Electronic Journal of Plant Breeding, 4(1): 1043-1049 (Mar 2013)
ISSN 0975-928X

Research Article

Response of groundnut (*Arachis hypogaea* L.) genotypes to soil fertilization of micronutrients in alfisol conditions

P. Arunachalam , P. Kannan, J. Prabhaharan[1], G. Prabukumar and Zadda Kavitha
Dryland Agricultural Research Station, Chettinad - 630 102, Tamil Nadu, India.
[1]Agricultural College and Research Institute, Madurai - 625 104, Tamil Nadu, India.
Email: arunachalp@gmail.com

(Received: 22 Dec 2012; Accepted: 12 Jan 2013)

Abstract

In this study, an attempt was made to assess the genetic variability of kernel micronutrients and to enrich the micronutrient content in groundnut. Twenty one different genotypes and three cultivars were evaluated for micronutrient response under alfisol condition. To enhance the soil micronutrient availability recommended dose of Fe and Zn were applied as basal. The experiment was conducted at Dryland Agricultural Research Station, Chettinad under rainfed condition during August to December 2011. Yield parameters and micronutrients content in kernel were assessed. In alfisol, basal application of Zn and Fe enhanced the soil available Zn and Fe content. Basal application of micronutrients increased the kernel Zn content to an average of 28.7 per cent and pod yield of 12.6 per cent in groundnut cultivars. Significant genetic variability was observed among genotypes for Fe, Zn, Cu and Mn enrichment in kernel. The accessions ICGV 07225, ICGV 07222, ICGV 07247 and ICGV 07220 were having inherent ability to load high zinc content in kernel with high pod yield per plant. For developing high yielding zinc dense cultivars, the genotype identified in this study are to be tested in diverse environments for their stability.

Key Words:
Groundnut, biofortification, variability, micronutrient, zinc

Introduction

In Asia, about 35 per cent of children between 0-5 years of age suffer from iron (Fe) and zinc (Zn) deficiency (Singh *et al.* 2009). It affects large segment of population mostly women infants and children in resource poor families in the country. The most commonly deficient elements in the diet of humans are Fe and Zn (Franca and Ferrari, 2002). Zn deficiency is manifested with symptoms like growth failure, depressed immunity, anorexia, diarrhoea, altered skeletal function and reproductive failure. Diagnosis of Zn deficiency is more difficult because of the non-specific clinical features. All food grains are good sources of zinc. But like iron, zinc is lost on milling and processing of the grains. Pulses and nuts are relatively rich sources of Zn. In India, the recommended dietary allowance (RDA) for zinc is 12 mg day^{-1} for adult. RDA for iron is 17 mg day^{-1} for men and 21 mg day^{-1} for women. Anaemia is a serious public health problem in India, affecting all segments of the population (50-70%), especially infants and young children, adolescent boys and girls, women of childbearing age and pregnant women. Over 50% women (particularly pregnant women) and children suffer from iron deficiency anaemia (IDA), aggravated by helminthic infections (ICMR Report, 2009).

During the green revolution, the focus was given to increase the crop yield by evolving major nutrient responsive high yielding cultivars. Further, least importance was given to the nutritional quality of the grains produced. Over the year, this approach exploited the plant available micro-nutrient in the soil and hinders the crop yield. The efficient and sustainable strategy is to develop micronutrient-efficient plant genotypes that can tolerate low nutrient supply which may increase productivity on low fertility soils and reduce the fertilizer requirements (Gourley *et al.,* 1994; Khoshgoftarmanesh *et al*. 2010).

