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EFFECT OF ORGANIC AND INORGANIC SOURCES OF NUTRIENTS IN MICRONUTRIENTS UPTAKE AND AVAILABILITY ON GROUNDNUT IN SANDY CLAY LOAM SOIL

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Abstract

An experiment was carried out during winter season of 2009-2010 to assess the response of organic and inorganic sources of nutrients in micronutrients uptake on groundnut in sandy clay loam soil of vanniyarpalayam village, cuddalore district, Tamilnadu. The experimental soil having Sandy clay loam in texture (*Typhic Haplustalf*) had the value of pH 6.8 and EC of 0.37 dSm^{-1}. The soil analyzed low in organic carbon, low in alkaline $KMnO_4$-N, low in Bray-1- P and medium in NH_4OAC-K. Field experiment was conducted with the following treatments T_1 – RDF, T_2 - RDF + $ZnSO_4$, T_3 - RDF + Boron, T_4 -RDF + $ZnSO_4$ + Boron, T_5 - RDF + FYM, T_6 - RDF + $ZnSO_4$ + FYM, T_7 - RDF + Boron + FYM, T_8 - RDF + $ZnSO_4$ + Boron + FYM, T_9 - 75% RDF + HA, T_{10} - 75% RDF + $ZnSO_4$ + HA, T_{11} - 75% RDF + Boron + HA, T_{12} -75% RDF + $ZnSO_4$ + Boron + HA, T_{13} - 50% RDF + LFA, T_{14} - 50% RDF + $ZnSO_4$ + LFA, T_{15} - 50% RDF + Boron + LFA, T_{16} - 50% RDF + $ZnSO_4$ + Boron + LFA. The experiment was laid out in Randomized Block Design with three replications. The results of the field experiment clearly indicated that combined application of 100% RDF, $ZnSO_4$ @ 25 kg ha^{-1}, Boron @ 10 kg ha^{-1} and FYM @ 12.5 t ha^{-1} (T_8) registered the highest nutrient uptake in sandy clay loam soil and maximum uptake of micronutrients such as zinc, manganese, copper and boron as compared to 100% RDF alone at all stages of crop growth. Application of 100% RDF + FYM (T_5) @ 12.5 t ha^{-1} recorded the highest DTPA-extractable Cu and Mn. The highest DTPA extractable zinc was noticed in treatment 100% RDF + $ZnSO_4$ + FYM (T_6) but the highest boron was observed in treatment 100% RDF + Boron + FYM (T_7) in sandy clay loam soil. The results of the field experiment indicated that application of FYM @ 12.5 t ha^{-1} along with 75% RDF, $ZnSO_4$ @ 25 kg ha^{-1} + B @ 10 kg ha^{-1} + HA @ 20 kg ha^{-1} maximized the micronutrients uptake of groundnut in sandy clay loam soil of Cuddalore district as well as improved the availability of macro and micronutrients status of soil.

Key words: micronutrients, Mn, Zn, Cu and B, Groundnut, sandy clay loam soil

Introduction

Groundnut (*Arachis hypogaea* L.) is unique and important oil seed crop of India, it is cultivated in 55.27 lakh ha^{-1} with production of 96.72 lakh tonnes and productivity of 1750 kg ha^{-1} (2013-2014). Tamilnadu ranks third in the country with an area of 3.42 lakh ha^{-1} contributing 6.48% and production of 9.62 lakh tonnes contributing 14.12% with an average productivity of 2.81 t ha^{-1}. The major production constraints in light textured soils are mainly the low organic matter content, poor fertility status, imbalanced use of high analysis chemical fertilizers accompanied by restricted use of organic manures made the soils not only deficient in secondary and micronutrients, but also deteriorated the soil health (Akbari *et al.*, 2011). The poor retention and leaching of nutrients also necessities for the increased rate of nutrient application especially NPK in such soils.

Integrated application of organic and inorganic manures showed higher uptake of NPK rather than sole application of organic manures due to increased nutrient availability and improvement in physical condition of the soil. The available nutrient status of the soil significantly improved with combined application of organic and inorganic manures. Conjunctive use of organic manures and optimum dose of NPK produced the highest and sustainable crop yields and improved the fertility status of the soil (Laxminarayana, 2004). The present investigation was, therefore undertaken to integrate the application of inorganic fertilizers along with organic sources and micronutrients so as to reduce or substitute the inorganic fertilizer requirement and to sustain the

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groundnut production in sandy clay loam soil.

