International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

GROWTH, YIELD AND QUALITY PARAMETERS OF GROUNDNUT (*Arachis hypogaea* L.) GENOTYPES AS INFLUENCED BY ZINC AND IRON THROUGH FERTI-FORTIFICATION

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ABSTRACT

The investigation was carried out to study the effect of zinc and iron ferti- fortification on plant height, yield and quality parameters of groundnut (*Arachis hypogaea* L.) genotypes. Among the groundnut genotypes, ICGV-00351 recorded significantly higher plant height at harvest (40.05 cm), pod yield (2656 kg ha^{-1}) and quality parameters *viz.,* protein and oil yield (427.72 and 935.25 kg ha^{-1}, respectively) as compared to other genotypes. Among micronutrients application, soil (25 kg ha^{-1}) and foliar (0.5 %) application of $ZnSO_4$ (S_4) recorded significantly higher plant height at harvest (42.09 cm), pod yield (2656 kg ha^{-1}) and quality parameters *viz.,* protein and oil yield (427.72 and 935.25 kg ha^{-1}, respectively) as compare to other treatments.

Keywords: Groundnut genotypes, Pod yield, Protein and Oil yield, Zinc and Iron fortification.

INTRODUCTION

Among the oilseed crops, Groundnut (*Arachis hypogaea* L.),"king of oilseeds" belongs to the family leguminoceae and is commonly called as poor man's almond. It is the world's fourth most important source of edible oil and third most important source of vegetable protein.

About half of the world's population suffers from micronutrient malnutrition (a term used to refer any condition in which the body does not receive enough nutrients for proper function), including Se (Selenium), Zn (Zinc), Fe (Iron) and I (Iodine), which is mainly associated with low dietary intake of micronutrients in diets with less diversity of food (Mayer *et al.*, 2008). Micronutrient malnutrition can lower intelligence quotient, cause stunting and blindness in children, lower resistance to disease in both children and adults and increase risks for both mothers and infants during child birth.

ISSN: 2455-6939

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Zn and Fe deficiency is a well-documented problem in food crops, causing decreased crop yields and nutritional quality. Generally, the regions in the world with Zn and Fe deficient soils are also characterized by widespread Zn and Fe deficiency in humans. According to WHO report on the risk factors responsible for development of illnesses and diseases, Zn and Fe deficiencies rank 11th and 12th among the 20 most important factors in the world and 5th and 6th among the 10 most important factors in developing countries (Anon., 2002).

There are several approaches to increase the concentration of micronutrients in foods, including food stuff nutrient fortification, supplementation programmes, conventional breeding and genetic engineering to diagnose and manage the problem of micronutrient malnutrition. However, these approaches appear to be expensive and not easily accessible by those living in developing countries. Alternatively, bio-fortification of staple food crops with micronutrients through the use of agricultural tools (e.g., breeding and fertilization) is a cost-effective and sustainable approach to address this problem. However, plant breeding, the most powerful agricultural approach, may not effectively work in regions where soils have very low plant-available pools of micronutrients due to very adverse soil chemical and physical conditions (Cakmak, 2008). Besides, finding sufficient and promising genotypic variation and maintaining the stability of targeted micronutrient traits across diverse types of environments may also be difficult. Under such circumstances, agronomic bio-fortification, including the use of micronutrient fertilizers, is an important complementary solution (White and Broadley, 2009).

Hence, the present investigation was carried out to assess the performance of groundnut genotypes with respect to dry matter production, yield and yield parameters as influenced by ferti-fortification.

MATERIAL AND METHODS

A field experiment was conducted during *rabi* season of 2014-15 at Agronomy field unit, College of Agriculture, UAS, Raichur. The soil of the experimental site was deep black soil, clay in texture (sand 23.5 %, silt 27.5 % and clay 49.2 %) with a bulk density of 1.30 Mg m^{-3} having pH 8.4. Soil was low in available N status (231 kg ha^{-1}), medium in available P_2O_5 (27.3 kg ha^{-1}) and high available K_2O (345 kg ha^{-1}). DTPA extractable zinc and iron was 0.45 and 3.72 ppm and were found deficient. During crop growth period (November 2014 to March 2015), the rainfall received was 48.7 mm.

The experiment was conducted in split plot design having three replications with three groundnut genotypes (ICGV-00351, K-9 and TMV-2) in the main plots and seven micronutrient treatments *viz.,* control (RDF+ FYM), soil application of $ZnSO_4$ @ 25 kg ha^{-1}, foliar application of $ZnSO_4$ @ 0.5% at 30 and 45 DAS, soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar application of $ZnSO_4$

ISSN: 2455-6939

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@ 0.5% at 30 and 45 DAS, soil application of $FeSO_4$ @ 25 kg ha^{-1}, foliar application of $FeSO_4$ @ 0.5% at 30 and 45 DAS, soil application of $FeSO_4$ @ 25 kg ha^{-1} + foliar application of $FeSO_4$ @ 0.5% at 30 and 45 DAS) in the sub-plots.

