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Research Article

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Influence of plant growth retardants on morpho-physiological parameters and yield of pigeonpea (*Cajanus cajan* L. Millsp)

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ABSTRACT
The field experiment was conducted at Agricultural Research Station, Bheemarayanagudi, during *Kharif* 2021- 22 to know the influence of plant growth retardants on morpho-physiological and yield parameters in pigeonpea. The experiment was laid out in randomized complete block design and replicated three times with eight treatments including control, nipping at 60 DAS, mepiquat chloride @ 1000 ppm, thiourea @ 1000 ppm, chlormequat chloride @ 1000 ppm, daminozide @ 1250 ppm, ancymidol @ 1000 ppm and paclobutrazol @ 150 ppm were applied through foliar application at 60 DAS. Results revealed that nipping and all growth retardant treatments significantly reduced the plant height (cm) and increased total number of branches, total dry matter production, total leaf area, leaf area index and seed yield compared to control. Among the treatments, foliar application of mepiquat chloride @ 1000 ppm was recorded significantly lower plant height (153.72 cm) and higher total number of branches (37.85 plant^{-1}), total dry matter production (149.12 g plant^{-1}), total leaf area (85.83 dm^{2} plant^{-1}), leaf area index (2.384) and seed yield (1970 kg ha^{-1}) as compared to all other treatments. The treatment T_5 (chlormequat chloride @ 1000 ppm) was recorded second best morpho-physiological parameters and yield in pigeonpea. The results concluded that foliar application of mepiquat chloride @ 1000 ppm at 60 DAS was found best in recording better growth parameters and higher yield in pigeonpea.
Keywords: Pigeonpea Crop, Plant growth retardants, *Kharif season*, nipping

INTRODUCTION

Pigeonpea [*Cajanus cajan* L. Millsp] is one of the major grain legumes (pulse) crop of the tropics and subtropics, endowed with several unique characteristics. Pigeonpea also known as redgram or arhar or tur, is the second most significant pulse crop of India after bengalgram. Worldwide, pigeonpea is grown in about 4.9 M ha with a production of 3.65 Mt and productivity of 898 kg ha^{-1}. India is the largest producer of pigeonpea accounting about 82.0 per cent of total production and 81.0 per cent of total area of the world (Anon., 2021). Although, pigeonpea is most important pulse crop of India but yield is very low as compared to world's average. The main constraints for lower yield and low harvest index in pigeonpea are improper translocation of photo assimilates, reduced availability of photo-assimilates at the time of seed set and excessive vegetative growth, which leads to poor productivity. Nowadays nipping practice is done in pigeonpea crop to solve the excessive vegetative growth problem and also to get more yield but it is laborious work as it needs more time and more labours. Hence, this experiment was planned to study the effect of nipping on growth and yield comparing with other treatments like foliar application of different plant growth retardants.

MATERIALS AND METHODS

The field experiment was conducted at Agricultural Research Station, College of agriculture, Bheemarayanagudi during *Kharif* 2021-22. GRG-811 variety was used in experiment. Seeds were sown at spacing of 120 cm between rows and 30 cm between plants at a depth of 5 cm. The experiment was laid out in randomized complete block design and replicated three times with eight treatments including control, nipping at 60 DAS, mepiquat chloride @ 1000 ppm, thiourea @ 1000 ppm, chlormequat chloride @ 1000 ppm, daminozide @ 1250 ppm, ancymidol @ 1000 ppm and paclobutrazol @ 150 ppm were applied through foliar application at 60 DAS. Five plants were selected randomly from each net plot and were tagged for recording various observations. Based on observations recorded on five tagged plants, average values per plant were calculated. Observations on growth parameters were recorded at 100 DAS and yield was calculated after harvest of crop.

RESULTS AND DISCUSSION

Morphological parameters

Plant height

The data recorded on plant height in pigeonpea presented in Table 1. At 100 DAS the significantly higher plant height was recorded in control (177.47 cm) over other treatments except treatment nipping (173.93 cm) which was on par with control. Among the treatments, foliar application of mepiquat chloride @ 1000 ppm was found with lower plant height (153.72 cm), followed by chlormequat chloride @ 1000 ppm (158.35 cm). The treatments daminozide @ 1250 ppm (168.43 cm) and ancymidol @ 10 ppm (167.87 cm) were on par with each other. Basically, plant height is a genetically controlled character, but several studies indicated that plant height can be either increased or decreased by the application of synthetic plant growth regulators. Our results are in line with the results obtained by Gurdeep *et al*. (2020) in green gram; Arora *et al*. (1998) in chickpea; who reported that the growth retardants have specific capability to reduce plant height by reducing internodal length. Among the treatments, foliar application of mepiquat chloride @ 1000 ppm reduced plant height significantly than other treatments as it counteracts the gibberellin biosynthesis which in turn reduces internodal length and further plant height decreased. Similar findings were obtained by Sudharani and Sudhakar (2018) in pigeonpea and Arunakumar and Uppar (2007) in moth bean.

