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Interaction of myo-inositol, seed phosphorus, oil and yield in groundnut genotypes

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In India, groundnut is gown on 5.7 million hectare with a production of 4.7 million tonnes, with an average productivity of 0.8 tons ha^{-1} during the rainy season and in the post-rainy season it is grown on 0.9 million hectare with a production of 1.5 million tonnes, and an average productivity of 1.6 t ha^{-1} (Radhamani and Singh, 2008). The productivity in India is low with low seed quality. It is attributed to several biotic and abiotic stresses during crop growth and post harvest storage. The polyol inositol, an important sugar alcohol has a major role in mobilization of nutrients during kernel development and has strong affinity for water and is found to accumulate in plant under moisture stress and low temperature stress. Phytic acid, a phosphorylated derivative of myo-inositol, functions as the major storage form of phosphorus in plant seeds (Hegman *et al.*, 2001). Phosphate and mineral nutrients are released upon hydrolysis of phytic acid and utilized during seed germination and for seedling growth (Robay, 2001). Increasing phosphorus level increased oil content in groundnut (Chodhary *et al.*, 1991) and seed protein (Hossain *et al.*, 2007). Knowing the role of inositol in mobilization of nutrients particularly the phosphorus during seed development an attempt was made to know whether the foliar application of myo-inositol during pod development and seed filling in groundnut enhance translocation of assimilates and enrich seeds with phosphorus and oil in ten groundnut genotypes.

A field experiment was conducted at the Main Agricultural Research Station, University of Agriculture Science, Dharwad during *kharif* 2008. The experiment consisted of two treatments, foliar application of inositol @ (T2) 100 ppm at 65 DAS (During pod and seed development) in 10 genotypes of groundnut (TAG 24, JL 24, R-2001-3, K-07, GPBD 4, GPBD 5, K-134, TKG-19A, Girnar 1, and GPBD 6) and another set of genotypes maintained without application as control (T_1). The experiment was laid out in factorial design with 20 treatment combinations in three replications.

The genotypes were harvested at physiological maturity and pod yield was expressed as Kg ha^{-1}. The random samples of kernel were collected in each replication and ground to fine powder and oil was extracted by Soxhlet apparatus using petroleum spirit (60-80 ℃). The phosphorus content in defatted powder of all the genotypes was analysed by Vanadomolybdate method. The data was statistically analysed and results were discussed.

Seed is the most important economic and nutritionally rich of all the parts of plant. Seed size, quality and its nutrient content is determined by the interaction of genotypes, environment and management. Pod formation and seed filling in groundnut, phenologies of post flowering are important and critical, facing environmental stresses frequently and affecting the seed quality and pod yield.

Many plants store sugar and alcohol rather than pentose or hexose sugar. These molecules are referred to as polyols having a strong affinity for water and have been found to accumulate in plants under moisture and low temperature stress. Polyols appear to serve as protective agents against damage from environmental stress. Inositol is polyhydroxylated molecule commonly found in plant and it does exist in several isomeric forms, myo-inositol is the form commonly found in plants. Structural configuration of myo-inositol is same as D-glucose-6-phosphate in plants. Inositol is found as a constituent of membrane as phosphatidylinositol. The triploid endosperm generally precedes the development of zygote during the seed development and usually contains 85 per cent carbohydrate (on dry weight basis) (Noggle and fritz, 2000).

Myo-Inositol(1,2,3,4,5,6)hexakisphosphate ($InsP_6$ or 'phytic acid') was first known as the storage form of phosphorus in seeds (Raboy, 2001) and typically represents 75% of the total phosphorus and > 80% of soluble myo-inositol (Ins) phosphates in seeds (Dorsch *et al.*, 2003). In the present investigation the plants were sprayed with myo-inositol at 65 DAS.

The leaf phosphorus content analysed at 75 DAS was not affected and remains as per the control (Table 1), whereas the seed phosphorus content after harvest increased significantly due to myo-inositol (Table 2). The average increase in the mobilization of phosphorus in the seed due to inositol was 6.7 percent and thus myo-inositol concentrated the seed with higher phosphorus content. Variation in the mobilization of phosphorus in the seeds varied significantly among the genotypes. The genotype

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TKG-19A mobilised maximum phosphorus (25.5%) as compared to other genotypes. Interestingly all the genotypes responded well to the application of inositol except the genotype GPBD 6 and variation in mobilization indicated the genetic control of inositol translocation and mobilization of phosphorus in to the seeds of groundnut.

