272.00	0.0493	3.45	0.0115
T_5	278.00	0.0482	3.11	0.0116
T_6	274.00	0.0529	3.14	0.0123
T_7	261.00	0.0464	3.17	0.0109
T8	262.00	0.0505	3.04	0.0120
T9	251.00	0.0470	2.98	0.0107
Mean	**267.00**	**0.0496**	**3.25**	**0.0116**
SEm±	**0.71**	**0.0004**	**0.030**	**0.00009**
CD at 5%	**2.12**	**0.0013**	**0.089**	**0.00028**

Table 08. Plant growth retardants paclobutrazol, and chlormequat chloride on Morph physiological\yield attributing parameter at maturity stage

Treatments	Plant height /plant (cm)	No. of branches /plant	No. of flowers	No. of pods	No. of seed/pod
T_1	129.67	7.66	403.74	251.33	5.00
T_2	125.20	10.44	450.73	287.66	4.66
T_3	117.13	10.77	467.27	337.33	5.22
T_4	122.65	9.11	345.97	238.66	4.33
T_5	127.09	9.33	329.20	199.00	4.44
T_6	129.89	10.11	407.57	321.89	5.00
T_7	139.42	10.33	454.87	295.89	4.33
T8	122.11	9.88	372.27	244.78	4.22
T9	141.76	7.11	222.67	150.11	3.77
Mean	**128.32**	**9.42**	**383.81**	**258.52**	**4.55**
SEm±	**2.52**	**0.40**	**42.20**	**9.13**	**0.28**
CD at 5%	**7.55**	**1.19**	**126.51**	**27.37**	**0.85**

Table 09. Effect of Plant growth retardents paclobutrazol, and chlormequat chloride on Morph physiological yield attributing parameter at maturity stage

Treatments	No. of filled pods	No. of unfilled pods	Pod length(cm)	Pod width(cm)
T_1	320.87	27.87	4.95	2.42
T_2	258.98	24.67	5.13	2.41
T_3	346.73	22.83	5.41	2.77
T_4	257.50	27.40	4.96	2.54
T_5	293.49	23.40	4.90	2.49
T_6	318.37	26.50	4.92	2.59
T_7	329.21	26.60	5.40	2.76
T8	291.60	23.00	5.15	2.63
T9	162.33	30.30	4.83	2.34
Mean	**286.57**	**25.84**	**5.10**	**2.57**
SEm±	**5.91**	**0.61**	**0.08**	**0.06**
CD at 5%	**17.70**	**1.83**	**0.25**	**0.17**

Table 10. Effect of plant growth retardants paclobutrazol, and chlormequat chloride on Morph physiological yield attributing parameter at maturity stage

Treatments	100 seed wt. (g)	Biological yield (Q/ha)	Harvest index (%)	Grain yield (Q/ha)
T_1	8.26	86.90	22.27	19.22
T_2	7.62	90.19	21.43	20.23
T_3	8.60	94.43	27.52	24.83
T_4	7.13	86.16	22.85	19.65
T_5	7.88	70.39	33.33	21.84
T_6	8.27	70.86	32.31	22.76
T_7	7.85	94.06	23.45	22.07
T8	7.66	73.63	27.31	20.16
T9	7.61	92.90	19.59	18.15
Mean	**7.88**	**84.39**	**25.56**	**20.99**
S.Em±.	**0.15**	**2.34**	**2.34**	**0.91**
CD at 5%	**0.45**	**7.01**	**7.03**	**2.73**

Table 11. Effect of plant growth retardants paclobutrazol, and chlormequat chloride on Nitrogen, Protein and Carbohydrate in seed of Pigeonpea.

Treatments	Nitrogen, Protein and Carbohydrate (%) in seed		
	Nitrogen (%)	Protein (%)	Carbohydrate (%)
T_1	3.06	19.13	57.63
T_2	3.54	22.13	60.63
T_3	3.85	24.08	62.57
T_4	3.38	21.15	62.37
T_5	3.69	23.06	60.67
T_6	3.69	23.07	59.63
T_7	3.74	23.41	58.60
T8	3.39	21.24	58.80
T9	3.05	19.08	57.40
Mean	**3.49**	**21.82**	**59.81**
SEm±	**0.09**	**0.57**	**0.58**
CD at 5%	**0.27**	**1.71**	**1.74**

References

1. **Beadle, C.L.** 1985. Plant growth analysis, p. 20-25. *In* J. Coombs, D.O. Hall, S.P. Long & J.M.O. Scurlock (eds.). *Techniques in Bioproductivity and Photosynthesis*. Oxford, USA.