The recommended dose of fertilizer nitrogen, phosphorus and potassium were applied at the rate of 25:75:25 kg N, P_2O_5 and K_2O ha^{-1} in the form of 12:36:12, a complex fertilizer. The entire quantity of fertilizer was applied at the time of sowing in the furrows opened 5cm spacing away from the seed line and later furrows were covered with soil. Zinc as $ZnSO_4$ @ 25 kg and iron as $FeSO_4$ @ 25 kg ha^{-1} were applied to the respective plots as per the treatments at the time of sowing. Foliar application of $ZnSO_4$ @ 0.5% and $FeSO_4$ @ 0.5% at 30 and 45 DAS were applied as per the treatments. Zinc and iron each @ 2.25 kg ha^{-1} was dissolved in 450 litters of water and sprayed through power sprayer.

Groundnut seeds were treated with *Trichoderma,* Rhizobium and phosphate solubilising bacteria @ 4 g, 2.5 kg and 2.5 kg ha^{-1}, respectively. Gypsum as a soil application was applied at the rate of at 500 kg ha^{-1} at 35 DAS. The furrows were opened with the help of wooden marker. The seeds were hand dibbled and covered by soil. The sowing operation was carried on 19th November, 2014 at a spacing of 30 cm x 10 cm. All the genotypes were harvested on 18th March 2015. Shelling was done manually. The seeds were winnowed, cleaned and seed weight per net plot was recorded on hectare basis and expressed in kg ha^{-1}.

RESULTS AND DISCUSSION

Performance of groundnut genotypes

The plant height of groundnut differed significantly among the genotypes at different growth stages. Among the groundnut genotypes, ICGV-00351 recorded significantly higher plant height at harvest (40.05 cm) as compared to other genotypes. Significantly lower plant height (35.38 cm) was observed in TMV-2 at harvest.

The pod yield of groundnut differed significantly among the genotypes. The genotype ICGV-00351 produced significantly higher pod yield (2656 kg ha^{-1}) than TMV-2 (2074 kg ha^{-1}) and was on par with K-9 (2534 kg ha^{-1}). The higher yield could be attributed to higher dry matter production and cumulative effect of yield attributes.

Among genotypes, significantly higher protein and oil yield (427.72 and 935.25 kg ha^{-1}, respectively) was noticed in genotype, ICGV-00351 than the genotype TMV-2 (307.32 and 623.87 kg ha^{-1}, respectively) and it was found on par with K-9 (393.71 and 856.83 kg ha^{-1}, respectively). This might be due to inherent character of endosperm which have resulted in higher oil content which is also evidenced from genotype characteristics. Results obtained by

ISSN: 2455-6939

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Virender *et al.* (2008) and Bandopadhyay and Samui (2000) clearly showed that groundnut genotypes varied significantly in their oil content, oil and protein yield.

Effect of micronutrients application

Among micronutrients application, soil (25 kg ha^{-1}) and foliar (0.5 %) application of $ZnSO_4$ and $FeSO_4$ resulted in significantly higher plant height in all the genotypes over control at all the stages of crop growth. At harvest, soil (25 kg ha^{-1}) and foliar (0.5 %) application of $ZnSO_4$ (S_4) produced higher plant height (42.09 cm) over other treatments. Significantly lower plant height (31.49 cm) was recorded in control. The improvement in plant height due to zinc application might be attributed to proper nourishment of crop and optimum growth. Addition of FYM might have helped in release of micronutrients favourable for the crop growth. Also, increase activity of meristamatic cells and cell elongation with application of micronutrients as they were known to have favourable effect on metabolic process (Price *et al*., 1972).

The pod yield of groundnut was influenced significantly due to different micronutrients application. Significantly higher pod yield of groundnut was recorded with soil (25 kg ha^{-1}) and foliar (0.5 %) application of $ZnSO_4$ (S_4) (2789 kg ha^{-1}) over other treatments *viz*., control (2042 kg ha^{-1}), soil application of $ZnSO_4$ (2509 kg ha^{-1}), foliar application of $ZnSO_4$ (2300 kg ha^{-1}), soil application of $FeSO_4$ (2419 kg ha^{-1}) and foliar application of $FeSO_4$ (2231 kg ha^{-1}). However, it was found on par with soil (25 kg ha^{-1}) and foliar (0.5 %) application of $FeSO_4$ (2659 kg ha^{-1}) (S_7).