Indian soils are generally low in zinc, the total and available Zn ranges 7 to 2960 mg kg^{-1} and 0.1 to 24.6 mg kg^{-1} respectively (Singh, 2009). Major soil physical and chemical factors affects the availability of zinc to roots are high $CaCO_3$, high pH, high clay soil, low organic matter, low soil moisture, high Fe and Al oxides (Cakmak, 2008). The total and available iron content in Indian soils is high, ranging from 4000 to 273000 mg kg^{-1} and 0.36 to 174 mg kg^{-1} respectively. Acid and lateritic soils had high available iron content and iron toxicity is common. Whereas, Zn availability is lower in soils of arid and semi-arid regions (Singh, 2009). Zinc is immobile in the soil and moderately mobile in plants; application of $ZnSO_4$ can also increase yield and Zn concentrations in cereals and legumes (White and Broadley, 2005). In contrast, Fe has a low mobility in soil because $FeSO_4$ is rapidly bound by soil particles and converted into Fe (III); therefore, Fe fertilizers have not been successful in biofortification efforts (Grusak and DellaPenna, 1999). Furthermore, large quantities of metals applied to soils can be deleterious to plant growth and other soil organisms (Grusak and Cakmak, 2005).

In India, zinc is now considered the fourth most important yield-limiting nutrient after, nitrogen, phosphorus and potassium. Periodic assessment of soil test data also suggests that Zn deficiency in soils of India is likely to increase from 49 per cent to 63 per cent by the year 2025 as most of the marginal soils brought under cultivation are showing zinc deficiency (Singh, 2006).

The response of micronutrients varies with soil type and crop plants. Within the crop plant the genetic make-up/cultivars also influence the uptake from soil and assimilation of micronutrients in economic parts. The application of micronutrient fertilizer is inexpensive, but real sense uptake efficiency is influenced by several factors which varies with agro-climatic regions like soil factors, method of application, mineral mobility and its accumulation site. Selecting and breeding of food crops which are more efficient in the uptake of trace minerals from the soil and load more trace minerals into their seeds; have benefits on agricultural productivity and human nutrition (Khoshgoftarmanesh *et al*. 2010). Harvest Plus, a CGIAR programme, classifies the peanut as phase II crop in its efforts to biofortification of food crops. This investigation was carried out to study the i) response of groundnut cultivars to the iron and zinc fertilization in terms of assimilation of micronutrient in kernel and pod yield under alfisol condition, ii) variability for kernel micronutrients which exists in the genetically diverse groundnut genotypes.

Material and Methods

The genetic material used for this study were the groundnut accessions received from International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru; Regional Agricultural Research Station, Thirupathi and the cultivars released from the Tamil Nadu Agricultural University, Coimbatore. A total of 21 groundnut genotypes and three cultivars were evaluated at Dryland Agricultural Research Station (DARS), Chettinad. Each genotype was sown in 5 rows of 4 m length with a spacing of 30 cm x 15 cm in a randomized block design with two replications. The crop was grown by adopting recommended package of practices during August to December 2011 under rainfed condition. The weather data were recorded from automatic weather station located 150 m away from the experimental field.

The soil application of 10 kg ha^{-1} Fe and 5 kg ha^{-1} Zn was recommended by All India Coordinated Research Project on micronutrients (Singh, 2010). Based on this required quantity of $FeSO_4$ and $ZnSO_4$ were applied as basal dose with 50 kg ha^{-1} and 25 kg ha^{-1} respectively as a source of iron and zinc. Plants were harvested at maturity and after drying, the mean pod yield per plant (g), shelling percentage and hundred seed weight (g) were calculated for each accession. The soil samples were collected from native soil (control) and after the application of micronutrients. The concentration of iron and zinc in groundnut kernel was estimated using di-acid extract in Atomic Absorption Spectrophotometer (AAS) using Lindsay and Norwell (1978) method.

Results and Discussion

The quantity of rainfall during crop period was 599 mm, distribution was throughout the cropping period (31 rainy days) and average soil moisture was 12.9 per cent at 15 cm depth. This indicates there was sufficient soil moisture availability in the rhizosphere of groundnut and no dry spell recorded during the cropping period. Hence, there was no moisture stress or hindrance for the nutrient uptake and crop growth.

Soil properties and available nutrient status***:*** Physical and chemical properties of the experimental soil are presented in Table 1. The experimental soil was low in pH and EC. Available N, P and K were medium in status. Organic carbon content was low (<0.5%). The water holding capacity, bulk density and porosity of the surface (0–15 cm) soil were 12%, 1.41 mg m^{-3} and 45%, respectively (DARS report, 2011). Soil availability of Fe, Mn and Cu were found to be sufficient i.e., above the critical limit. Whereas, available Zn was found to be deficient in experimental soil (1.10 ppm). The zinc concentration of below 1.2 ppm was reported as critical limit in red soils of Tamil Nadu (Singh *et al.,* 2003).