Materials and Methods

The field experiment was conducted in farmer field atvanniyarpalayam village during December, 2009 to March, 2010 . The treatments consisted of different levels of NPK viz., 100% and 75% RDF and different sources of nutrients viz., farm yard manure @ 12.5 t ha^{-1}, fly ash (FA) @ 10t ha^{-1} and humic acid (HA) @ 20 kg ha^{-1} along with micronutrients boron @ 10 kg ha^{-1} and zinc sulphate @ 25 kg ha^{-1}. The experimental soil having Sandy clay loam in texture (*Typhic Haplustalf*) had the value of pH 6.8 and EC of 0.37 dSm^{-1}. The soil analyzed low in organic carbon, low in alkaline $KMnO_4$-N, low in Bray-1- P and medium in NH_4OAC-K. Field experiment was conducted with the following treatments T_1 – RDF, T_2 - RDF + $ZnSO_4$, T_3 - RDF + Boron, T_4 -RDF + $ZnSO_4$ + Boron, T_5 - RDF + FYM, T_6 - RDF + $ZnSO_4$ + FYM, T_7 - RDF + Boron + FYM, T_8 - RDF + $ZnSO_4$ + Boron + FYM, T_9 - 75% RDF + HA, T_{10} - 75% RDF + $ZnSO_4$ + HA, T_{11} - 75% RDF + Boron + HA, T_{12} -75% RDF + $ZnSO_4$ + Boron + HA, T_{13} - 50% RDF + LFA, T_{14} - 50% RDF + $ZnSO_4$ + LFA, T_{15} - 50% RDF + Boron + LFA,T_{16} - 50% RDF + $ZnSO_4$ + Boron + LFA. The experiment was laid out in Randomized Block Design with three replications. The experiment was laid out in randomized block design (RBD) with three replications and tested with groundnut crop var.JL-11. Required quantities of nutrient sources as per the treatment schedule were incorporated. Calculated amount of fertilizer doses of 17:34:54 kg N: P_2O_5:K_2O ha^{-1} was applied in sandy clay loam soil as per the treatment schedule. The total uptake of individual micronutrient was computed by multiplying the respective nutrient content with DMP. At harvest stage, the nutrient uptake by pod and haulm were also computed.

Results and discussion

Uptake of micronutrients by groundnut

Zinc deficiency is most common in sandy clay loam soil. Zinc plays a major role in promoting both the reproductive growth *i.e.,* production of flowers, pegs and reproductive branches and also play significant role in promoting the vegetative growth *i.e.,* root and shoot of groundnut. Application of borax plays stimulatory effect on the availability of micronutrients, *viz.,* Zn, Mn, Cu and B. The effect of treatment *i.e.,* combined application of 100% RDF + $ZnSO_4$ + Boron + FYM was pronounced in increasing the availability. In present study (Table 1, 2, 3& 4) application of $ZnSO_4$ + 100% RDF + Boron along with organics significantly increased Zn uptake of groundnut. Application of organic matter resulted in higher micronutrient availability due to mineralization according to Thampan (1993). Organics application could result in release of more micronutrients in easily available form, which could be reflected in overall growth of crop plants. These results are in accordance with the earlier reports of Chitdeshwari and Poongothai (2003). The addition of Zn through fertilizer and also the release of micronutrients from the added organics could have contributed for better availability of Zn in rhizosphere. These results are in agreement with the findings of several researchers (Jha and Chandel, 1987 and Kalia and Sharma, 1988).

