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Effect of drought at different growth stage on carbohydrates and lipids composition of groundnut (*Arachis hypogaea* L.) pod.

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A B S T R A C T

The groundnut or peanut (*Arachis hypogaea* L.) is an important oil seed crop contributing to a large share of edible oil supply in India. Various abiotic stresses including drought or moisture deficit stress are known to affect adversely the yield, quality and composition of pod. Hence an attempt was made to understand effect of drought at different growth stage on carbohydrates and lipids composition of groundnut pod. Groundnut variety GG-2 was grown in replicated plots in summer season and subjected to drought by with-holding two successive irrigation at different plant growth stages. As the maturity approaches from premilch to mature stages, per cent concentration of moisture, total carbohydrates, soluble sugars and reducing sugars decreases while that of total lipid and nonpolar lipid increased in general. Drought treatment increases total soluble sugars and reducing sugars content in pod whereas total lipid fraction affects adversely.

Introduction

The cultivated groundut or peanut (*Arachis hypogaea* L.) was originated in South America. The term *Arachis* is derived from the Greek word "arachos", meaning a weed, and *hypogaea*, meaning underground chamber, i.e. in botanical terms, a weed with fruits produced below the soil surface. It is one of the important legume crops of tropical and semiarid tropical countries including India, where it provides a major source of carbohydrates, oil and proteins.

Drought is one of the main environmental stresses that adversely affect plant growth, economic outcome, and environmentally sustainable productivity. Flowering and pegging stages were considered as most sensitive ones. Period of late flowering and pod formation was most sensitive to moisture Roy *et.al.*, (1988). Majority of reports reveal that pod development stage is the most sensitive to moisture stress during which the demand of photosynthetic products for active sinks (pods) is higher(Meisner, 1991; Ramachandrappa, *et.al.*, 1992; Vakharia, *et.al.*,1997). Reduction in yield due to stress at pod development stage was attributed to the decrease in seed size, whereas that during pod formation primarily to reduction in number of seed per pod (Patel and Golakiya, 1988).

There are several reports regarding effect of water deficit stress on carbohydrates and lipid compositions of kernel. However, studies related to developmental stage-specific response of peanut pod due to water deficit stress under field conditions are lacking. Hence, the objective of this study was to quantify the carbohydrates and lipid and its fractions in four different developmental stages of peanut pod under water deficit stress.

Materials and Methods

Groundnut variety GG-2 was grown in replicated plots under standard agricultural practices in summer season. The crop was subjected to moisture stress by with-holding two successive irrigation at different plant growth stages viz., flowering stage (35-55 DAS i.e., Days after sowing), pegging stage (55-75 DAS), pod formation stage (75-95 DAS) and pod development stage (95-115 DAS).

The plants in the control plots received normal irrigation at every 10 days intervals. The crop was harvested at 120 DAS, pods were manually picked up, classified according to its developmental stages viz., premilch, milch, dough and mature pod. The whole pods were used for various analyses. This was the reasons for lower lipid value than the reported for the seed. A total carbohydrate from whole pod was estimated as per method described by Yemm and Willis, 1954. Soluble sugars (Dubois *et.al.*, 1956) and reducing sugars were estimated form the same extract (Nelosan, 1944). Total pod oil was estimated by soxhlet extraction. Neutral lipids form whole pod were extracted with petroleum ether. Form the residue after extraction of neutral lipids, the polar lipids were extracted with chloroform:methanol (2:1) (Kandoliya *et.al.*, 2000).

Results and Discussion

Pod moisture content decreased from to from premilch (85.62%) to mature stage (57.72%) and found statistically significant. The highest reduction in moisture per cent was observed between dough to mature stage. Decrease in moisture per cent could be due to accumulation of dry matter in pod and deposition of storage material such as carbohydrates, lipids and proteins with advancement of developmental stages i.e., maturity of pod. Similar trend was also recorded in groundnut during development (Baxi, 1989). Higher moisture percentage in the treatment T_2 and T_4 indicated delay in maturity due to drought which resulted in lower amount of dry matter accumulation.

