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AGRONOMY

Effect of Paclobutrazol on Growth and Yield of *Kharif* Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was done during 2013 and 2014 to reduce the unnecessary vegetative growth of *kharif* groundnut through application of paclobutrazol (PBZ), a growth retardant and to study its impact on yield. The experiment was laid out in split–plot design with six treatments in main plot (PBZ @ 50, 100, 150, 200, 250 ppm and control) and three treatments in sub–plot (Single spraying at 30 Days after emergence (DAE), single spraying at 50 DAE and double spraying at 30 and 50 DAE) and replicated thrice. PBZ in different concentration had the positive response to reduce the plant height during later stages of growth. In case of time of application, significant variation in crop growth rate (CGR) was found before harvesting. Among different yield attributes, pod dry weight (g) plant^{-1} was increased upto 32% with increase in concentration of PBZ and upto 28% with time of application as compared to control and single application, respectively. PBZ @ 250ppm with double spraying remarkably augmented total kernel yield (Kg ha^{-1}), harvest index as well as oil percentage of this crop and ultimately improved the net return: cost ratio.

Highlights

- Application of paclobutrazol reduced remarkable plant height of groundnut.
- Kernel yield and oil% were increased significantly with double spraying of paclobutrazol@ 250ppm.

Keywords: Groundnut, paclobutrazol, growth attributes, yield components, oil content, net return: cost ratio

Groundnut (*Arachis hypogaea* L.) is considered one of the most important oilseed crops, containing 44–56% oil along with 22–30% protein on a dry seed basis. Securing first rank in case of production as well as area in India (Rai *et al*. 2016), it plays a vital role in Indian agricultural economy (Madhusudhana 2013). Groundnut has occupied around 45% and 55% of total oilseed area and production, respectively. In India, the crop is grown in all three seasons *viz*. *kharif*, *rabi* and summer mostly under *rainfed* condition; among these, *kharif* production alone accounts for around 75% of total production. Being semi-determinate crop, groundnut has continuous vegetative growth even after start of reproductive stage and this is one of the reasons of sink-source imbalance which ultimately results in lower productivity. Besides this, during *kharif* mutual shading due to excess vegetative growth reduces the production of groundnut (Gatan and Gonzales 2015); excessive dry matter distribution to stems also hampers the harvest index of this crop. Hence, an amendment to change the sharing pattern of assimilates may be a suitable option for increasing the yield as well as improving management of this crop and this can be taken place with the use of growth retardants.

Paclobutrazol (PBZ), a member of the triazole family, reduces shoot length by the inhibition of gibberellin biosynthesis and helps in partitioning of assimilates effectively (Ziauka and Kuusiene

2010). This research was done to find out the effects of different concentrations of PBZ and its different time of application on plant growth and yield along with economics.

MATERIALS AND METHODS

The field experiment was carried out during *kharif* season in 2013 and 2014 at the District Seed Farm, 'AB' block, Kalyani, under Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India. The soil of the experimental field was alluvial and sandy loam having good water holding capacity (WHC) and neutral in reaction. The organic carbon content in soil was medium (0.5%) with low in nitrogen (231 kg ha^{-1}), medium in phosphorus (21.63 kg ha^{-1}) and potash (190.7 kg ha^{-1}) contents. The experimental design was split-plot with 6 doses (T_1:50ppm, T_2:100ppm, T_3:150ppm, T_4:200ppm, T_5: 250ppm and T_6:control) of PBZ in main-plot treatments and 3 different times of application (S_1:single spraying at 30 days after emergence (DAE), S_2: single spraying at 50 DAE and S_3:double spraying at 30 and 50 DAE) in sub-plot treatments which were replicated thrice. The variety of groundnut used in this experiment was TG51 (Mutant derivatives of TG26 x Chico by Bhaba Atomic Research Centre, Mumbai) with around 90 days duration and the source of PBZ was CULTAR (23%W/W SC 25% W/V). The recommended doses of N: P_2O_5: K_2O fertilizer were 20: 60: 40 kg ha^{-1} and sources were urea, single superphosphate (SSP) and muriate of potash (MOP), respectively; entire quantity was applied as basal.