The total uptake of Zn, Cu, Mn and B increased significantly with conjoint application of organics and recommended dose of fertilizers in comparison with control and recommended fertilizers alone treatments followed by organic treatments. These results are in agreement with the findings of Mukeshkumar *et al.* (2012). The increased Mn uptake might be due to the role of applied zinc in activating the enzymatic system helping in the translocation of Mn to other plant parts. Yadav *et al.* (1991), Devarajan and Palaniappan (1995), Raghuwanshi *et al.* (1997) and Latha *et al.* (2002) have reported similar results. In enhancing the B nutrition of groundnut, a significantly superior effect of the treatment 100% RDF + $ZnSO_4$ + Boron + FYM was clearly brought out. Higher B uptake might be attributed to better availability of these nutrients in soil with the combined effect of $ZnSO_4$, 100% RDF and FYM resulting in better nutrient absorption by crop plants. The results are in conformity with Ganeshappa (2000), Takkar and Nayyar (1984) and Patel *et al.* (2010). Among treatments, the highest uptake of Cu at all stages of crop growth were significantly superior with the application of 100% RDF + $ZnSO_4$ + Boron + FYM as uptake being a parameter associated with the DMP. The increased growth characters and yield characters resulted in the production of higher dry matter production with this treatment. This findings corroborate the earlier results of Takkar and Nayyer (1984), and Malewar (2003).

The addition of Zn-humate with FYM in soil application and also release of micronutrients from the added organics could have contributed for better availability of Zn in rhizosphere. These results are in agreement with the findings of several researchers (Patel *et al.*, 2010) recorded the highest uptake of micronutrients (Zn, Cu, Fe and Mn) with the combination of different zinc fertilizer and organic application. Integration of B and Zn with 100% RDF showed maximum nutrient uptake in comparison to 75% RDF and 50% RDF treatments. Higher accumulation and uptake of nutrients under these

Table 1: Effect of organic and inorganic sources of nutrients on zinc uptake (g ha^{-1}) in groundnut

Treatments	Sandy clay loam soil			
	FS	PFS	POD	HAULM
T_1- RDF	189.75	319.20	183.04	147.25
T_2-RDF+ $ZnSO_4$	201.15	338.54	194.10	156.20
T_3-RDF +Boron	194.32	326.56	188.50	150.70
T_4-RDF+ $ZnSO_4$+Boron	214.91	360.35	208.44	166.80
T_5– RDF + FYM	217.10	365.35	210.40	168.01
T_6–RDF+ $ZnSO_4$ + FYM	228.62	380.70	219.50	173.95
T_7– RDF +Boron + FYM	221.74	373.05	215.02	172.15
T_8- RDF+$ZnSO_4$+Boron +FYM	235.49	384.61	221.80	177.51
T_9– 75% RDF + HA.	147.55	249.10	142.71	115.20
T_{10}- 75% RDF + $ZnSO_4$+HA.	158.20	266.10	153.40	122.80
T_{11}- 75% RDF + Boron+HA.	150.88	253.40	146.30	117.13
T_{12}– 75% RDF +$ZnSO_4$ +Boron+HA.	160.80	268.45	155.01	124.05
T_{13}– 50% RDF + LFA	96.00	161.50	93.10	74.50
T_{14}– 50% RDF + $ZnSO_4$+LFA	107.30	180.70	104.20	83.30
T_{15}- 50% RDF + Boron+LFA	105.10	176.10	102.00	81.60
T_{16}- 50% RDF + $ZnSO_4$ +Boron +LFA	114.26	190.24	110.80	88.15
SED	5.60	9.39	5.41	4.45
CD (P=0.05)	11.42	19.17	11.04	8.89

Table 2: Effect of organic and inorganic sources of nutrients on copper uptake (g ha^{-1}) in groundnut

Treatments	Sandy clay loam soil			
	FS	PFS	POD	HAULM
T_1- RDF	137.81	122.25	137.60	53.94
T_2-RDF+ $ZnSO_4$	146.11	129.62	145.90	57.19
T_3-RDF +Boron	141.13	125.20	140.92	55.24
T_4-RDF+ $ZnSO_4$+Boron	156.07	138.46	155.09	61.09
T_5– RDF + FYM	157.73	139.93	157.60	61.74
T_6–RDF+ $ZnSO_4$ + FYM	166.04	147.30	165.86	64.99
T_7– RDF +Boron + FYM	161.05	142.88	160.88	63.04
T_8- RDF+$ZnSO_4$+Boron +FYM	171.02	151.71	170.94	67.58
T_9– 75% RDF + HA.	107.92	95.80	107.20	42.24
T_{10}- 75% RDF+$ZnSO_4$+HA.	114.89	101.36	112.77	44.97
T_{11}- 75% RDF+Boron+HA.	109.58	97.20	109.46	42.89
T_{12}– 75% RDF +$ZnSO_4$ +Boron+HA.	116.06	102.96	115.93	45.49
T_{13}– 50% RDF + LFA	69.73	61.86	69.62	27.29
T_{14}– 50% RDF + $ZnSO_4$+LFA	78.03	69.22	77.90	30.54
T_{15}- 50% RDF + Boron+LFA	76.37	67.75	76.26	29.89
T_{16}- 50% RDF + $ZnSO_4$ +Boron +LFA	83.00	73.65	82.90	32.59
SED	4.19	3.61	3.94	1.59
CD (P=0.05)	8.55	7.36	8.04	3.24

