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The Effect of Growth Retardants on Reprodutive Efficiency and Yield of Groundnut (*Arachis hypogaea* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was carried out during *Kharif,* 2023 at dryland farm of S. V. Agricultural College, Tirupati campus of Acharya N. G. Ranga Agricultural University, Andhra Pradesh. The experiment was laid out in a split-plot design with three replications and two genotypes as main factor (G_1- Dharani, G_2- K-6), growth retardants as sub factor. The current experiment was conducted with an

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objective to study the impact of growth retardants on reduction of plant stature thereby enhancing the reproductive and assimilates partitioning efficiency along with yield. This article discusses various yield and reproductive efficiency related attributes of groundnut as influenced by growth retardants. The experimental results revealed that, the T5 (PBZ @ 250 ppm at 45 DAS) reported Maximum number of pegs per plant (58.50), number of pods per plant (28.89), shelling % (70.39) and harvest index (32.52 %). Among the two genotypes studied, G1 (Dharani) demonstrated more number of flowers (73), number of pegs per plant (50), number of pods per plant (26), shelling % (69) and harvest index (32 %).

Keywords: Groundnut; maleic hydrazide; paclobutrazol; cycocel and abscisic acid.

1. INTRODUCTION

Groundnut often referred to as the 'unpredictable legume', goes also by different local names such as earthnut, peanut, monkey nut, and manilla nut. It belongs to the family *Fabaceae* and order fabales. It is a widely cultivated annual crop that exhibits dicotyledonous behaviour and self-pollination. The term '*Arachis'* originates from Greek, signifying a legume, while '*hypogaea'* refers to its geocarpic nature of pod formation. Groundnut is grown in tropical, sub-tropical and warm climate zones between the latitudes of 40° N and 40° S. Groundnut is a rich source of edible oil (47-54%), high-quality protein (22-30%), starch (6-24%), cellulose (1-2%), minerals (2-3%) and calories (5-6%). Groundnut. India ranks second next to China in Groundnut producing countries. Nigeria, Senegal, Sudan, Burma and United States are the top producers, with most of the production concentrated in Asian and African nations [1,2].

According to the data published by 2nd advance estimates, Groundnut outlook, Agricultural Market Intelligence Centre, Annual report, January 2021, India ranks first in Groundnut area under cultivation and is the second largest producer in the world with 102 lakh tonnes with productivity of 1831 kg ha^{-1} in 2020-21. Gujarat, Andhra Pradesh and Tamil Nadu are some of the top producing states. In Andhra Pradesh, Groundnut was grown under 8.09 lakh hectares with a production of 5.35 lakh tonnes and productivity of 661 kg ha^{-1} during 2021-22.

The use of growth retardants is regarded as one of the most significant developments in agricultural technology. Growth inhibitor cycocel (chlormequat (2- chlorethyl) trimethyl ammonium chloride) is known to suppress endogenous gibberellin levels, which may aid in limiting vegetative growth and promoting blooming. PGRs can change a plant's growth and developmental pattern in various ways, such as stem elongation, flowering, fruiting and overall architecture. The growth retardants can be utilized to manage the Groundnut's indeterminate nature, which can lead to improved distribution of reserves to the early-formed pods, increasing the number of full pods and reducing the number of unfilled and immature pods [3,4].

Maleic hydrazide (MH) is used to inhibit the seed germination in peanuts. The results of various studies indicate that, within five days of the spraying, differences in height could be identified and in six weeks after planting, the untreated plants started to bloom [5].

Paclobutrazol (PBZ) is known to minimize the plant stature, improve the yield and also increases the relative water content, leaf area, which further reduces evapo-transpiration, lowers plant moisture stress and increases plant tolerance to both biotic and abiotic stress.

Growth inhibitor cycocel is known to suppress endogenous gibberellin levels, which may aid in limiting vegetative growth and promoting blooming, with increase in laterals and earlier flowering time.