Per cent concentration of total carbohydrates was follows similar trend which decreased from 62.83 % to 21.81% during maturation from premilch to mature stage. Probably, the reduction in carbohydrates may indicate the conversion of carbohydrates to other biosynthetic products such as lipids and proteins. In the present experiment, higher rate of oil accumulation was observed during milch to mature stage which could be the reason for decrease in concentration of total carbohydrates.

Basha *et al.*, (1976) also reported that the stored, non structural carbohydrates serves as a source of energy for synthesis of lipids and proteins. Among the stress treatments, however the differences were nonsignificant, pod contains higher concentration of total carbohydrate at dough and mature stage as compared to control may be due to drought effect as reported by Musingo and Basha (1986) and Musingo *et al.*, (1989).

As the maturity progresses, total soluble sugars in whole pod of groundnut decreased from 30.94 to 10.60 %. Nagaraj and Kailashkumar (1984) also reported the similar change in the groundnut variety GAUG-1 from 24% to 16%. As compared to the control, all the drought treatment contained about 3% to 16 % higher soluble sugars compared to control. Similar results were also obtained in groundnut by Musingo and Basha (1986) as well as by Ross and Kavin (1989). Reducing sugars also follows the same trend.

Table.1 Effect of moisture stress on changes in moisture per cent during development of groundnut pod

Treatment	**Maturity stages**				
	Premilch	**Milch**	**Dough**	**Mature**	**Mean (T)**
T_1(Control)	84.7	81.2	74.3	57.8	74.5
T_2(35-55)	87.0	84.3	78.0	58.1	76.8
T_3(55-75)	85.8	83.9	68.9	56.5	73.8
T_4(75-95)	85.6	84.3	79.0	58.5	76.9
T_5(95-115)	85.1	82.8	77.4	57.7	75.8
Mean (S)	85.6	83.3	75.5	57.7	
	S	T	S x T		
S.Em±	0.456	0.510	1.019		
C.D. at 5%	1.289	1.442	2.882		
C.V.%	2.70				

Table.2 Effect of moisture stress on changes in per cent total carbohydrate during development of groundnut pod

Treatment	**Maturity stages**				
	Premilch	**Milch**	**Dough**	**Mature**	**Mean (T)**
T_1(Control)	62.0	50.0	27.4	20.7	40.0
T_2(35-55)	64.2	49.9	29.5	21.4	41.3
T_3(55-75)	64.7	49.7	30.1	22.1	41.7
T_4(75-95)	63.1	49.4	30.1	22.1	41.1
T_5(95-115)	60.2	46.9	32.0	22.8	40.5
Mean (S)	62.8	49.2	29.8	21.8	
	S	T	S x T		
S.Em±	0.5	0.5	1.0		
C.D. at 5%	1.4	NS	2.9		
C.V.%	5.00				

Table.3 Effect of moisture stress on changes in per cent total soluble sugars during development of groundnut pod

Treatment	Maturity stages				
	Premilch	Milch	Dough	Mature	Mean (T)
T1(Control)	30.1	19.2	15.7	9.4	18.6
T2(35-55)	30.0	19.8	17.1	10.0	19.2
T3(55-75)	31.8	22.3	19.0	11.3	21.1
T4(75-95)	31.1	21.4	18.2	10.9	20.4
T5(95-115)	31.7	23.4	19.9	11.4	21.6
Mean (S)	30.9	21.2	18.0	10.6	
	S	T	S x T		
S.Em±	0.3	0.3	0.6		
C.D. at 5%	0.9	0.9	NS		
C.V.%	6.21				

Table.4 Effect of moisture stress on changes in per cent reducing sugars during development of groundnut pod

Treatment	Maturity stages				
	Premilch	Milch	Dough	Mature	Mean (T)
T_1(Control)	1.72	1.11	0.65	0.30	0.95
T_2(35-55)	1.68	1.32	0.66	0.35	1.00
T_3(55-75)	1.75	1.24	0.77	0.40	1.04
T_4(75-95)	1.66	1.17	0.68	0.38	0.97
T_5(95-115)	1.54	1.06	0.64	0.37	0.90
Mean (S)	1.67	1.18	0.68	0.36	
	S	T	S x T		
S.Em.±	0.03	0.03	0.060		
C.D. at 5%	0.08	0.08	NS		
C.V.%	12.21				