The soil application of $FeSO_4$ and $ZnSO_4$ enhanced the soil availability of iron and zinc to 0.94 ppm (4.45%) and 0.84 ppm (76.36%) respectively (Table 2). To increase Zn accumulation in grain required for a measurable biological impact, sufficient amount of plant-available Zn must be maintained in soil (Cakmak, 2008). In response to soil application of micronutrients, there was quantum leap in zinc availability compared to iron availability in alfisol. Experimental soil was deficient in zinc (1.1 ppm) which is below the critical limit of 1.2 ppm. Soil application of Zn to annual crops is a preferred method over less efficient foliar sprays. Broadcasting of 5-10 kg Zn ha^{-1} as $ZnSO_4.7H_2O$ before the last ploughing followed by mixing has been found to be efficient in enhancing grain yields of wheat (Rattan *et al*. 2009).

Soil available Fe content (21.1 ppm) was higher than the critical limit of 3.6 ppm. There was no positive response in Fe availability to the soil application $FeSO_4$, due to the higher Fe content in the native soil. Further organic carbon content was very low in experimental soil and addition of more organic matter certainly increases the Fe availability to crop plants.

Varietal response to iron and zinc fertilization***:*** Response of groundnut cultivars to micronutrient application in soil indicates, there was positive increase in the zinc content in kernel of TMV 7 from 52.2 to 69.9 mg kg^{-1}, in TMV(Gn)13 from 36.2 to 61.1 mg kg^{-1} and in VRI(Gn) 6 from 49.1 to 61.8 mg kg^{-1}. All the groundnut cultivars exhibited positive response to the zinc fertilization with an average increase of 28.7 per cent in the kernel (Table 3). But there was no significant increase of iron content in kernel was recorded under alfisol conditions. This contrast response of zinc and iron in alfisol is due to Zn is a mobile element and uptake by the plant in the Zn deficient soil is better. Whereas, Fe is unavailable to plant due its fixation of Fe^{3+} as Iron and aluminum oxide especially in red lateritic soil.

Micronutrient application increased the pod yield per plant in groundnut cultivars *viz*., TMV 7 from 19.2 to 21.4 g, TMV(Gn)13 from 18.4 to 22.5 g and VRI(Gn)6 from 35.7 to 38.6 g. The overall increase in pod yield per plant was 12.6 percen t. Chitdeshwari and Poongothai (2003) reported that, the response of groundnut to the soil application of zinc 5 kg ha^{-1} + boron 1 kg ha^{-1} + sulphur 40 kg ha^{-1} significantly increased the pod yield to the tune of 24.2 per cent for TMV 7 and 14.8 per cent for JL 24 over control. The micronutrient response of groundnut studied in different states of India under rainfed conditions concluded that an application of Zn, B and S along with N and P was economical. The application of these nutrients critical for higher and sustained productivity of rainfed crops in semi arid regions of India (Srinivasarao *et al.* 2008).

<u>Zinc use efficiency</u>***:*** The experimental soil was deficient in zinc than iron, hence better response was observed for zinc fertilization in alfisol in terms of uptake and increasing the pod yield. The Agronomic Efficiency of Zinc (AEZ) to assess the increase of pod yield per unit quantity of zinc applied was calculated as per the Fageria *et al.* (2008) for groundnut cultivars. The results showed that AEZ in enhancing pod yield was 97.77 kg kg^{-1} in TMV 7, 128.88 kg kg^{-1} in VRI(Gn)6 and 182.22 kg kg^{-1} in TMV(Gn)13. The increase of groundnut yield to zinc application was from 210 to 470 kg ha^{-1} (Takkar *et.al.* 1989). Gobarah *et al.* (2006) reported highest groundnut seed yield, oil and protein with the application of P_2O_5 along with foliar spray of zinc. The soil application of 5, 1, 0.5 kg ha^{-1} Zn, B, and molybdenum (Mo) respectively along with NPK increased the groundnut yield to 30 per cent (Nayak *et al.* 2009). Muthukumararaja and Sriramachandrasekharan (2012) observed increase in yield with zinc fertilization in Zn deficient soil in rice. The AEZ indicated that soil application of zinc at 5 kg ha^{-1} as basal dose increased the pod yield to an average 136.29 kg kg^{-1} by in the zinc wanting soils in groundnut. This suggests that there was a significant increase in the economic yield by the zinc fertilization in the zinc wanting soils.

