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Effect of plant growth regulators on dry matter production and yield attributes of groundnut (*Arachis hypogaea* L.) cv. GJG-9

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Abstract
A field experiment was conducted during the *kharif* 2017 at Cotton Research Station, Junagadh Agricultural University, Junagadh to study the effects of different plant growth regulators on dry matter production and yield attributes of groundnut cv. GJG-9. The investigation was carried out in RBD design three replications and foliar application of different concentration of growth regulators such as GA_3 (50, 100 ppm), NAA (40, 80 ppm), TRIA (2.5, 5.0 ppm), BR (10, 15 ppm) and water spray (control) at 40 & 55 DAS. The experiment results revealed that foliar application of PGRs increased the total dry matter production and increase was more in GA_3 @ 100 ppm treated plants. Among different treatments, significantly higher no. of filled pods per plant (14.87), shelling percentage (77.32 %) and yield (1732.36 kg ha^{-1}) were observed in GA_3 @ 100 ppm treated plants as compared to control.

Keywords: BR, GA_3, NAA, TRIA

Introduction
Cultivated groundnut (*Arachis hypogaea* L.) is commonly known as monkey-nut, peanut, goobernut, manillanut, earthnut and popularly called as *magphooli*, which is one of the principal economic crops of the world, ranking 13th among food crops. It is also first ranking oilseed crop of India. Cultivated groundnut is a self-pollinated, autotetraploid legume crop with 2n=4x=40 chromosomes and belong to the family *Fabaceae*. The groundnut kernels are consumed as raw, boiled, roasted or fried products and also used in a variety of culinary preparations like peanut butter, peanut milk and chocolates. Groundnut is commercially cultivated over 100 countries in an area of 26.4 million hectares with a production of 37.1 million metric tons and an average productivity of 1.4 metric tons/ha. The total groundnut production in India during the year 2017 was 7.07 million tons from 4.15 million hectares area with an average productivity 1.70 metric tons/ha. Groundnut is the major oilseed crop of Gujarat with 2.79 million hectare area and 3.05 million tons of production with 1.87 metric tons/ha productivity (Anon., 2017) [1].
In a given environment the physiological performance like dry matter production and partitioning of dry matter to the economic product will indicate some of the characters which are essentially involved in contributing to higher yield.
The intent of the present study is to evaluate effects of different plant growth regulators on total dry matter production, yield attributes and finally yield.

Materials and Methods
The present investigation was conducted at Cotton Research Station, JAU, Junagadh during *kharif* season of 2017. The soil of the experimental plot was clayey in texture and medium black in reaction with pH 7.99 and EC 0.42 dS/m. The soil has available nitrogen (301 N kg/ha) and available phosphorus (34.26 P_2O_5 kg/ha) while available potash (660 K_2O kg/ha). The experiment constituted of 10 treatment combinations were laid out in RBD design with three replications. Solutions of GA_3 (50, 100 ppm), NAA (40, 80 ppm), TRIA (2.5, 5.0 ppm), BR (10, 15 ppm) were prepared and sprayed on the foliage of plants at 40 & 55 DAS with the help of hand sprayer as per treatment. The crop was fertilized with a uniform dose of nitrogen and phosphorus at the rate of 12.5 kg and 25 kg ha^{-1}, respectively. The below mentioned observations were recorded at 50, 70 and 90 DAS.

Statistical analysis

The data were analyzed by method of analysis of variance obtained by Panse and Sukhatme (1984) [8]. Significance was tested by "F" value at 5 percent level of probability. Critical differences were worked out for the effects which are significant.