Total lipid data are recorded in table. 5A revealed that, as the maturity progresses, the concentration of lipid increased from 7.61 to 62.06% and the rate of accumulation was greater between dough to mature stage possibly due to the greater fall in carbohydrate concentration by this time. Our results are in agreement with Niranjankumar *et. al.,* (1988) who reported that marked accumulation of lipid in seed take place as the maturity approaches. However, on imposing drought, total lipid percentage decreased though the treatment differences were found statistically nonsignificant. As maturity approaches the percentage non polar lipid increases (Table 5.B) and the stages were found to be significant. Increase in non polar lipid from 70.86% to 96.63% indicates the rate of synthesis increased as compared to that of polar lipid fraction during pod development. Similar observation were recorded in groundnut by Sanders (1980). Higher rate of accumulation of non polar lipids was recorded between milch to dough stage. Drought had adverse effect on mean percentage of non polar lipids though the differences were statistically non significant. Data for polar lipid percentage for growth stages were found to be significant and it decreased with the advancement of maturity (Table 5 C). The reduction in polar lipid fraction during development could be due to the rise in non polar lipid. Similar results were recorded by Nagaraj and Kailashkumar (1984) and Niranjankumar *et al.* (1988). In the present experiment, the drought treatments adversely affected the polar lipid fraction. The above findings were supported by Sukhija *et al.* (1980) during the development of sunflower seed.

Table.5 Effect of moisture stress on changes in per cent [A] Total lipid [B] Nonpolar lipid and [C] Polar lipid during development of groundnut pod

Treatment	Maturity stages				
	Premilch	**Milch**	**Dough**	**Mature**	**Mean (T)**
[A] Per cent Total Lipid					
T_1(Control)	7.83	16.16	24.34	32.40	20.18
T_2(35-55)	7.74	14.55	23.46	31.71	19.36
T_3(55-75)	7.62	13.09	22.12	31.94	18.69
T_4(75-95)	7.64	14.23	23.42	32.37	19.42
T_5(95-115)	7.24	15.29	23.02	31.91	19.36
Mean (S)	7.61	14.67	23.27	32.06	
	S	T	S x T		
S.Em±	0.315	0.353	0.705		
C.D. at 5%	2.677	NS	NS		
C.V.%	7.27				
[B] Per cent Nopolar lipid fraction of Total Lipid					
T_1(Control)	67.30	78.78	93.14	97.16	84.09
T_2(35-55)	68.07	83.56	92.95	96.84	85.33
T_3(55-75)	72.79	85.83	92.79	96.75	87.04
T_4(75-95)	75.57	84.64	92.56	96.63	87.35
T_5(95-115)	70.58	86.19	92.79	95.77	86.33
Mean (S)	70.86	83.80	92.82	96.63	
	S	T	S x T		
S.Em±	0.739	0.826	1.652		
C.D. at 5%	2.112	NS	NS		
C.V.%	3.33				
[C] Per cent Polar lipid fraction of Total Lipid					
T_1(Control)	32.70	21.22	6.86	2.84	15.91
T_2(35-55)	31.93	16.44	7.05	3.16	14.65
T_3(55-75)	27.21	14.17	7.21	3.25	12.96
T_4(75-95)	24.43	15.36	7.44	3.37	12.65
T_5(95-115)	29.42	13.81	7.21	4.23	13.67
Mean (S)	29.14	16.20	7.15	3.37	
	S	T	S x T		
S.Em±	0.475	0.531	1.063		
C.D. at 5%	1.358	NS	NS		
C.V.%	16.63				

Conclusion

As the maturity approaches from premilch to mature stages, per cent concentration of moisture, total carbohydrates, soluble sugars and reducing sugars decreases, while that of total lipid and nonpolar lipid increased in general. Drought treatment increases total soluble sugars and reducing sugars concentration in pod whereas total lipid fraction adversely affected as compared to the control.

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