<u>Variability for iron and zinc content in groundnut kernel</u>***:*** Variability for iron content in groundnut kernel ranged from 55. 3 mg kg^{-1} (Narayani) to 187.6 mg kg^{-1} (ICGV 91114) with a mean of 108.7 mg kg^{-1}. High iron content was recorded in genotypes namely, ICGV 91114 (187.6 mg kg^{-1}), K 134 (143.1 mg kg^{-1}), TCGS 913 (141 mg kg^{-1}), ICGV 07225 (137.8 mg kg^{-1}), ICGV 06424 (134.9 mg kg^{-1}), Chico (132.1 mg kg^{-1}) and JL 24 (126.2 mg kg^{-1}). Among these genotypes, ICGV 07225 and K 134 resulted in high pod yield per plant (Table 4).

The variability for zinc content in groundnut kernel ranged from 28.7 mg kg^{-1} (ICGV 07219) to 70.2 mg kg^{-1} (ICGV 07225) with a mean of 56.3 mg kg^{-1}. Brar *et. al.* (2011) screened 220 rice genotypes and the iron and zinc content in dehusked grains ranged from 5.1 to 441.5 mg kg^{-1} and 2.12 to 39.4 mg kg^{-1} respectively. The genotypes with higher zinc content were ICGV 07225 (70.2 mg kg^{-1}), ICGV 07220 (69.8 mg kg^{-1}), ICGV 07222 (69.4 mg kg^{-1}), Narayani (66.4 mg kg^{-1}), ICGV 07247(65.4 mg kg^{-1}), TLG 45 (62.6 mg kg^{-1}) and JL 24 (60.6 mg kg^{-1}).

The accessions which recorded high pod yield per plant over check were ICGV 07241 (45.4 g), ICGV 07225 and ICGV 07222 (41.8 g), ICGV 07262 (39.8 g), ICGV 07247 (39.4 g), ICGV 07220 (35 g), ICGV 07240 (33.2 g), ICGV 07219 (29.8 g), ICGV 07228 (29.0 g) and ICGV 07268 (28.4 g). The higher pod yield was due to increase in kernel weight and shelling percentage. Pendashteh *et al.* (2011) reported that zinc spraying up to 1 g L^{-1} had increased the seed yield, pod yield, plant height, 100 seed weight, seed length and seed width.

The accessions ICGV 07225, ICGV 07222, ICGV 07247 and ICGV 07220 were having inherent ability to load higher zinc content in kernel and also recorded higher pod yield per plant (Table 4). Zinc plays as an activator of many enzymes in plants and is directly involved in the biosynthesis of growth substances like auxin which produce more cells and dry matter that in turn will be stored in seeds as a sink. Thus the increased seed yield is more expected (Devlin and Withan, 1983).

Copper (Cu) content ranged from 148.4 mg kg^{-1} (ICGV 07225) to 260.2 mg kg^{-1} (TCGS 913) with the mean 229.9 mg kg^{-1}. Manganese (Mn) content in kernel varied from 32.6 mg kg^{-1} (ICGV 07225) to 90.2 mg kg^{-1} [TMV(Gn)13)].

<u>Association of kernel iron and zinc content</u>***:*** The correlation among kernel micronutrients content and the yield parameters among all genotypes

studied are presented in Table 5. The value indicated that, there was no significant association among micronutrients in groundnut. The kernel Fe content had significant positive relationship with shelling percentage (0.55) and hundred seed weight (0.491). The Zn content did not have any relationship with yield parameters. Copper content exerted significant negative association with hundred seed weight (-0.506). Manganese had a positive correlation with shelling out-turns (0.536). Hundred seed weight had positive relationship with shelling per cent (0.437). Chakraborti *et al.* (2011) reported positive correlation between Fe and Zn in maize grain, but there was no relationship of these micronutrients with grain yield.