Table 3: Effect of organic and inorganic sources of nutrients on manganese uptake (g ha^{-1}) in groundnut

Treatments	Sandy clay loam soil			
	FS	PFS	POD	HAULM
T_1- RDF	193.25	204.40	198.12	100.30
T_2-RDF+ $ZnSO_4$	204.89	216.70	210.05	106.35
T_3-RDF +Boron	197.91	209.30	202.90	102.75
T_4-RDF+ $ZnSO_4$+Boron	218.86	232.45	224.35	113.60
T_5– RDF + FYM	221.19	234.00	226.70	114.80
T_6–RDF+ $ZnSO_4$ + FYM	232.84	246.32	238.71	120.90
T_7– RDF +Boron + FYM	225.90	238.90	231.54	117.25
T_8- RDF+$ZnSO_4$+Boron +FYM	242.20	256.20	248.26	125.80
T_9– 75% RDF + HA.	151.30	160.10	155.10	78.58
T_{10}- 75% RDF + $ZnSO_4$+HA.	160.65	170.40	165.16	83.66
T_{11}- 75% RDF + Boron+HA.	153.65	162.59	157.54	79.79
T_{12}– 75% RDF +$ZnSO_4$ +Boron+HA.	162.75	172.26	166.89	84.50
T_{13}– 50% RDF + LFA	97.79	102.40	100.10	50.77
T_{14}– 50% RDF+$ZnSO_4$+LFA	109.40	115.80	112.20	56.80
T_{15}- 50% RDF+Boron+LFA	107.06	113.26	109.50	55.60
T_{16}- 50% RDF + $ZnSO_4$ +Boron +LFA	116.40	125.20	119.50	60.49
SED	5.70	6.03	5.85	2.96
CD (P=0.05)	11.64	12.31	11.93	6.04

Table 4: Effect of organic and inorganic sources of nutrients on boron uptake (g ha^{-1}) in groundnut

Treatments	Sandy clay loam soil			
	FS	PFS	POD	HAULM
T_1- RDF	1.794	1.908	2.365	4.288
T_2-RDF+ $ZnSO_4$	1.837	1.954	2.422	4.391
T_3-RDF +Boron	1.902	2.023	2.508	4.546
T_4-RDF+ $ZnSO_4$+Boron	2.032	2.161	2.679	4.856
T_5– RDF + FYM	2.053	2.184	2.709	4.908
T_6–RDF+ $ZnSO_4$ + FYM	2.097	2.230	2.766	5.011
T_7– RDF +Boron + FYM	2.162	2.299	2.850	5.167
T_8- RDF+ $ZnSO_4$+Boron + FYM	2.270	2.390	2.965	5.373
T_9– 75% RDF + HA.	1.405	1.494	1.852	3.358
T_{10}- 75% RDF+$ZnSO_4$+HA.	1.426	1.517	1.881	3.410
T_{11}- 75% RDF+Boron+ HA.	1.496	1.590	1.972	3.575
T_{12}– 75% RDF +$ZnSO_4$ +Boron+HA.	1.511	1.607	1.992	3.611
T_{13}– 50% RDF + LFA	0.908	0.965	1.197	2.170
T_{14}– 50% RDF+$ZnSO_4$ + LFA	0.994	1.057	1.311	2.376
T_{15}- 50% RDF+Boron + LFA	1.016	1.080	1.339	2.428
T_{16}- 50% RDF + $ZnSO_4$ +Boron +LFA	1.081	1.149	1.425	2.583
SED	0.052	0.056	0.058	0.132
CD (P=0.05)	0.108	0.114	0.118	0.268

treatments could be ascribed to better availability and synergistic effect of applied nutrients.