Number of branches plant^{-1}

The data revealed that the treatment mepiquat chloride @ 1000 ppm recorded significantly higher number of branches (37.85plant^{-1}) than other treatments followed by chlormequat chloride @ 1000 ppm (36.21 plant^{-1}) and paclobutrazol @ 150 ppm (35.08 plant^{-1}). The significantly less number of branches (30.24 plant^{-1}) were noticed in control than all other treatments. Our results are in agreement with the results obtained by Sharma *et al*. (2003) in pigeonpea and Grossman (1990) who reported that the anti-gibberellin activity of mepiquat chloride, chlormequat chloride and other growth retardants might have lowered the growth in vertical axis and therefore, growth correlation mechanism could have boosted more axillary growth by elongating the axillary sprouts into branches.

Total dry matter production plant^{-1}

The significantly higher total dry matter production per plant was recorded in treatment mepiquat chloride @ 1000 ppm (149.12 g plant^{-1}) compared to all other treatments. The treatments daminozide @ 1250 ppm (131.94 g plant^{-1}) and ancymidol @ 10 ppm (133.47 g plant^{-1}) were on par with each other. Significantly lower dry matter production per plant was seen in control (119.21 g plant^{-1}). The increase in total dry matter accumulation with growth retardants treated plots might be due to increased photosynthetic efficiency of leaves and also due to the translocation of stored photo-assimilates towards the development of reproductive organs thus, assisting in accumulation of more photosynthates by plants and ultimately resulting in higher dry matter accumulation. Other important reason might be increased stem thickness in shorter plants than taller plants in control, had also contributed to increased dry matter production in growth retardant treatments.

Table 1. Influence of nipping and plant growth retardants on morphological parameters at 100 DAS and yield in pigeonpea

Treatments	Plant height (cm)	Total number of branches	Total dry matter (g plant^{-1})	Total leaf area (dm^2 plant^{-1})	Leaf area index (LAI)	Yield (kg ha^{-1})
T_1 – Control	177.47	30.24	119.21	57.87	1.607	1580.28
T_2 - Nipping at 60 DAS	173.93	31.75	124.50	64.78	1.800	1631.94
T_3 - Mepiquat chloride @ 1000 ppm at 60 DAS	153.72	37.85	149.12	85.83	2.384	1970.00
T_4 - Thiourea @ 1000 ppm at 60 DAS	172.86	32.05	126.73	66.88	1.858	1668.89
T_5 - Chlormequat chloride @ 1000 ppm at 60 DAS	158.35	36.21	143.35	81.29	2.258	1885.00
T_6 - Daminozide (Alar, B-9) @ 1250 ppm at 60 DAS	168.43	33.47	131.94	72.20	2.006	1725.56
T_7 - Ancymidol (A-Rest) @ 10 ppm at 60 DAS	167.87	33.93	133.47	73.23	2.034	1746.94
T_8 - Paclobutrazol @ 150 ppm at 60 DAS	163.32	35.08	138.83	77.14	2.143	1823.06
Mean	166.99	33.82	133.39	72.40	2.005	1753.96
S.Em (±)	1.49	0.35	1.37	0.81	0.023	18.16
C.D at 5%	4.53	1.06	4.17	2.42	0.068	55.07

Our results are similar with the findings of Gangadhara *et al*. (2022) in horse gram and Phulekar *et al*. (1998) in groundnut. The treatment that received foliar application of mepiquat chloride @ 1000 ppm was found superior with significantly higher total leaf area (85.83 dm^2 $plant^{-1}$) than all other treatments in control (57.87 dm^2 $plant^{-1}$) compared to all other treatments. Leaf is the physiological platform for the process of photosynthesis which is the main input of yield. The total leaf area per plant found more in all treatments over the control. Increase in leaf area was due to increased production of secondary branches as influenced by mepiquat chloride and other growth retardant treatments and thus, there will be new growth of a greater number of leaves. Garg *et al*. (2006) in cluster bean and Phulekar *et al*. (1998) in groundnut were also reported the similar results. The significantly highest leaf area index was recorded in treatment mepiquat chloride @ 1000 ppm (2.384) compared to all other treatments and lowest was observed in control (1.607). The enhanced leaf area index in growth retardant treatments could be due to increased efficiency in translocation of stored photosynthates laterally across the plant which resulted in enhanced total leaf area and increased production of both primary and secondary branches. Our results are in line with the findings of Srivastava and Tiwari (1981); Islam and Jahan (2016) in chickpea.