As pre-harvest observations plant heights at different intervals and crop growth rate (CGR) i.e the total dry matter production of crop community per unit land area over a certain period of time was calculated by the following formula and expressed in g m^{-2} day^{-1}. CGR = $[(W_2 – W_1)/(t_2 – t_1)]$ where, W_1 and W_2were the dry weights of plant parts per unit land area at times t_1 and t_2, respectively. As post-harvest observations average pod dry weights per plant in gram and shelling% following the formula i.e. Shelling (%) = [{Total weight of kernel (g)/ Total weight of seed pod (g)} × 100] were recorded in treatment wise during both the years. Net plots were harvested separately and after harvesting the weight of kernels were recorded and converted it into kg ha^{-1} basis. Then harvest index was calculated from the following formula: Harvest index (%) = [(Economic yield/ Biological yield) × 100] and oil content (%) in kernel was calculated for each treatments as follows: Oil in seed (%) = [{Weight of oil (g)/ Weight of seed meal taken (g)} × 100].

RESULTS AND DISCUSSION

Effect of PBZ on growth attributes of *kharif* groundnut

Effect of PBZ on plant height

Plant height varied significantly due to application of paclobutrazol (Table 1). But at 30 days after emergence (DAE), there was no significant result because PBZ was not applied before. After application of PBZ, the treated plant heights were significantly lowerthan the control. At 60 DAE, plant height was gradually decreased with increasing dose of PBZ upto T_3 (150ppm) treatments and it was at par with other doses i.e. T_2 (100ppm), T_4 (200 ppm) and T_5 (250 ppm). In case of different times of application, S_3 (double spraying at 30 and 50 DAE)had shortest plants (30.6 cm) as compared to others. At harvest, similar trend was found and the minimum plant height was recorded (48.0 cm) in the treatment T_3 which was significantly lower than control. There was no significant result with different time of application during harvest. Plant height might have been reduced due to anti-gibberellin action of PBZ which stop cell division as well as cell elongation that are generally influenced by gibberellins. This is in accordance with the findings of Hegazi and El-Shraiy (2007). So, foliar application of PBZ@ 50-250 ppm spraying at initial stage and another at 10-15 days after flower initiation proved better in reducing excessive vegetative growth of groundnut. The findings are in close agreement with the results obtained by Kathmale and Kamble (2010).

Effect of PBZ on crop growth rate (CGR)

During 30 to 45 DAE, 46 to 60 DAE and 75 to harvest no significant results were found among the treated plots (Table 1). At 61 to 75 DAE, CGR was significantly different among the treatments and maximum CGR (4.09 g m^{-2} day^{-1}) was found in T_5. Significant effect was found with different times of application of PBZ at 30 to 45 DAE and 75 to harvest. CGR (3.35 g m^{-2} day^{-1}) was maximum in

Table 1: Effect of paclobutrazol (PBZ) on growth attributes of groundnut during *kharif* season (Pooled over two years)

Treatments	Plant height (cm)			Crop growth rate (g m^{-2} day^{-1})			
	30DAE	60DAE	At harvest	30–45 DAE	46–60 DAE	61–75 DAE	76 DAE – at harvest
Doses of PBZ (T)							
T_1: PBZ @50ppm	30.8	34.0	53.2	1.82	2.02	2.20	3.07
T_2: PBZ @100ppm	30.4	29.4	51.7	1.84	2.28	1.77	4.11
T_3: PBZ @150ppm	32.5	28.6	48.0	1.75	2.08	3.40	2.79
T_4: PBZ @200ppm	29.6	30.1	48.4	2.16	1.92	3.27	2.56
T_5: PBZ @250ppm	34.5	30.5	49.6	1.98	2.20	4.09	2.35
T_6: Control	36.9	39.4	64.7	1.24	1.69	3.48	1.87
SEm (±)	0.99	0.95	1.76	0.10	0.30	0.17	0.29
CD (P=0.05)	NS	2.42	4.48	NS	NS	0.40	NS
Time of application (S)							
S_1: Single spraying at 30DAE	31.9	32.9	54.7	1.90	1.94	2.85	2.56
S_2: Single spraying at 50DAE	32.8	32.4	55.0	1.81	1.96	3.25	2.47
S_3: Double spraying at 30 DAE and 50 DAE	32.3	30.6	54.0	1.82	2.20	3.01	3.35
SEm (±)	0.53	0.68	1.24	0.05	0.15	0.19	0.16
CD (P=0.05)	NS	2.52	NS	0.18	NS	NS	0.61

S_3 during 75 DAE to harvest. These results might be due to the fact that application of PBZ increases the photosynthetic rate of plants through increasing chlorophyll content and improved plant canopy which enhance the light penetration and ultimately helps in upsurge the growth rate of plants. These results completely collaborate with the findings of Kumar *et al.* (2012).