Results and Discussion

Dry matter accumulation and partitioning

Dry matter is the end product of assimilates from source organs *via* a transport path to the sink organs. The potential growth rate and potential capacity to accumulate assimilates has been shown to be an important parameter that quantitatively reflects the sink strength of an organ. The effect of different growth regulators showed significant effect on dry weight of root, lamina, stem and reproductive parts of plant at 50, 70 and 90 DAS (Table 1). The dry weight of root was found significantly higher in treatment T_8 (3.11 g plant^{-1}) and it was statistically at par with treatment $T_{7,}$ while control T_{10} (1.65 g plant^{-1}) was recorded the lowest dry weight of root. Significantly highest dry weight of lamina (8.49 g plant^{-1}) was reported under treatment T_2 (GA_3 @ 100 ppm) and it was statistically at par with treatments T_1 and $T_{8,}$ while control T_{10} (5.09 g plant^{-1}) was recorded the lowest dry weight of lamina. The dry weight of stem was found significantly higher in treatment T_2 (14.25 g plant^{-1}), in comparison of control T_{10} (10.72 g plant^{-1}). Stem dry weight was increase up to 90 DAS than it was declined due to reserve photosynthate transported for pod development. Overall experimental result showed that dry weight of reproductive parts was found higher in treatment T_2 (19.89 g plant^{-1}).

It is evident from the results that plants treated with growth regulators especially GA_3 showed greater increase in dry matter production followed by BR. The data given in Table 2 revealed that different growth regulator treatments showed their significant effect on total dry matter production per plant at 50, 70 and 90 DAS. In compared with control significantly the higher total dry matter production was observed in treatment T_2 (45.05 g plant^{-1}). Similarly increase in dry matter production per plant due to application of BR was observed in groundnut by Surendar *et al.* (2013) [12]. Shinde (2010) [11] revealed a significant increase leaf dry weight, stem dry weight, dry weight of reproductive parts and total dry weight with the application of PGRs like, GA_3 (20, 40 and 60 ppm), CCC (500 and 1000ppm) and TIBA (100 and 200 ppm). Gardner (1988) [2] reported that foliar application of GA_3 increased the total dry matter production by 29 percent in groundnut. Kataria and Bhatt (1994) [5] reported that the dry matter accumulation in root, stem, leaf and whole plant increased with crop age.

The dry matter partitioning in lamina and stem decreased with the age of the crop whereas it increased in reproductive parts. This decline in leaf and stem dry weight at later stages of crop might be due to translocation of stored photosynthates towards reproductive organs. Different PGRs induced higher yields are mainly due to altered photosynthate distributive patterns within the plant by coordinating plant processes to synthesize maximum dry matter and partitioning the major quantum of this increased dry matter into effective yield contributing factors. The dry weight of reproductive parts showed an increasing trend throughout the growing period of the crop due to growth regulator treatments. The enhanced dry weight of reproductive parts by growth regulators could be due to increased size, number of pods per plant and also efficient translocation of assimilates from leaf and stem to reproductive parts. Nawalagatti *et al*. (1991) [7] studied the effect of different levels of plant growth regulators on growth and yield in groundnut and found that application of 50 ppm GA_3 and 10 to 20 ppm NAA increased dry matter production and partitioning as compared to control.

Yield and yield attributes

The yield of crop plants is attributed to total assimilation achieved during the growing season and the way it is partitioned between the desired storage structures and rest of the plant. The number of filled pods per plant were recorded at harvest are furnished in Table 3. A perusal of data revealed that different growth regulator treatments showed their significant influence on number of filled pods per plant as compared to control (T_{10}). The number of filled pods per plant was found significantly higher in treatment T_2 (14.87), which was followed by $T_{1,}$ T_7 and T_8, while control T_{10} (10.43) was recorded the lowest number of filled pods per plant at harvest. In the present study, it is revealed that the application of plant growth regulators significantly increased number of pods per plant and finally kernel yield per plant which is the most important yield determining components in groundnut. Reddy and Shah (1984) [10] reported that application of 25 and 50 ppm NAA on groundnut varieties, J-11, 28-4-1, Gaug 10 and M-13 resulted in significantly higher mature pods per plant, 100 seed weight and pod yield compared to control and also an increase in pod number per plant (50-70%), pod weight (22-29%) and pod yield (43-56%) with the application of GA_3 at 10 and 50 ppm concentrations over control in groundnut. Gupta and Singh (1982) [4] reported that foliar application of NAA at 40 ppm and GA_3 at 100 ppm to groundnut cv. T 64 increased the number of pods, shelling percentage and pod yield.