Abscisic acid (ABA) quickens the abscission of leaves and fruits. It also delays flowering in long-day plants kept under short days. It resembles the impact of short days for many reactions [6].

The information on the identification of suitable Plant growth retardants and concentrations of application on groundnut cultivars for improving the yield and reproductive efficiency is lacking. Keeping this in view, the present investigation 'Effect of growth retardants on plant yield and biochemical parameters of Groundnut (*Arachis hypogaea* L.) was undertaken.

2. MATERIALS AND METHODS

The experiment was conducted during *Rabi*, 2022-23 in Field No. 17 of wetland farm, S.V.

Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University which is geographically situated at 13.5° N latitude and 79.5° E longitude at an altitude of 182.9 m above mean sea level in the Southern Agro-climatic Zone of Andhra Pradesh. The experimental field soil was sandy loam in texture, neutral in reaction (pH - 6.8), low in organic carbon (0.38%) and available nitrogen (120.3 kg ha^{-1}), high in available phosphorus (27.2 kg ha^{-1}) and medium in potassium (214 kg ha^{-1}). The plots of 3.15 m × 2 m size were used for each treatment. The experiment was laid out in split-plot design with main plots and sub plot treatments replicated thrice. with two Genotypes as main factor (G_1: Dharani, G_2: K-6) and Growth retardants as sub factor (T_1: Control + RDF of NPK, T_2: MH @ 2000 ppm at 20 DAS, T_3: MH @ 2000 ppm at 45 DAS, T_4: PBZ @ 250 ppm at 20 DAS, T_5: PBZ @ 250 ppm at 45 DAS, T_6: ABA @ 250 ppm at 20 DAS, T_7: ABA @ 250 ppm at 45 DAS, T_8: ABA @ 500 ppm at 20 DAS, T_9: ABA @ 500 ppm at 45 DAS, T_{10}: CCC @ 5000 ppm at 20 DAS and T_{11}: CCC @ 5000 ppm at 45 DAS. Fertilizers were applied to the experimental plots with 30 kg ha^{-1} of N_2, 40 kg ha^{-1} of P_2O_5 and 50 kg ha^{-1} K_2O were applied at sowing in the form of Urea, Single super phosphate and Murate of potash as a basal dose. Gypsum was applied at 500 kg ha^{-1} at beginning of flowering to supply calcium and sulphur. The foliar sprays were applied at 20 and 45 days after sowing. All the weeds were removed by hand weeding twice at 20 and 40 days after sowing and crop irrigated at regular intervals up to one week before harvesting. The plants in net plot were harvested, dried for 2 days and then threshed. The seed and yield from each net plot were recorded separately and expressed as kg ha^{-1}. The data were recorded during the investigation was statistically analyzed following the analysis of variance for split–plot design as suggested by Panse and Sukhatme [7]. Statistically significance was tested with 'F' value at five per cent level of probability.

Pre-harvest chemical treatment Sprays were applied at 20 and 45 days after sowing harvest. The particulars of preparation and application of treatments to Groundnut is detailed hereunder. In order to prepare 2000 ppm of maleic hydrazide, 6g of MH was diluted in NaOH to aid in dissolving the chemical. It was added to 3 litres of water. To prepare 250 ppm of PBZ 750 mg was diluted in NaOH to aid in dissolving the chemical. It was added to 3 litres of water. In order to prepare @ 250ppm of ABA 750 mg is dissolved in 3litres of water. 1.5 g of ABA was dissolved in 3litres of water to prepare @ 500 ppm of ABA. 15 g of Cycocel chemical was dissolved in 3litres of water to prepare Cycocel @ 5000 ppm.

3. RESULTS AND DISCUSSION

3.1 Reproductive Efficiency Attributes

PBZ (Paclobutrazol) treatments resulted in a noticeable decrease in the number of flowers per plant (Table 1), especially at later growth stages (60 and 90 DAS). At the 30 DAS stage, T1 exhibited the maximum number of flowers per plant (13.92), followed closely by T2 and minimum was observed in T5 (10.81). At 60 DAS, similar trends were observed with T1, T2 and T5 having the highest number of flowers. The PBZ was recorded to be efficient in reducing the number of flowers per plant at the later stages, which could benefit the plant by reducing the wastage of resources to late formed flowers and thereby enhancing the seed filling. The results also indicates that Dharani has a higher potential for flower production. This also translates to better yield and harvest index of genotype Dharani over K-6.