Effect of PBZ on yield components and yield of *kharif* groundnut

Effect of PBZ on pod dry weight per plant

Significantly higher pod dry weight per plant (6.8g) was obtained from T_5 treatment which was statistically at par with T_3 and T_4 and double spraying at 30 and 50 DAE showed superior result (6.5g) than other treatments (Table 2). The increment of pod dry weight is attributed to more partition of photo assimilates to reproductive system. These observations are in close conformity to those obtained by Hua *et al*. (2014).

Effect of PBZ on shelling percentage

Shelling percentage did not vary significantly due to application of different concentration of PBZ. Significantly higher shelling out turn (69.7%) was noticed in double spraying at 30 and 50 DAE (S_3) compared to single spraying at 30 DAE (S_1) which was statistically at par with S_2. Hence, in later stage of the crop growth, 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.

Effect of PBZ on 100 kernel weight

Different concentrations of PBZ had no significant effect on 100 kernel weight. Similar results also obtained in case of different times of application. Senoo and Isoda (2003) also reported that application of PBZ had not considerable effect on kernel weight.

Effect of PBZ on kernel yield

All concentrations of PBZ had superior result than control and the higher kernel yield (1233 kg ha^{-1}) was obtained with the treatment T_5 which was statistically at par with T_4. So, PBZ@ 150 to 250 ppm were more responsive to increase the kernel yield. In addition, kernel yield (1157 kg ha^{-1}) was found maximum when PBZ was applied in both

30 DAE and 50 DAE (S_3). In case of interaction outcome the significantly higher kernel yield (1332 kg ha^{-1}) was recorded in T_5S_3 and the lower kernel yield was obtained in T_6S_2 (Fig 1). This increment in kernel yield might be due to alteration of dry-matter distribution from vegetative parts to kernels because of the reduction of stem elongation. The findings are in close vicinity with the results obtained by Khafaga *et al.* (2009) and Ashraf *et al*. (2017).

Effect of PBZ on harvest index

Significantly higher harvest index (42.6%) was found by application of 250ppm PBZ (T_5) which was statistically at par with T_4 (41.8%) and T_3 (41.6%). In case of time of spraying, significantly higher harvest index was found in S_3 (41.1%) followed by S_2 (40.5%) and S_1 (39.9%). 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. This observation is in close agreement with the results obtained by Win *et al*. (2017).

Effect of PBZ on oil content in kernel

From table 2 it was found that oil content (%) of groundnut increased with increasing the doses of PBZ and significantly higher result was obtained in the treatment T_2 which was statistically at par with all the applied doses of PBZ (T_1-T_5). Double spraying at 30 and 50 DAE significantly increased the oil content as compared to single spraying at 30 DAE. However, single spraying at 50 DAE was statistically at par with double spraying. So at later stage foliar application of PBZ not only increased the kernel yield but also the oil content in *kharif* groundnut. Similar result was witnessed by Chen *et al*. (2010).

Effect of PBZ on economics of *kharif* groundnut

Economics is the foremost consideration for the farmers while taking a decision regarding the acceptance of a new technology, hence net return and cost ratio was computed for different treatments. Significantly higher net return: cost

Table 2: Effect of paclobutrazol (PBZ) on yield attributes, yield and economics of groundnut during *kharif* season (Pooled over two years)