Available micronutrients

Table 5: Effect of organic and inorganic sources of nutrients on available copper (mg kg^{-1}) in soil

Treatments	Sandy clay loam soil		
	FS	PFS	HS
T_1- RDF	0.742	0.471	0.436
T_2-RDF+ $ZnSO_4$	0.717	0.454	0.426
T_3-RDF +Boron	0.736	0.463	0.430
T_4-RDF+ $ZnSO_4$+Boron	0.697	0.430	0.420
T_5– RDF + FYM	0.800	0.525	0.463
T_6–RDF+ $ZnSO_4$ + FYM	0.775	0.508	0.446
T_7–RDF +Boron + FYM	0.781	0.517	0.455
T_8- RDF+ $ZnSO_4$+Boron + FYM	0.751	0.486	0.441
T_9– 75% RDF + HA.	0.685	0.421	0.415
T_{10}- 75% RDF + $ZnSO_4$+ HA.	0.653	0.405	0.356
T_{11}- 75% RDF + Boron+ HA.	0.677	0.418	0.361
T_{12}– 75% RDF+$ZnSO_4$+Boron+HA.	0.640	0.392	0.346
T_{13}– 50% RDF + LFA	0.632	0.382	0.341
T_{14}– 50% RDF + $ZnSO_4$+LFA	0.621	0.369	0.331
T_{15}- 50% RDF + Boron+LFA	0.627	0.375	0.335
T_{16}- 50% RDF + $ZnSO_4$+Boron+LFA	0.588	0.349	0.324
SED	0.019	0.012	0.006
CD (P=0.05)	0.040	0.026	0.013

Table 6: Effect of organic and inorganic sources of nutrients on available zinc (mg kg^{-1}) in soil

Treatments	Sandy clay loam soil		
	FS	PFS	HS
T_1- RDF	1.75	1.42	1.18
T_2-RDF+ $ZnSO_4$	1.86	1.57	1.24
T_3-RDF +Boron	1.70	1.45	1.15
T_4-RDF+ $ZnSO_4$+Boron	1.82	1.40	1.20
T_5– RDF + FYM	1.96	1.68	1.32
T_6–RDF+ $ZnSO_4$ + FYM	2.07	1.76	1.38
T_7–RDF +Boron + FYM	1.90	1.61	1.27
T_8-RDF+ $ZnSO_4$+Boron + FYM	2.06	1.74	1.35
T_9–75% RDF + HA.	1.52	1.45	1.07
T_{10}-75% RDF + $ZnSO_4$+ HA.	1.63	1.54	1.13
T_{11}-75% RDF + Boron+ HA.	1.46	1.41	1.02
T_{12}–75% RDF+$ZnSO_4$+Boron+ HA.	1.60	1.50	1.10
T_{13}–50% RDF + LFA	1.45	1.35	0.97
T_{14}–50% RDF + $ZnSO_4$+ LFA	1.55	1.46	1.04
T_{15}-50% RDF + Boron+LFA	1.40	1.30	0.92
T_{16}-50% RDF + $ZnSO_4$+Boron+LFA	1.52	1.42	1.01
SED	0.050	0.043	0.034
CD (P=0.05)	0.104	0.088	0.069

Zinc availability in light textured soils are very low. The present experimental soil also showed (Table 5, 6, 7& 8) deficiency of Zn and hence the availability of Zn in soil as affected by different treatments assumes

Table 7: Effect of organic and inorganic sources of nutrients on available manganese (mg kg^{-1}) in soil

