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Iron and Nitrogen Interactions in Groundnut Nutrition[1]

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ABSTRACT

A pot experiment was conducted to estimate the levels of iron (Fe) needed to correct Fe-deficiency chlorosis in groundnut grown in an alkaline soil and to study Fe x nitrogen (N) interactions in soil and plant and their associated effects on growth and yield. Four levels of Fe (0, 2.5, 10, and 25 mg Fe kg^{-1} soil as Fe-EDDHA) and two levels of N (0 and 100 mg N kg^{-1} soil as NH_4NO_3) were applied factorially in a completely randomized block design. Higher rates of 10 and 25 mg Fe kg^{-1} caused a significant reduction in leaf area and aerial biomass accumulation irrespective of N treatment. The Fe x N interaction was significant for all of these parameters. Specific leaf area increased at higher levels of Fe application. Higher Fe levels induced symptoms suggestive of manganese (Mn) deficiency. This diagnosis was

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Mn deficiency (interveinal chlorosis of relatively young leaves; necrotic spots on margins of older chlorotic leaves; slender and weak stems) were noticed in plants grown in pots treated with the highest Fe levels, 10 and 25 mg Fe kg^{-1} soil. There was a visible reduction in plant growth associated with these symptoms.

Plant Growth

Leaf area (LA) decreased significantly ($P<0.001$) at 10 and 25 mg Fe kg^{-1} treatments compared to values at 0 and 2.5 mg Fe kg^{-1} (Table 1). Application of N increased LA only at 0 and 2.5 mg Fe kg^{-1} levels. Opposite trends for the effect of Fe on specific leaf area (SLA) were apparent. Application of N decreased SLA significantly ($P<0.001$) only at the highest level of applied Fe (Table 1). Treatment effects on leaf dry matter (LDM) and shoot dry matter (SDM) reflected those on LA (Table 2). At 45 DAS there were only immature pods (IP), the yield of which declined with increasing Fe level. The N and Fe x N effects were not significant (Table 2). Treatment effects on total dry matter (TDM) were similar to those on LA, LDM, and SDM (Table 2). Maximum TDM (4.19 g $plant^{-1}$) was obtained with 0 Fe and 100 mg N kg^{-1} and the minimum (1.66 g $plant^{-1}$) with the 25 mg Fe and 0 N kg^{-1} combination.

Treatment Effects on Soil Chemical Characteristics

The main effects of Fe, N and Fe x N interaction on soil pH were not significant (Table 3). Increasing fertilizer application increased EC (Table 3). Available N increased by about 4-fold due to fertilizer N application when Fe was also applied, while in the absence of added N, Fe alone slightly increased available N (Table 3). In the absence of added Fe, N application did not result in enhanced available N in soil. Available Fe was increased by about 70% due to application of 25 mg Fe kg^{-1} (Table 3).

Effect of Fe and N Fertilizers on Nutrient Concentration in Leaf Blade

Application of 25 mg Fe kg^{-1} resulted in significant increase of N ($P<0.001$), P ($P<0.01$), K ($P<0.01$), Fe ($P<0.05$), Zn ($P<0.001$), Cu ($P<0.001$), and Mg ($P<0.05$) concentration with or without N fertilization, however, it significantly depressed the concentration of Ca ($P<0.05$) and Mn ($P<0.01$) in leaf blades (Tables 4 and 5). The N and Fe x N interaction effects were not significant for all above mentioned nutrients, except Mg. In the case of Mg, applied N increased Mg uptake and Fe increased Mg concentration only in the absence of applied N. Application of Fe resulted in a 74% decrease in Mn concentration (Table 5).

DISCUSSION

Symptoms typical of Fe deficiency chlorosis appeared only gradually when Fe was not applied, with a mild chlorosis only distinct at 45 DAS. These symptoms

TABLE 1. Leaf area (LA), specific leaf area (SLA), and leaf dry mass (LDM) of 45-day-old pot-grown groundnut genotype TMV 2 as affected by different treatment levels of Fe and N.