Table 2. Influence of plant growth retardants on biophysical, biochemical parameters at 100 DAS and yield of pigeonpea

Treatments	Photosynthetic rate (µ mol CO_2 m^{-2} s^{-1})	Transpiration rate (m mol H_2O m^{-2} s^{-1})	Total chlorophyll content (mg g^{-1} fresh weight)
T_1 – Control	15.00	4.32	1.470
T_2 - Nipping at 60 DAS	15.59	4.86	1.530
T_3 - Mepiquat chloride @ 1000 ppm at 60 DAS	17.97	6.28	1.996
T_4 - Thiourea @ 1000 ppm at 60 DAS	15.75	5.13	1.586
T_5 - Chlormequat chloride @ 1000 ppm at 60 DAS	17.43	5.95	1.889
T_6 - Daminozide (Alar, B-9) @ 1250 ppm at 60 DAS	16.28	5.37	1.680
T_7 - Ancymidol (A-Rest) @ 10 ppm at 60 DAS	16.43	5.48	1.739
T_8 - Paclobutrazol @ 150 ppm at 60 DAS	16.89	5.71	1.828
Mean	16.42	5.39	1.715
S.Em (±)	0.16	0.06	0.019
C.D at 5%	0.50	0.18	0.057

Biophysical and Biochemical parameters

The data recorded on biophysical, biochemical parameters (Table 2) in pigeonpea. At 100 DAS, there was significant difference between the treatments in photosynthetic rate. The foliar application of mepiquat chloride @ 1000 ppm recorded significantly higher photosynthetic rate (17.97 µ mol CO_2 m^{-2} s^{-1}). Whereas, the lower photosynthetic rate was noticed in control (15.00 µ mol CO_2 m^{-2} s^{-1}), ancymidol @ 10 ppm (16.43 µ mol CO_2 m^{-2} s^{-1}) and paclobutrazol @ 150 ppm (16.89 µ mol CO_2 m^{-2} s^{-1}) were on par with each other. The significantly highest transpiration rate (6.28 m mol H_2O m^{-2} s^{-1}) was noticed in foliar application of mepiquat chloride @ 1000 ppm over all other treatments followed by treatment chlormequat chloride @ 1000 ppm (5.95 m mol H_2O m^{-2} s^{-1}) and the significantly lower transpiration rate was noticed in control (4.32 m mol H_2O m^{-2} s^{-1}).

The photosynthetic rate in all the treatments was found significantly more compared to control, which can be attributed to increased chlorophyll content and increased leaf area index by application of plant growth retardants than control. Similar results were reported by Rajesh *et al*. (2014) in greengram and Karuppusamy *et al*. (2021) in pigeonpea. At 100 DAS, the foliar application of mepiquat chloride @ 1000 ppm was found superior with significantly higher total chlorophyll content (1.996 mg g^{-1} fresh weight) than all other treatments. The significantly lowest total chlorophyll content (1.470 mg g^{-1} fresh weight) was found in control. Similar increase in total chlorophyll content was also reported in sunflower due to application of mepiquat chloride (1000 ppm) by Kulkarni *et al*. (1995). It has also been suggested that the application of growth retardants improved source-sink transport which in turn increased the availability of assimilates *i.e.,* hormone directed translocation of photosynthates, which will cause prolonged chlorophyll synthesis (Stoddart, 1965).

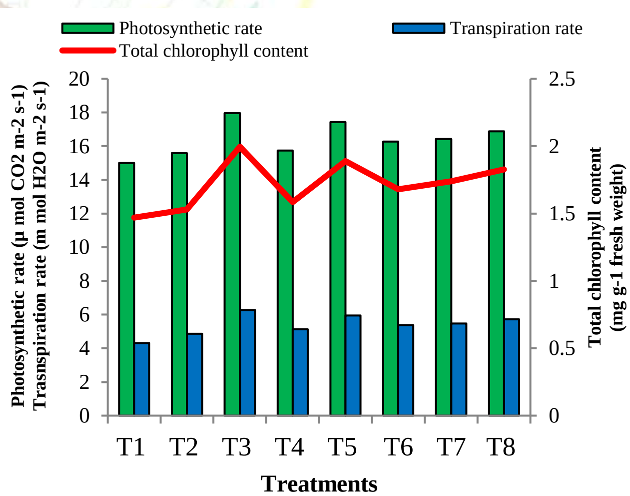

Figure 1. Influence of plant growth retardants on biophysical, biochemical parameters at 100 DAS and yield of pigeonpea

Seed yield (kg ha^{-1})

The data recorded on yield presented in Table 1. The data showed that foliar application of mepiquat chloride @ 1000 ppm was found best with significantly highest seed yield of 1970.00 kg ha^{-1}, which was 24.66 % more than control followed by treatment chlormequat chloride @ 1000 ppm (1885.00 kg ha^{-1}), paclobutrazol @ 150 ppm (1823.06 kg ha^{-1}) and control recorded significantly lowest seed yield (1580.28 kg ha^{-1}) compared to all other treatments. Similar findings were also reported by Techapinyawat *et al*. (1995) in mung bean, Kalyankar *et al*. (2007) in soybean and Pourmohammad *et al*. (2014) in rapeseed.