Conclusions

The study revealed that the micronutrient application in groundnut not only changed the quality of kernel by enhancing the zinc content and also contributed for the substantial increase in the pod yield under alfisol conditions. Hence, soil application of zinc is a cost effective way to enrich the groundnut kernel with zinc. There was no significant response to soil application of iron in increasing kernel iron content due to high Fe content in alfisol conditions. But considerable genetic variability was found in the kernel for iron content. This implies that the soil application of zinc is ideal to enhance the soil availability, but iron is recommended depending upon the availability of Fe in native soil.

The accessions ICGV 07225, ICGV 07222, ICGV 07247 and ICGV 07220 were having inherent ability to load higher zinc content in kernel and also recorded higher pod yield per plant. For developing high yielding zinc rich cultivars, the genotypes identified in this study need to be tested in diverse environments for their stability. Further analysis of phytic acid content is essential to asses the bioavailability. The Fe and Zn rich groundnut kernels can be included in human food through value added peanut products like peanut butter, defatted peanuts, blanched peanuts, coated peanuts, roasted and salted peanuts to increase the dietary intake of Fe and Zn in human being.

Acknowledgements

The authors gratefully acknowledge Dr.S.N.Nigam, Principal Scientist (Groundnut) ICRISAT, Patancheru; Dr. R.P.Vasanthi, Principal Scientist, Dr.T.Muralikrishna, Senior Scientist, Regional Agricultural Research Station, Thirupathi for providing breeding lines/culivars used in this study. Thankful to the Department of Soil and Environment, Agricultural College and Research Institute, Madurai for the kind assistance rendered for analyzing micronutrients.

References:

Brar, B., Jain, S., Singh, R. and Jain. R.K. 2011. Genetic diversity for iron and zinc contents in a collection of 220 rice (*Oryza sativa* L.) genotypes. *Indian J. Genet.*, **71**(1): 67-73.

Cakmak, I. 2008. Enrichment of cereal grains with zinc: agronomic or genetic biofortification? Plant and Soil, **302**:1–17.

Chakraborti, M., Prasanna, B.M., Hossain, F. and Singh, A.M. 2011. Evaluation of single cross quality protein maize (QPM) hybrids for kernel iron and zinc concentration. *Indian J. Genet.*, **71**(4): 312-319.

Chitdeshwari, T. and Poongothai. S. 2003. Yield of groundnut and its nutrient uptake as influenced by zinc, boron and sulphur, *Agrl. Sci. Digest,* **23** (4): 263 – 266.

Devlin, R.M. and Withan, F.H. 1983. *Plant physiology*. Wadsworth publishing company: California.

Fageria, N. K., Baligar, V.C. and Li. Y.C. 2008. The Role of Nutrient Efficient Plants in Improving Crop Yields in the Twenty First Century. *J. Plant Nut.,* **31**(6): 1121-1157.

Franca, F. and Ferrari. M. 2002. Impact of micronutrient deficiencies on growth: The stunting syndrome. *Ann. Nut. Metab*., **46**: 8-17.

Gobarah, M.E., Mohamed, M.H. and Tawfik, M.M. 2006. Effect of Phosphorus Fertilizer and Foliar Spraying with Zinc on Growth, Yield and Quality of Groundnut under Reclaimed Sandy. *Soils J. Appl. Sci. Res.,* **2**(8): 491-496.

Gourley C.J.P., Allan, D.L. and Russelle, M.P. 1994. Plant nutrient efficiency: A comparison of definitions and suggested improvement. *Plant and Soil,* **158**: 29–37.

Grusak, M.A., and Cakmak, I. 2005. Methods to improve the crop-delivery of minerals to humans and livestock. In: *Plant Nutritional Genomics*, eds. M.R. Broadley and P.J. White Oxford: Blackwell Science, p. 265-86.

Grusak, M.A., and D. DellaPenna. 1999. Improving the nutrient composition of plants to enhance human nutrition and health. *Annu. Rev. Plant Physiol. Plant Mol.Biol*., **50**:133-61.