It is essential to arrest production of new flowers after 60 DAS [8]. When PBZ applied to peanut plants at the three different stages of pod formation, it was found that the earliest treatment was the most effective for increasing seed yield [9].

Treatments T4 and T5, resulted in the maximum number of pegs per plant (Table 2), with values of 58.43 and 58.50 respectively. A minimum number of pegs per plant were noted in control (T1) (42.38). Genotype G1 exhibited a higher number of pegs per plant (50) compared to G2 (41). This could be due to greater assimilate translocation efficiency of G1 which ultimately leads to greater yield potential.

Treatments T4 and T5, which involved the application of PBZ @ 250 ppm at 20 DAS and 45 DAS, respectively, resulted in the highest number of mature pods per plant, with values of (28.86) and (28.89), respectively. Minimum number of mature pods per plant were recorded in T1 (Control). The possible increments in pod yield in PBZ treated plants might be due to the change in canopy coverage, in which the plant developed broader canopy due to decreased height, which further facilitates better light interception for greater photosynthesis in leaves and stems groundnut plants.

Table 1. Effect of growth retardants on number of flowers per plantin groundnut genotypes

Treatments	30 DAS	60 DAS	90 DAS
T_1 : Control + (RDF of NPK)	13.92	139.38	71.78
T_2 : MH @ 2000 ppm at 20 DAS	13.81	139.30	71.6
T_3 : MH @ 2000 ppm at 45 DAS	13.75	139.12	71.52
T_4 : PBZ @ 250 ppm at 20 DAS	11.15	113.71	60.97
T_5 : PBZ @ 250 ppm at 45 DAS	10.81	113.67	60.89
T_6 : ABA @ 250 ppm at 20 DAS	13.68	139.04	71.34
T_7 : ABA @ 250 ppm at 45 DAS	13.62	138.86	71.26
T_8 : ABA @ 500 ppm at 20 DAS	13.51	138.78	70.08
T_9 : ABA @ 500 ppm at 45 DAS	13.47	138.60	70
T_{10} : CCC @ 5000 ppm at 20 DAS	13.36	138.52	69.82
T_{11} : CCC @ 5000 ppm at 45 DAS	13.29	138.49	69.74
SEm±	0.34	3.29	1.44
CD (P = 0.05)	2.09	20.02	8.77
Genotypes			
G_1 : Dharani	15.67	141.59	73.00
G_2 : K-6	10.58	127.04	65.85
SEm±	0.26	2.49	1.33
CD (P = 0.05)	0.74	7.11	3.80
Interaction			
T × G			
SEm±	0.74	7.14	3.82
CD (P = 0.05)	NS	NS	NS
G × T			
SEm±	0.60	5.80	2.97
CD (P = 0.05)	NS	NS	NS

Table 2. Effect of growth retardants on number of pegs per plant and number of mature pods per plant in groundnut genotypes

Treatments	No. of pegs /plant	No. of maturepods / plant
T_1 : Control + (RDF of NPK)	42.38	23.22
T_2 : MH @ 2000 ppm at 20 DAS	42.50	23.32
T_3 : MH @ 2000 ppm at 45 DAS	42.57	23.38
T_4 : PBZ @ 250 ppm at 20 DAS	58.43	28.86
T_5 : PBZ @ 250 ppm at 45 DAS	58.50	28.89
T_6 : ABA @ 250 ppm at 20 DAS	42.70	23.51
T_7 : ABA @ 250 ppm at 45 DAS	42.76	23.58
T_8 : ABA @ 500 ppm at 20 DAS	42.89	23.71
T_9 : ABA @ 500 ppm at 45 DAS	42.96	23.79
T_{10} : CCC @ 5000 ppm at 20 DAS	43.03	23.92
T_{11} : CCC @ 5000 ppm at 45 DAS	43.04	23.92
SEm±	2.13	0.65
CD (P = 0.05)	13.00	3.97
Genotypes		
G_1 : Dharani	50	26
G_2 : K-6	41	23
SEm±	0.47	0.27
CD (P = 0.05)	1.36	0.79
Interaction		
T × G		
SEm±	1.3	0.79
CD (P = 0.05)	NS	NS
G × T		
SEm±	2.08	0.79
CD (P = 0.05)	NS	NS