Table 1: Effect of inositol on leaf phosphorus content (%) in groundnut genotypes at 75 DAS

Genotypes	Treatments		Mean
	T_1	T_2	
TAG 24	0.22	0.22	0.22
JL 24	0.23	0.20	0.22
R-2001-3	0.23	0.23	0.23
K-07	0.24	0.24	0.24
GPBD 4	0.22	0.23	0.23
GPBD 5	0.25	0.25	0.25
K-134	0.22	0.23	0.22
TKG-19A	0.26	0.24	0.25
Girnar 1	0.28	0.28	0.28
GPBD 6	0.27	0.26	0.26
Mean	**0.24**	**0.24**	**0.24**
Comparison of mean	**SEm(±)**		**LSD (0.05)**
Treatments	**0.00**		**NS**
Genotypes	**0.00**		**0.01**
Treatments × Genotypes	**0.01**		**NS**

Note: T_1 = Control, T_2 = Foliar application of myo-inositol, NS = Non significant

Table 2: Effect of inositol on seed phosphorus content (%) in groundnut genotypes

Genotypes	Treatments		Mean	% increase over control
	T_1	T_2		
TAG 24	0.57	0.58	0.58	1.75
JL 24	0.59	0.64	0.61	8.47
R-2001-3	0.55	0.58	0.57	5.45
K-07	0.75	0.76	0.75	1.33
GPBD 4	0.94	0.97	0.95	3.19
GPBD 5	0.75	0.79	0.77	5.33
K-134	0.38	0.44	0.41	15.79
TKG-19A	0.47	0.59	0.53	25.53
Girnar 1	0.51	0.58	0.55	13.73
GPBD 6	0.46	0.46	0.46	0.00
Mean	**0.60**	**0.64**	**0.62**	**6.67**
Comparison of mean	**SEm(±)**			**LSD (0.05)**
Treatments (T)	**0.00**			**0.01**
Genotypes (G)	**0.01**			**0.02**
T × G	**0.01**			**0.03**

Note: T_1 = Control, T_2 = Foliar application of myo-inositol

Role of phosphorus in oil synthesis can not be ruled out since the application of phosphorus increased the seed oil content in groundnut significantly (Choudhary *et al.*, 1991). Phosphorus in seed increased due to inositol and further enhanced seed oil content too in all the genotypes significantly. Chavan and Kalra (1983) speculated that the higher oil content in seeds may be attributed to formation of lecithin and important forms of vegetable fat, the synthesis of which is favored by phosphate application. The genotype TKG-19A which had higher mobilization of Phosphorus (25.5 %) also had increased oil content (10 %). K-134 is a genotype which is second in per cent increase in phosphorus. GPBD 6 was very poor in phosphorus mobilization. Similarly, all the genotypes also had higher oil content; however, the order of phosphorus mobilization in the genotypes did not coincide with the order of oil content increase (Table 3).

Table 3: Effect of inositol on seed oil content (%) in groundnut genotypes

Genotypes	Treatments		Mean	% increase over control
	T_1	T_2		
TAG 24	42.56	42.80	42.68	0.56
JL 24	41.85	44.57	43.21	6.50
R-2001-3	43.41	45.57	44.49	4.98
K-07	46.30	46.94	46.62	1.38
GPBD 4	53.30	54.35	53.82	1.97
GPBD 5	42.97	45.58	44.28	6.07
K-134	46.65	47.47	47.06	1.76
TKG-19A	37.86	41.66	39.76	10.04
Girnar 1	43.41	44.55	43.98	2.63
GPBD 6	42.75	44.53	43.64	4.16
Mean	**44.10**	**45.80**	**44.95**	**3.85**
Comparison of mean	**SEm(±)**			**LSD (0.05)**
Treatments (T)	**0.11**			**0.32**
Genotypes (G)	**0.25**			**0.73**
T × G	**0.36**			**1.03**

Note: T_1 = Control, T_2 = Foliar application of myo-inositol

This differential behaviour of the genotypes for these traits due to inositol confirmed the interference of other factors in the synthesis of oil other than phosphorus in groundnut. The GPBD 4 had higher phosphorus content (0.97%) and also had higher oil content (54.3%) and not influenced much due to inositol.

Thus, behaviour of genotypes did not remain same for mobilization of phosphorus. The inositol application increased oil content in all the genotypes. However least increase was with the genotype TAG 24 (0.56 %). In all, inositol increased these two traits.

The pod yield due to application of inositol was also higher compared to control. The genotype Girnar 1 had higher pod yield (5576 kg ha^{-1}) followed by the genotype K-07 (5527 kg ha^{-1}). The lowest yield was recorded in GPBD 6 (2951 kg ha^{-1}).Increase in the pod yield due to inositol was attributed to increase in sink size that was in the form of higher number of pods and oil content due to inositol.

Table 4: Effect of inositol on pod yield (kg ha^{-1}) in groundnut genotypes

Genotypes	Treatments		Mean
	T_1	T_2	
TAG 24	2725	3364	3044
JL 24	2717	3403	3060
R-2001-3	4620	4953	4787
K-07	5148	5906	5527
GPBD 4	4116	4520	4318
GPBD 5	4097	4590	4343
K-134	4097	5342	4720
TKG-19A	3736	4725	4231
Girnar 1	5203	5949	5576
GPBD 6	2634	3269	2951
Mean	**3909**	**4602**	**4256**
Comparison of mean	**SEm(±)**		**LSD(0.05)**
Treatments (T)	**34**		**97**
Genotypes (G)	**76**		**218**
T × G	**108**		**308**

Note: T_1 = Control, T_2 = Foliar application of myo-inositol

It can be inferred from the discussion that foliar application of inositol enhanced the mobilization of phosphorus, synthesis of oil and pod yield. However, the response of the genotypes varied. Hence, the use of myo-inositol for specific genotypes of ground nut to be conformed.

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