ICMR Report. 2009. Nutrient requirements and recommended dietary allowances for Indians, National Institute of Nutrition. Hyderabad, India. p 334.

Khoshgoftarmanesh, A.H., Schulin, R., Chaney, R.L., Daneshbakhsh, B. and Afyuni, M. 2010. Micronutrient-efficient genotypes for crop yield and nutritional quality in sustainable agriculture: A review. *Agron. Sustainable Dev*., 30: 83–107.

Lindsay, W.L. and Norvell. W.A. 1978. Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Sci. Soc. America J*.,**42**: 421-428.

Muthukumararaja, T.M. and Sriramachandrasekharan, M.V. 2012. Effect of zinc on yield, zinc nutrition and zinc use efficiency of low land rice. *J. Agrl. Tech*., **8**(2): 551-561.

Nayak, S.C., Sarangi, D., Mishra, G.C. and Rout, D.P. 2009. Response of groundnut to secondary and micronutrients. *SAT eJournal*, 7.

Pendashteh, M., Tarighi, F., Doustan, H.Z., Keshavarz, A., Azarpour, E., Moradi, M. and Bozorgi, H.R. 2011. Effects of foliar zinc spraying and nitrogen fertilization on seed yield and several attributes in groundnut (*Arachis hypogaea* L.,), *World Applied Sci. J.*, **13**(5): 1209-1217.

Rattan, R.K., Patel, K.P., Manjaiah, K.M. and Datta, S.P., 2009. Micronutrients in Soil, Plant, Animal and Human Health. *J. Ind. Soc. Soil Sci.*, **57**(4): 546- 558.

Singh, M.V., Patel, K.P. and Ramani, V.P. 2003. Crop responses to secondary and micronutrients in swell-shrink soils. *Fert. News*, **48**(4): 63-66.

Singh, M.V. 2006. Micronutrients in crops and in soils of India. In *Micronutrients for global crop production*. ed. B.J. Alloway, Springer. Business.

Singh, M.V. 2009. Micronutritional problem in soils of India and improvement for human and animal health. *Ind. J. Fert*., **5**(4): 11-16.

Singh, M.V., Narwal, R.P., Bhupal, R.G., Patel, K.P. and Sadana. U.S. 2009. Changing scenario of micronutrient deficiencies in India during four decades and its impact on crop responses and nutritional health of human and animals. *The Proceed. of the International Plant Nutrition Colloquium XVI.* Department of Plant Sciences, UC Davis.

Singh, M.V. 2010. Micronutrient deficiency in Indian soils and field usable practices for their correction. *AICRP(micronutrient) Annual Report*, Indian Institute of Soil Science, Bhopal.

Srinivasarao, Ch., Wani, S.P., Sahrawat, K.L., Rego, T.J. and Pardhasaradhi, G. 2008. Zinc, boron and sulphur deficiencies are holding back the potential of rainfed crops in semi-arid India: Experiences from participatory watershed management. *Int. J. Plant Prod*., **2**(1): 89-99.

Takkar, P.N., Chhibba, I.M. and Mehta, S.K. 1989. Bulletin No. 1. Indian Institute of Soil Science Bhopal, India.

White, J. and Broadley, M.R. 2005. Biofortifying crops with essential mineral elements. *Trends Plant Sci*., **10**:586–93.

.

Table 1. Physical and Chemical properties of experimental soil

Soil Type:	Typic Haplustalfs	pH:	5.20
Soil texture:	Sandy Loam	EC (dS/m):	0.15
Depth (cm):	120	Organic carbon (%):	0.48
Sand (%):	69	Available N (kg/ha):	280
Silt (%):	10	Available P (kg/ha):	33
Clay (%):	21	Available K (kg/ha):	218

Table 2. Micronutrient status of native and Fe and Zn fertilized alfisol of experimental field

	Available Micronutrients (ppm)			
	Fe	**Zn**	**Cu**	**Mn**
Control soil	21.10	1.10	1.15	52.03
Fe and Zn applied	22.04	1.94	1.23	55.79
Change over control (%)	4.45	76.36	6.95	7.22