Fe applied ($mg\ kg^{-1}$)	LA			SLA			LDM		
	N applied ($mg\ kg^{-1}$)		Mean of Fe treatments	N applied ($mg\ kg^{-1}$)		Mean of Fe treatments	N applied ($mg\ kg^{-1}$)		Mean of Fe treatments
	0	100		0	100		0	100	
	$cm^2\ plant^{-1}$			$cm^2\ g^{-1}$			$g\ plant^{-1}$		
0	408	462	435	252	240	246	1.62	1.92	1.77
2.5	395	445	420	243	250	247	1.62	1.78	1.70
10	359	321	340	285	289	287	1.26	1.11	1.19
25	269	252	260	323	279	301	0.84	0.90	0.87
Mean of N treatments	358	370	-	276	264	-	1.34	1.43	-
SE(m)									
Fe		± 12.8			± 6.5			± 0.048	
N		± 9.0			± 4.6			± 0.034	
Fe x N		± 18.0			± 9.3			± 0.068	

TABLE 4. Concentration of macronutrient elements in groundnut leaves (cv. TMV 2) as affected by different treatment levels of Fe and N in a pot experiment.

Fe applied ($mg\ kg^{-1}$)	N: N applied ($mg\ kg^{-1}$) 0	N: N applied 100	N: Mean of Fe treatments	P: N applied ($mg\ kg^{-1}$) 0	P: N applied 100	P: Mean of Fe treatments	K: N applied ($mg\ kg^{-1}$) 0	K: N applied 100	K: Mean of Fe treatments	Ca: N applied ($mg\ kg^{-1}$) 0	Ca: N applied 100	Ca: Mean of Fe treatments	Mg: N applied ($mg\ kg^{-1}$) 0	Mg: N applied 100	Mg: Mean of Fe treatments
	%			%			%			%			%		
0	2.97	2.86	2.92	0.25	0.24	0.25	2.03	1.72	1.88	1.76	1.81	1.79	0.46	0.57	0.52
25	4.23	4.32	4.28	0.44	0.45	0.45	2.84	2.81	2.83	1.42	1.47	1.45	0.52	0.57	0.55
Mean of N treatments	3.60	3.59	-	0.35	0.35	-	2.44	2.27	-	1.59	1.64	-	0.49	0.57	-
SE(m)															
Fe	± 0.078			± 0.019			± 0.133			± 0.089			± 0.009		
N	± 0.078			± 0.019			± 0.133			± 0.089			± 0.009		
Fe x N	± 0.111			± 0.027			± 0.188			± 0.126			± 0.013		

TABLE 5. Concentration of micronutrient elements in groundnut leaves (cv. TMV 2) as affected by different treatment levels of Fe and N in a pot experiment.

Fe applied ($mg\ kg^{-1}$)	Fe: N applied ($mg\ kg^{-1}$) 0	100	Mean of Fe treatments	Zn: N applied ($mg\ kg^{-1}$) 0	100	Mean of Fe treatments	Mn: N applied ($mg\ kg^{-1}$) 0	100	Mean of Fe treatments	Cu: N applied ($mg\ kg^{-1}$) 0	100	Mean of Fe treatments
	$mg\ kg^{-1}$			$mg\ kg^{-1}$			$mg\ kg^{-1}$			$mg\ kg^{-1}$		
0	159	158	158	20.3	19.0	19.7	21.0	17.6	19.3	3.6	3.5	3.6
25	478	221	349	38.3	32.3	35.3	5.9	4.3	5.1	8.9	10.7	9.8
Mean of N treatments	319	189	-	29.3	25.7	-	13.4	10.9	-	6.3	7.1	-
SE(m)												
Fe	± 39.9			± 1.26			± 2.19			± 0.81		
N	± 39.9			± 1.26			± 2.19			± 0.81		
Fe x N	± 56.4			± 1.79			± 3.10			± 1.14		

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