Treatments	Pod dry weight (g) per plant	Shelling %	100 kernel weight (g)	Kernel yield (Kg ha^{-1})	Harvest index (%)	Oil content (%)	Net return: Cost
Doses of paclobutrazol (T)							
T_1: PBZ @50ppm	4.6	68.6	43.6	918	39.1	46.0	0.78
T_2: PBZ @100ppm	4.8	68.3	43.8	1045	40.2	47.0	0.91
T_3: PBZ@150ppm	6.4	69.7	43.8	1143	41.6	46.1	1.05
T_4: PBZ@200ppm	6.0	69.6	44.5	1185	41.8	45.2	1.06
T_5: PBZ @250ppm	6.8	69.6	44.5	1233	42.6	45.9	1.06
T_6: Control	4.6	67.9	43.1	805	37.8	44.6	0.62
SEm (±)	0.38	0.61	0.50	21.83	0.37	0.939	0.06
CD (P=0.05)	0.97	NS	NS	55.88	0.94	2.469	0.15
Time of application (S)							
S_1: Single spraying at 30DAE	4.7	68.2	43.3	968	39.9	44.4	0.79
S_2: Single spraying at 50DAE	5.4	69.1	44.0	1040	40.5	45.8	0.92
S_3: Double spraying at 30 DAE and 50 DAE	6.5	69.7	44.4	1157	41.1	47.2	1.03
SEm (±)	0.27	0.43	0.36	15.44	0.26	0.616	0.04
CD (P=0.05)	0.65	1.04	NS	37.98	0.63	1.507	0.09

ratio was recorded with T_3 which was statistically at par with all other paclobutrazol treatments except T_1 and T_6. Double spraying at 30 and 50 DAE (S_3) showed the significantly higher result as compared to single spraying at 30 DAE (S_1); though, treatment S_3 was statistically at par with S_2. Therefore, in the present investigation, higher net return: cost ratio was recorded with the application of PBZ. The results are substantiating the findings of Tandel and Patel (2011).

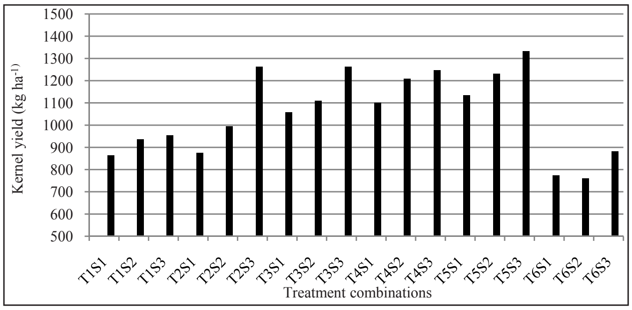

Fig. 1: Effect of different treatment combinations on kernel yield (Kg ha^{-1})

Correlation analysis

The correlation results (Table 3 and 4) indicated that kernel yield was negatively correlated (r = -0.883 and -0.775 for different doses and times of application, respectively) with plant height. The result showed that reduction in plant height is useful to improve yield. Significant positive correlation was found between kernel yield and yield components like pod dry weight per plant (r = 0.894** and 0.999** for different doses and times of application, respectively), 100 kernel weight (r = 0.929** and 0.957** for different doses and times of application, respectively) and harvest index (r = 0.997** and 0.991** for different doses and times of application, respectively). In this study, it was also found that kernel yield is highly correlated (r = 0.991**) with oil content in case of different times of application of PBZ (Table 4).

CONCLUSION

Paclobutrazol (PBZ) had reduced the plant height in comparison to untreated plants and had remarkable effect on growth as well as on yield of *kharif* groundnut. Among different yield attributes, pod dry weight (g) plant^{-1} was increased upto 32% with increase in concentration of PBZ and upto 28% with double time of application as compared to control and single application, respectively. The inference of this experiment can be drawn as double spraying at 30 and 50 DAE with 250ppm concentration of PBZ showed positive upshots in case of different yield parameters which ultimately resulted on the yield of the crop. Therefore, application of PBZ can be a sound option for *kharif* groundnut production.