The data regarding 100 pod weight are furnished in Table 3. A calculated data in Table 3 revealed that different growth regulator treatments did not exhibit their significant influence on 100 pod weight. An appraisal of data Table 3 indicated that growth regulator treatments exerted their significant consequence on shelling percentage. Significantly highest shelling percentage (77.32 %) was registered under treatment T_2 (GA_3 @ 100 ppm) and it was found statistically at par with treatments T_1, T_7 and $T_{8,}$ while control T_{10} was recorded the lowest (68.99 %) shelling percentage. Gopalakrishnan and Srinivasan (1975) [3] reported that application of NAA from 5 to 160 ppm concentrations and GA 10 to 50 ppm concentrations increased pod yield and shelling percentage in groundnut.

An appraisal of data Table 3 indicated that growth regulator treatments exerted their significant consequence on yield. Significantly highest yield (1732.36 kg/ha) was registered under treatment T_2 (GA_3 @ 100 ppm) and it was found statistically at par with treatments T_1 (1700.19 kg ha^{-1}) and T_8 (1708.01 kg ha^{-1}), while control T_{10} was recorded the lowest (1381.52 kg ha^{-1}) yield at harvest. The photosynthetic productivity and partitioning of photosynthate finally lead to the economic yield which is the pods in groundnut. The yield in groundnut depends upon the accumulation of photo-assimilates during the growing period and the way in which they are partitioned between desired storage organs of plant. Seed yield and its related parameters in groundnut were influenced by the application of different growth regulators, which indicated that these growth regulators have differential influence on the distribution of assimilates between vegetative and reproductive organs. The increase in yield due to growth regulators in groundnut might be due to an increase in per cent distribution of peg and pod dry weight, higher partitioning of dry matter towards reproductive organs, increase in leaf thickness, number of pods per plant, higher no. of peg and total dry matter production. The hormonal concentration is correlated with the progress of plant, yield and yield components (Krishnamoorthy, 1981) [6]. Similarly increases in yield were reported by Gupta and Singh (1982) [4] and Reddy (1984) [9, 10] with GA_3 in groundnut. Yakubu *et al.* (2012) [13] reported that the highest pod, kernel and haulm yield were obtained at 100 mg l^{-1} levels of gibberellic acid during wet and dry seasons.

Table 1: Effect of growth regulators on dry weight of different parts of groundnut cv. GJG-9

Treatments		Dry weight of root (g plant^{-1})			Dry weight of lamina (g plant^{-1})			Dry weight of stem (g plant^{-1})			Dry weight of reproductive parts (g plant^{-1})		
		50 DAS	70 DAS	90 DAS	50 DAS	70 DAS	90 DAS	50 DAS	70 DAS	90 DAS	50 DAS	70 DAS	90 DAS
T_1	GA_3 @ 50 ppm	0.59	1.33	2.33	7.14	11.33	7.97	7.31	11.45	13.48	1.05	11.82	19.26
T_2	GA_3 @ 100 ppm	0.61	1.38	2.46	7.62	12.62	8.49	7.96	12.35	14.25	1.35	13.15	19.89
T_3	NAA @ 40 ppm	0.54	1.17	2.34	6.88	10.97	7.48	5.85	10.70	12.43	0.91	10.95	16.95
T_4	NAA @ 80 ppm	0.55	1.36	2.29	6.62	10.92	7.36	5.59	10.81	12.32	0.82	10.94	16.95
T_5	TRIA @ 2.5 ppm	0.70	1.80	2.45	6.46	10.68	6.72	6.94	10.53	12.29	1.15	10.66	16.34
T_6	TRIA @ 5.0 ppm	0.68	1.81	2.59	6.51	10.51	7.20	6.89	10.56	12.77	1.19	10.99	16.37
T_7	BR @ 10 ppm	0.72	2.10	2.89	6.89	11.14	7.47	7.31	11.36	13.28	1.22	10.59	17.80
T_8	BR @ 15 ppm	0.76	2.23	3.11	7.09	11.21	7.55	7.16	10.98	13.40	1.17	11.38	18.07
T_9	Water spray	0.49	1.03	1.72	5.16	8.55	5.69	5.17	8.98	10.58	0.71	8.53	14.08
T_{10}	Control	0.46	0.97	1.65	5.10	8.47	5.09	5.11	8.97	10.72	0.69	8.16	13.69
S.Em.±		0.04	0.09	0.15	0.34	0.55	0.33	0.35	0.52	0.58	0.05	0.64	0.86
C.D. at 5%		0.11	0.26	0.43	1.00	1.65	0.99	1.04	1.54	1.74	0.16	1.91	2.55
C.V. %		10.30	10.05	10.56	8.92	9.03	8.13	9.34	8.42	8.07	8.84	10.39	8.79