Table 3. Effect of growth retardants on shelling percentage and harvest index in groundnut genotypes

Treatments	Shelling percentage (%)	Harvest index (%)
T1 : Control + (RDF of NPK)	65.31	28.90
T2 : MH @ 2000 ppm at 20 DAS	65.56	28.94
T3 : MH @ 2000 ppm at 45 DAS	65.85	30.02
T4 : PBZ @ 250 ppm at 20 DAS	68.94	32.35
T5 : PBZ @ 250 ppm at 45 DAS	70.39	32.52
T6 : ABA @ 250 ppm at 20 DAS	65.60	30.22
T7 : ABA @ 250 ppm at 45 DAS	65.67	30.49
T8 : ABA @ 500 ppm at 20 DAS	65.79	30.55
T9 : ABA @ 500 ppm at 45 DAS	65.92	31.13
T10 : CCC @ 5000 ppm at 20 DAS	66.05	31.21
T11 : CCC @ 5000 ppm at 45 DAS	66.13	31.27
SEm±	1.75	1.28
CD (P = 0.05)	10.67	NS
Genotypes		
G1 : Dharani	69	32
G2 : K-6	64	29
SEm±	0.47	0.57
CD (P = 0.05)	1.37	NS
Interaction		
T × G		
SEm±	1.37	1.64
CD (P = 0.05)	NS	NS
G × T		
SEm±	1.80	1.61
CD (P = 0.05)	NS	NS

Genotype G1 exhibited a higher number of mature pods per plant (44), compared to genotype G2 (39), which might be attributed to its efficiency of dry matter production and assimilate translocation to reproductive portions of plant.

3.2 Yield Attributes

Among the treatment T5, resulted in the highest shelling percentage (Table 3) of 70.39%, whereas control (T1), had the lowest shelling percentage at 65.31%. Which confirmed these results with the application of PBZ had the greater influences to increase the shelling percentage. This result may be due to more photosynthates were conveyed efficiently to reproductive parts during pod development stages. Genotype G1 exhibited higher shelling percentage of 69 per cent, compared to G2 (64 %).

Maximum of harvest index was shown in T5 (32.52%), followed by T4 (32.35%), whereas the minimum was observed in T1 (28.90%). The possible increment of HI in paclobutrazol treated plants could be due to the change in canopy coverage, in which the plant develops broader canopy due to decreased height, facilitated improved light interception for better photosynthesis in leaves and stems. This may explain increased dry matter accumulation in stem and root and simultaneous yield. Similar results were also witnessed by Hua et al. [10]. The increase in dry matter production by PBZ by Gibberellin inhibition and increased leaf chlorophyll content. This leads to more dry matter production and efficient assimilates translocation among the reproductive parts. Among genotypes Genotype G2 displayed a lower harvest index (29%) compared to genotype G1 (32%). The increase in harvest index was due to the observed reduction in plant height and vegetative growth which possibly enhanced partitioning of assimilate to pods [11,12].

4. CONCLUSION

Hence, the present study concludes that higher shelling %, Harvest index, number of flowers, pegs and mature pods can be realized with the foliar application of PBZ @ 250 ppm at 45 DAS in Southern Agro-climatic Zone of Andhra Pradesh. The genotype Dharani performed relatively better than K-6 almost all the yield and reproductive efficiency attributes studied in the experiment.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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