Table 3: Correlation matrix of kernel yield with growth and yield components for different doses of PBZ

	1	2	3	4	5	6
1. Kernel yield (Kg ha^{-1})	1					
2. Plant height (cm)	-0.883	1				
3. Pod dry weight (g) per plant	0.894	-0.680	1			
4. 100 kernel weight (g)	0.929	-0.805	0.769	1		
5. Harvest index (%)	0.997	-0.878	0.919	0.918	1	
6. Oil content (%)	0.332	-0.569	0.039	0.202	0.315	1

Table 4: Correlation matrix of kernel yield with growth and yield components for different times of application of PBZ

	1	2	3	4	5	6
1. Kernel yield (Kg ha-1)	1					
2. Plant height (cm)	-0.775	1				
3. Pod dry weight (g) per plant	0.999	-0.769	1			
4. 100 kernel weight (g)	0.957	-0.560	0.960	1		
5. Harvest index (%)	0.991	-0.682	0.992	0.988	1	
6. Oil content (%)	0.991	-0.682	0.992	0.988	1	1

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REFERENCES

Ashraf, N., Ashraf, M., Bhat, M.Y. and Sharma, M.K. 2017. Paclobutrazol and summer pruning influences fruit quality of red delicious apple. *International Journal of Agriculture, Environment and Biotechnology*, **10**(3): 349-356.

Chen, H., Huang, J., Li, Q., Qiu, G., Li, S. and Xie, Z. 2010. Effect of paclobutrazol on development and quality of valencia type peanut. *Journal of Peanut Science*. #

Gatan, M.G.B. and Gonzales, V.D. 2015. Effect of different levels of paclobutrazol on the yield of asha and farmers' variety of peanut. *JPAIR Multidisciplinary Research*, **21**: 1-15.

Hegazi, A.M. and El-Shraiy, A.M. 2007. Impact of salicylic acid and paclobutrazol exogenous application on the growth, yield and nodule formation of common bean. *Australian Journal of Basic and Applied Sciences*, **1**(4): 834-840.

Hua, S., Zhang, Y., Yu, H., Lin, B., Ding, H., Zhang, D., Ren, Y. and Fang, Z. 2014. Paclobutrazol application effects on plant height, seed yield and carbohydrate metabolism in canola. *International Journal of Agriculture and Biology*, **16**: 471–479.

Kathmale, D.K. and Kamble, B.M. 2010. Yield maximization of winter groundnut (*Arachis hypogaea* L.) through integrated input management under polythene mulch in the Konkan region of Maharashtra. *International Journal of Plant Sciences*, **5**(1): 215-224.

Khafaga, H.S., Raeefa, A.H., Hala, M.M. and Alaa, S.A. 2009. Response of two faba bean cultivars to application of certain growth regulators under salinity stress condition at Siwa Oasis: 1- Growth traits, yield and yield components. Proceedings of the 4th Conference on Recent Technologies in Agriculture, November 3-4, 2009, Cairo, Giza, Egypt, pp. 236-249.

Kumar, S., Ghatty, S., Satyanarayana, J., Guha, A., Chaitanya, B.S.K. and Reddy, A.R. 2012. Paclobutrazol treatment as a potential strategy for higher seed and oil yield in field-grown *Camelina sativa* L. Crantz. *BMC Research Notes*, **5**: 137.

Madhusudhana, B. 2013. A survey on area, production and productivity of groundnut crop in India. *IOSR Journal of Economics and Finance (IOSR-JEF)*, **1**(3): 1-7.

Rai, S.K., Charak, D. and Bharat, R. 2016. Scenario of oilseed crops across the globe. *Plant Archives*, **16**(1): 125-132.

Senoo, S. and Isoda, A. 2003. Effects of paclobutrazol on dry matter distribution and yield in peanut. *Plant Production Science*, **6**(1): 90-94.

Tandel, Y.N. and Patel, N.L. 2011. Effect of chemicals on growth, yield and economics of mango (*Mangifera indica* L.). *Karnataka J. Agric. Sci.*, **24**(3): 362 – 365.

Win, A., Htwe, N.M., Myint, N.O., Toe, K. and Hom, N.H. 2017. Effects of paclobutrazol on growth of groundnut (*Arachis hypogaea* L.). *Journal of Agricultural Research*, **4**(1): 15-22.

Ziauka, J. and Kuusiene, S. 2010. Different inhibitors of the gibberellin biosynthesis pathway elicit varied responses during in vitro culture of aspen (*Populus tremula* L.). *Plant Cell, Tissue and Organ Culture (PCTOC)*, **102**(2): 221–228.

In Chinese with English abstract.