2. **Bokhari, M.H.; and Ashraf M.** 1990. *Pulse Crops of Pakistan*. Biological Society Lahore, Pakistan.

3. **Domoguen R.L.; Saxena K.B.; Mula M.G.; Sugui F.; Dar W.D**.2010. The multiple uses of pigeonpea. http://www.sunstar.com.ph/baguio/multiple-uses-pigeon pea. Retrieved 27 January 2012.

4. **Fisher, R. A.** 1925. Statistical Methods for Research Workers. Edinburgh: Oliver and Boyd.

5. **Garai, A.K and Data , J.K** .2003. Effect of phosphorus sources and cycocel spray on greengram. *Legume Research,* 26(1):15-19.

6. **Gardner F, Pearce R and Mitchell R.L.** 1985. Physiology of Crop Plants. Iowa State University Press, Ames, USA : 66.

7. **Kalpana, R. and Krishnarajan J.** 2003. Eeffect of combined application of nutrients and hormones on soybean yield. *Legume Research*, 26(2):151-152.

8. **Kannan N, White S.M, Worrall F, Whelan M.J.** 2007. Sensitivity analysis and identification of the best evapotranspiration and runoff options for hydrological modelling in SWAT-2000. Journal of Hydrology 332: 456–466. DOI: 10Ð1016/j.jhydrol.2006Ð08Ð001.

9. **Muhammad S, Tijjani A**.2009. Effects of plant growth regulators on root nodulation of cowpea (*Vigna unguiculata* L. Walp). *Journal of Phytology*. 6:112 –118.

10. **Radhakrishnan P, Renganayaki P.R.** 2008. Effect of plant growth regulators on seed germination and seedling growth of stored Simaruba (*Simaruba glauca* Linn.) seeds. *Indian Forester*. 134:7.

11. **Rao S.C, Coleman S.W, Maycux H.S.**2002. Forage production and nutritive value of selected pigeon pea ecotypes in southern Great Plains. *Journal of Crop Scencei.* 42:1259-1263.

12. **Richards, R.A., Condon, A.G., Rebetzke**. 2001. Traits to improve yield in dry environments. In Application of Physiology in wheat breeding, CIMMYT Mexico DF. PP. 88-100.

13. **Singh U, Jambunthan R, Saxena K.B and Subrahmanyam N.** 1990. Nutritional quality evaluation

of newly developed high-protein genotypes of pigeonpea (*Cajanus cajan* [L.]). *Journal of Science, Food and Agriculture,* 50: 201-209.

14. **Tahsin N, Kolev T**. 2006. Investigation on The Effect of Some Plant Growth Regulators on Sunflower *(Helianthus Annuus* L*..)* Tekirdað Ziraat Fakültesi Dergisi.3(2):229- 232.

15. **Udensi O, Edu EA, Umana UJ, Ikpeme EV** 2011 b. Estimate of genetic variability in locally grown pulses [*Cajanus cajan* (L.) Huth and *Vigna unguiculata* (L.)Walp]: A pancea for sourcing superior genotypes. Pakistan Journal of Biological Science. ;14(6):404-407.

16. **Udensi O, Umana, UJ, Edu EA, Ikpeme EV.**2011 a. Screening locally grown pulses for proximate, anti-nutritive and mineral compositions: Indices for conservation and improvement. Int. J. Agric. Res., 2011a ;6(6):504-510.

17. **Ullah MJ, Fatttah QA, Hossain F**.2007. Response of growth, yield attributes and yield to the application of KNap and NAA in cowpea (*Vigna unguiculata* (L.) Walp.). Bangaladesh Journal of Botany. 36(2):127-132

18. **Watson, D.J. (**1952). Physiological basis of varieties in yield. *Advance in Agronomy*, **4** : 101-145.