Table 2: Effect of growth regulators on total dry matter production (g plant^{-1}) of groundnut cv. GJG-9.

Treatments		Total dry matter production (g plant^{-1})			
		50 DAS	70 DAS	90 DAS	Mean
T_1	GA_3 @ 50 ppm	16.08	35.90	43.00	31.66
T_2	GA_3 @ 100 ppm	17.53	39.48	45.05	34.02
T_3	NAA @ 40 ppm	14.17	33.76	39.16	29.03
T_4	NAA @ 80 ppm	13.57	34.01	38.89	28.82
T_5	TRIA @ 2.5 ppm	15.19	33.64	37.78	28.87
T_6	TRIA @ 5.0 ppm	15.14	33.85	38.90	29.30
T_7	BR @ 10 ppm	16.12	35.17	41.40	30.90
T_8	BR @ 15 ppm	16.16	35.77	42.10	31.34
T_9	Water spray	11.53	27.07	32.03	23.54
T_{10}	Control	11.35	26.55	31.12	23.01
S.Em.±		0.63	1.44	1.76	1.28
C.D. at 5%		1.88	4.27	5.24	3.80
C.V. %		7.45	7.42	7.84	7.57

Table 3: Effect of growth regulators on yield and yield attributes of groundnut cv. GJG-9.

Treatments		Yield (kg ha^{-1})	No. of filled pods per plant	100 pod weight (g)	Shelling percentage (%)
T_1	GA_3 @ 50 ppm	1700.19	13.87	111.00	76.66
T_2	GA_3 @ 100 ppm	1732.36	14.87	111.40	77.32
T_3	NAA @ 40 ppm	1517.26	13.13	107.73	69.51
T_4	NAA @ 80 ppm	1396.15	13.10	106.90	69.72
T_5	TRIA @ 2.5 ppm	1415.51	12.50	106.46	69.13
T_6	TRIA @ 5.0 ppm	1390.51	12.47	105.46	69.11
T_7	BR @ 10 ppm	1646.05	13.43	110.10	74.70
T_8	BR @ 15 ppm	1708.01	13.37	110.53	76.69
T_9	Water spray	1386.05	11.00	101.10	69.09
T_{10}	Control	1381.52	10.43	100.33	68.99
S.Em.±		97.02	0.58	4.95	2.37
C.D. at 5%		288.27	1.71	NS	7.05
C.V. %		11.00	7.78	8.01	5.70

Conclusion

- This study showed that application of PGRs was increased the total dry matter production, number of filled pods per plant and seed yield of groundnut.
- There was a net reduction in dry weight of leaves and stem at the peak period of pod filling, however, the dry matter content of pods increased linear up to harvest.
- The highest yielding treatment GA_3 @ 100 ppm resulted higher production of photosynthate due to that more partioning of dry matter transported from leaf to pods and ultimately gave higher pod yield.

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