Significantly higher protein yield was recorded under soil (25 kg ha^{-1}) and foliar (0.5 %) application of $ZnSO_4$ (477.09 kg ha^{-1}) (S_4) as compared to other treatments, except soil (25 kg ha^{-1}) and foliar (0.5 %) application of $FeSO_4$ (436.73 kg ha^{-1}) (S_7). Different micronutrients application significantly influenced the oil yield of groundnut. Soil (25 kg ha^{-1}) and foliar (0.5 %) application of $ZnSO_4$ (S_4) recorded significantly higher oil yield (1025.37 kg ha^{-1}) as compared to the other treatments but was on par with soil (25 kg ha^{-1}) and foliar (0.5 %) application of $FeSO_4$ (944.01 kg ha^{-1}) (S_7). Zinc functions in plants largely as a metal activator of enzymes like cysteine disulphydrase, dihydropeptilase glycyle glycine dipeptidase. Thus, addition of zinc might have activated the enzymes responsible for producing oil and caused higher oil content. Singh (2007) also reported significantly higher oil content and oil yield with soil application of zinc in groundnut. Eman Abdel-Latif and El Haggan (2014) also reported significantly higher oil content and oil yield with foliar application of zinc in soybean

Table 1. Plant height (cm) and Pod yield (kg ha^{-1}) of groundnut genotypes as influenced by ferti-fortification at harvest

Micronutrient application	Plant height (cm)				Pod yield (kg ha^{-1})			
	Genotypes							
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1: Control (RDF+ FYM)	30.80	32.17	31.50	**31.49**	1453	2184	2489	**2042**
S_2: Soil application of $ZnSO_4$ @ 25 kg ha^{-1}	35.50	38.50	43.07	**39.02**	2194	2447	2887	**2509**
S_3: Foliar application of $ZnSO_4$ @ 0.5%	34.67	38.60	41.77	**38.35**	1786	2559	2554	**2300**
S_4: Soil application of $ZnSO_4$ @ 25 kg ha^{-1}+ foliar application of $ZnSO_4$ @ 0.5%	40.90	40.67	44.70	**42.09**	2559	2962	2846	**2789**
S_5: Soil application of $FeSO_4$ @ 25 kg ha^{-1}	32.97	38.33	40.10	**37.13**	2293	2441	2524	**2419**
S_6: Foliar application of $FeSO_4$ @ 0.5%	34.57	34.40	37.37	**35.45**	2039	2366	2289	**2231**
S_7: Soil application of $FeSO_4$ @ 25 kg ha^{-1}+ foliar application of $FeSO_4$ @ 0.5%	38.27	40.13	41.83	**40.08**	2197	2778	3002	**2659**
Mean	**35.38**	**37.54**	**40.05**	**-**	**2074**	**2534**	**2656**	**-**

For comparing means of	Plant height S.Em±	Plant height C. D. at 5%	Pod yield S.Em±	Pod yield C. D. at 5%
Genotypes	0.23	0.90	58	226
Micronutrients application	0.64	1.84	95	273
S at the same level of M	1.11	NS	165	NS
M at the same or different levels of S	1.05	NS	163	NS

M_1- TMV-2, M_2 - K-9, M_3 - ICGV-00351, NS - Non significant, Foliar application at 30 and 45 DAS

Table 2. Protein and oil yield of groundnut genotypes as influenced by ferti-fortification

Micronutrient application	Protein yield (kg ha^{-1})				Oil yield (kg ha^{-1})			
	Genotypes							
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1: Control (RDF+ FYM)	196.21	307.63	321.46	**275.10**	375.74	718.63	681.46	**591.94**
S_2: Soil application of $ZnSO_4$ @ 25 kg ha^{-1}	338.68	387.86	465.03	**397.19**	707.04	868.45	1067.42	**880.97**
S_3: Foliar application of $ZnSO_4$ @ 0.5%	246.59	397.15	414.04	**352.59**	513.13	787.30	856.40	**718.94**
S_4: Soil application of $ZnSO_4$ @ 25 kg ha^{-1}+ foliar application of $ZnSO_4$ @ 0.5%	397.80	523.20	510.27	**477.09**	810.42	1134.76	1130.94	**1025.37**
S_5: Soil application of $FeSO_4$ @ 25 kg ha^{-1}	339.34	392.12	409.55	**380.34**	658.56	769.98	911.18	**779.91**
S_6: Foliar application of $FeSO_4$ @ 0.5%	270.27	344.05	329.78	**314.70**	596.45	732.65	759.17	**696.09**
S_7: Soil application of $FeSO_4$ @ 25 kg ha^{-1}+ foliar application of $FeSO_4$ @ 0.5%	362.36	403.93	543.90	**436.73**	705.78	986.06	1140.19	**944.01**
Mean	**307.32**	**393.71**	**427.72**	-	**623.87**	**856.83**	**935.25**	-
For comparing means of	**S.Em±**		**C. D. at 5%**		**S.Em±**		**C. D. at 5%**	
Genotypes	16.34		64.17		22.89		90.04	
Micronutrients application	23.86		68.44		40.26		115.46	
S at the same level of M	41.33		NS		69.72		NS	
M at the same or different levels of S	41.61		NS		68.51		NS	

M_1- TMV-2, M_2 - K-9, M_3 - ICGV-00351, NS - Non significant, Foliar application at 30 and 45 DAS

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