Treatments	Sandy clay loam soil		
	FS	PFS	HS
T_1- RDF	18.23	16.98	14.08
T_2-RDF+ $ZnSO_4$	17.68	16.31	13.02
T_3-RDF +Boron	18.06	16.93	13.78
T_4-RDF+ $ZnSO_4$+Boron	17.03	15.93	12.67
T_5– RDF + FYM	20.33	17.98	15.72
T_6–RDF+ $ZnSO_4$ + FYM	19.33	17.51	15.14
T_7–RDF +Boron + FYM	20.26	17.73	15.60
T_8- RDF+ $ZnSO_4$+Boron + FYM	18.75	17.03	14.97
T_9– 75% RDF + HA.	16.93	15.75	12.35
T_{10}- 75% RDF + $ZnSO_4$+ HA.	16.28	14.82	11.90
T_{11}- 75% RDF + Boron+ HA.	16.59	15.39	12.16
T_{12}– 75% RDF+$ZnSO_4$+ Boron+ HA.	15.40	14.11	11.50
T_{13}– 50% RDF + LFA	14.67	13.90	11.02
T_{14}– 50% RDF+$ZnSO_4$ + LFA	14.38	13.31	10.52
T_{15}- 50% RDF+Boron + LFA	14.55	13.72	10.95
T_{16}- 50% RDF+$ZnSO_4$ +Boron +LFA	13.61	12.77	10.13
SED	0.506	0.426	0.385
CD (P=0.05)	1.013	0.852	0.786

Table 8: Effect of organic and inorganic sources of nutrients on available boron (mg kg^{-1}) in soil

Treatments	Sandy clay loam soil		
	FS	PFS	HS
T_1- RDF	0.075	0.074	0.070
T_2-RDF+ $ZnSO_4$	0.073	0.073	0.069
T_3-RDF +Boron	0.079	0.075	0.073
T_4-RDF+ $ZnSO_4$+Boron	0.078	0.075	0.072
T_5– RDF + FYM	0.086	0.074	0.073
T_6–RDF+ $ZnSO_4$ + FYM	0.083	0.073	0.072
T_7–RDF +Boron + FYM	0.090	0.077	0.076
T_8- RDF+ $ZnSO_4$+Boron + FYM	0.087	0.076	0.074
T_9– 75% RDF + HA.	0.068	0.070	0.066
T_{10}- 75% RDF + $ZnSO_4$+ HA.	0.065	0.068	0.065
T_{11}- 75% RDF + Boron+ HA.	0.073	0.072	0.071
T_{12}– 75% RDF + $ZnSO_4$+ Boron+ HA.	0.070	0.071	0.067
T_{13}– 50% RDF + LFA	0.063	0.064	0.062
T_{14}– 50% RDF + $ZnSO_4$ + LFA	0.062	0.063	0.061
T_{15}- 50% RDF + Boron + LFA	0.067	0.067	0.064
T_{16}- 50% RDF + $ZnSO_4$ +Boron +LFA	0.064	0.066	0.063
SED	0.0019	0.0018	0.0015
CD (P=0.05)	0.0038	0.0037	0.0030

significance. In the current study, the application of 100% RDF + $ZnSO_4$ + FYM significantly increased the availability of Zn in soil. The highest DTPA-Zn content was recorded with treatment T_6. The increased availability with the addition of $ZnSO_4$ along with 100% RDF + FYM in complexing and mobilizing property might have increased DTPA-Zn in soil. Earlier report of Thampan (1993) support the present findings. Similar opinion of increased Zn availability with 100 per cent NPK + $ZnSO_4$ (Ravankar*et al.*, 1999) and $ZnSO_4$ + FYM application (Khurana*et al.*, 1996) were already reported. In the present study, availability of Mn and Cu in soil was not significantly influenced by the application of $ZnSO_4$. Since $ZnSO_4$ has not played a direct role in increasing the availability of the above nutrients. This results are in accordance with the earlier reports of Arora and Sekhon (1982) and Ahmed *et al.* (1986). Several authors have also made observation on the non-significant effect of $ZnSO_4$ on the availability of Cu and Mn (Tandon, 1992 and Malewar, 2003).

The availability of micronutrients, Zn and B in soil was significantly increased with the application of borax along with FYM. Among treatments, application of 100% RDF + Boron was associated with increased availability of the above nutrients. The increased availability in soil might be due to increased plant growth and absorption of nutrients from applied and native sources. This findings are in line with earlier report of Revathy *et al.* (1997) and Tripathy *et al.* (1999). Further, the stimulatory effect of B on these nutrients also explains the reason for higher availability. Similar findings were already reported by Tandon (1992) and Shankhe*et al.* (2004). In the present study, effect of B along with FYM on increasing the availability of Mn and Cu was not evidenced. Possibly due to the reason that the B had no direct significant role in influencing the availability of these nutrients and moreover all the treatment received a common rate of organics. This was in accordance with the earlier findings of Das (2000) and Murthy (2011).

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