Table 3. Response of groundnut cultivar to micronutrient addition in soil and their yield under Alfisol

Cultivars	Concentration in kernel (mg/kg)				Shelling	100 seed	Pod yield/
	Fe	Zn	Cu	Mn	(%)	weight (g)	Plant (g)
Control							
TMV 7	226.4	52.2	185.2	45.5	75	30	19.2
TMV (Gn) 13	208.3	36.2	212.2	49.1	74	40	18.4
VRI (Gn) 6	174.8	49.1	240.3	44.1	68	28	35.7
Mean	203.1	45.8	212.6	46.2	72.3	32.7	24.4
Fe and Zn applied							
TMV 7	236.3	69.9	255.4	60.9	74	32	21.4
TMV (Gn) 13	210.9	61.1	203.4	90.2	76	41	22.5
VRI (Gn) 6	185.3	61.8	230.6	59.7	70	29	38.6
Mean	210.8	64.3	229.8	70.3	73.3	34.0	27.5
Change over control (%)	3.8	28.7	7.5	34.2	1.4	4.1	12.6

Electronic Journal of Plant Breeding, 4(1): 1043-1049 (Mar 2013)
ISSN 0975-928X

Table 4. Micronutrient composition and yield parameters in groundnut genotypes under alfisol

Genotypes	Concentration in kernel (mg/kg)				Shelling (%)	100 seed weight (g)	Pod yield/ plant (g)
	Fe	Zn	Cu	Mn			
ICGV 05155	78.7	47.4	220.5	38.8	59	32	8.8
ICGV 06423	76.1	54.7	233.0	36.4	53	27	23.2
ICGV 06424	134.9	58.5	237.5	39.1	62	30	17.6
ICGV 07219	95.1	28.7	222.9	41.3	64	28	29.8
ICGV 07220	104.4	69.8	248.8	45.0	58	25	35.0
ICGV 07222	91.9	69.4	257.9	43.3	66	28	41.8
ICGV 07225	137.8	70.2	148.4	32.6	69	45	41.8
ICGV 07228	98.3	42.6	253.0	66.0	64	23	29.0
ICGV 07240	94.5	57.5	236.1	49.4	73	30	33.2
ICGV 07241	96.7	50.0	234.2	38.4	67	36	45.4
ICGV 07247	81.8	65.4	214.2	71.8	68	29	39.4
ICGV 07262	94.9	49.7	227.9	49.1	64	25	39.8
ICGV 07268	89.9	52.4	226.1	52.4	67	31	28.4
ICGV 91114	187.6	52.4	257.3	58.8	73	38	23.0
Narayani	55.3	66.4	221.2	74.6	75	27	16.0
JL 24	126.2	60.6	229.3	51.4	67	36	20.5
TPT 25	105.1	52.9	225.4	33.8	58	27	24.0
TCGS 913	141.0	57.8	260.2	48.6	75	32	24.0
K 134	143.1	56.5	236.0	43.4	68	30	25.0
TLG 45	116.4	62.6	217.5	56.8	65	33	12.5
Chico	132.1	55.9	221.3	52.6	67	32	8.0
Mean	108.7	56.3	229.9	48.7	65.9	30.8	26.9
SEM ±	3.5	2.1	5.0	2.5	1.2	1.1	2.4
CD ($P \leq 0.05$)	2.3	1.2	3.1	1.2	1.8	1.4	3.4

Table 5. Correlation coefficient values of kernel micronutrients and yield parameters in groundnut

	Fe	Zn	Cu	Mn	Shelling (%)	100-seed weight (g)	Pod yield/ plant (g)
Fe	1.000	-0.113	-0.204	0.125	0.550**	0.491*	-0.208
Zn		1.000	-0.034	0.222	0.118	0.075	0.135
Cu			1.000	0.057	-0.139	-0.506**	0.027
Mn				1.000	0.536**	0.046	-0.142
Shelling (%)					1.000	0.437*	-0.056
100-seed weight (g)						1.000	-0.137
Pod yield/ plant (g)							1.000

*,** significant at 5 and 1 % respectively