CONCLUSIONS

From the results of the present experiment, it can be concluded that foliar application of mepiquat chloride @ 1000 ppm has helped the crop to record significantly higher growth attributes and also in attaining highest potential yield of the crop. The possible reason for the effect of mepiquat chloride maybe, as it is an anti-gibberellin chemical, it inhibited biosynthesis of gibberellin thus, reduced internodal length as well as height of the crop and promoted more lateral growth by increasing number of primary as well as secondary branches. It also significantly improved the source and sink relationship which ultimately helped the crop to attain maximum potential yield.

CONFLICT OF INTEREST

The author here declares that there is no conflict of interest in the publication of this article.

REFERENCES

Anonymous., 2021, Area and production of pulses. http://www.indiastat.com.

Arora, N., Kaur, B., Singh, P., and Usha, P., 1998, Effect of IAA and cycocel on yield contributing parameters of chickpea (*Cicer arietinum* L.). *Ann. Agri. Res*., **19**(3): 279-281.

Arunakumar, S. H. and Uppar, D.S. 2007, Influence of integrated nutrient management on seed yield and quality of moth bean (*Vigna aconitifolia* (Jacq.) Marchel). *Karnataka J. Agric. Sci*., **20**(2): 394-396.

Gangadhara, T., Patel, P. H., Akshay, K. K. and Yonika, S., 2022, Response of horse gram (*Macrotyloma uniflorum*) to spacing and nipping. *J. Pharm. Innov*., **11**(2): 1315-1321.

Grossman, K., 1990, Plant retardants as tools in physiological research. *Physiol. Plant*., 78(3): 642-48.

Garg, B. K., Burman, U. and Kathju, S., 2006, Influence of thiourea on photosynthesis, nitrogen metabolism and yield of cluster bean (*Cyamopsis tetragonoloba* (L.) Taub.) under rainfed conditions of Indian arid zone. *J. Plant Growth Regul*., **48**(1): 237–245.

Gurdeep, S., Kumar Kamalesh., Amanpreet, S. and Chahal, H. S., 2020, Effect of mepiquat chloride and detopping on growth and production of green gram (*Vigna radiata* L. Wilczek). *Environ. Conserv. J*., **21**(2): 85-88.

Islam, S. and Jahan, N., 2016, Growth analysis of chickpea var Bari chola-7 following application of TIBA (2,3,5- Triidobenzoic acid). *J. Bangladesh. Acad. Sci*., **40**(1): 199-205.

Kalyankar, S. V., Hudge, V. S., Shete, D. M., Hudge, B. V. and Deshmukh, J. D., 2007, Effect of plant growth regulators on growth and yield of soybean. *Ann. Plant Physiol*., **21**(2): 158-160.

Phulekar, C. S., Chetti, M. B., Naline, A. S. and Patil, A. B. 1998, Relationship of leaf characteristics with total dry matter and yield in groundnut as influenced by growth retardants. *Indian J. Agric. Res.*, **32**(2): 195-200.

Pourmohammad, F., Shekari. and V. Soltaniband., 2014, Cycocel priming and foliar application affect yield components of rapeseed (*Brassica napus* L.). Cercetari Agronomice in Moldova. XLVII (1):157.

Sharma, A., Potdar, M. P., Pujari, B. T. and Dharmara, P. S., 2003, Studies on response of pigeonpea to canopy modification and plant geometry. *Karnataka J. Agric. Sci*., **16**(1): 1-3.

Srivastava, S. K. and Tiwari, D. K., 1981, Correlation of physiological growth parameters of productivity in chickpea. *Jawaharlal Nehru Krishi Vishwa Vidyalaya Research* J., **15**(1): 75-76.

Sudha Rani, C. and Sudhakar, C., 2018, Effect of plant growth retardants on growth, yield and economics of *Kharif* pigeonpea. *Int. J. Che. Stud.*, **6**(1): 1495-1498.

Techapinyawat, S., Nakorn, M. N. and Sinbuathong, N., 1995, Effects of ethephon and paclobutrazol on growth and yield of mung bean cv Kamphaeng Saen. Kasetsart *J. Natural Sci*., **29**(2): 193- 204.

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