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Effect of integrated plant nutrients supply through organic and inorganic sources on productivity of groundnut in loamy sand soil

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Abstract
A field experiment was conducted to find out most suitable organic and inorganic sources of nutrients with different levels of recommended dose of fertilizer to groundnut in loamy sand soil of Ayeekuppam village, Cuddalore District during December, 2008 and March, 2009. The experimental soil at Ayeekuppam belongs to Vadapudupet series (Typic Haplustalf) with loamy sand texture having having pH 8.1 and EC 0.41 dSm^{-1}. The soil was low in organic carbon, alkaline $KMnO_4$–N, and Olsen-P and medium in NH_4OAC-K. The experiment was conducted with 10 treatment combinations (Refer table). The treatments consisted of different levels of NPK viz., 100%, and 75% and different sources of nutrients viz., farm yard manure @ 12.5 t ha^{-1}, fly ash @ 10 t ha^{-1} and humic acid @ 20 kg ha^{-1} along with micronutrients boron @ 10 kg ha^{-1} and zinc sulphate @ 25 kg ha^{-1}. The experiment was laid out in randomized block design (RBD) with three replications and tested with groundnut crop var.JL- 11.The results revealed that application of 75% RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + boron @ 10 kg ha^{-1}+ humic acid @ 20 kg ha^{-1} and farm yard manure @ 12.5 t ha^{-1} (T_8) recorded the highest pod and haulm yield in loamy sand (2452 and 3580kg ha^{-1}) soil. Similarly, the dry matter production of groundnut was the highest in the above said treatments. The loamy sand soil recorded a DMP of 2105 kg ha^{-1} at flowering and 3335 kg ha^{-1} at peg formation stage. The treatment T_8 recorded the highest yield characters of number of pods $plant^{-1}$(21.2), 100 kernel weight (47.02g) and shelling percentage (73.78). In the treatment T_6 - RDF + FYM+ $ZnSO_4$ + Boron the values of yield and yield parameters were on par with T_8 values.
Among the sources tried, FYM was superior in the performance of yield and yield parameters. The humic acid was the next best source. The micronutrient sources zinc sulphate and borax was relatively better in their performance but fly ash showed poor performance. Thus the result revealed that 75% RDF + Farm yard manure @ 12.5 t ha^{-1}+ $ZnSO_4$ @ 25 kg ha^{-1} + Boron @ 10 kg ha^{-1} and humic acid @ 20 kg ha^{-1} which resulted in better yield and yield parameters performance in loamy sand soil could be the best treatment.

Keywords: loamy sand soil, zinc, boron, organics, growth, yield, groundnut

Introduction
Groundnut (*Arachis hypogaea* L.) is an important oil seed crop and it has been rightly acclaimed as "King of Oil Seeds" by virtue of its special attention as source of the most important edible oil used in grown is an area of 5.48 million ha with production of 5.43 million tonnes and productivity of 991 kg ha^{-1} (2009-10). Tamilnadu ranks 3rd in the country both in area (6.03 lakh ha^{-1} contributing 8.45 %) and production (9.89 m t contributing 14.32 %) with an average productivity of 1.64 t ha^{-1} (Directorate of economics and statistics, Department of Agriculture and Cooperation, 2009-10). The low level of its productivity has been ascribed to several constraints. Among them, low organic matter content, poor fertility status, imbalanced use of high analysis chemical fertilizers accompanied by restricted use of organic manures that made the soils not only deficient in secondary and micronutrients, but also deteriorated the soil health (Akbari *et al*., 2011) [1].
Hence, it is necessary to integrate different sources of nutrients to meet the crop requirement. Sustainable yields in groundnut can be achieved through the conjunctive use of organic and inorganic fertilizers (Singh *et al*., 1990) [16]. Organic manures improved the soil physical, chemical and biological properties and also increase the efficiency of the applied nutrients especially in light soils (Pandey *et al*., 2009) [12].

Materials and methods
The field experiment was conducted in farmer field at Ayeekuppam village during December, 2008 to March, 2009.

The experimental soil at Ayeekuppam belongs to Vadapudupet series (Typic Haplustalf) with loam texture having pH 8.1 and EC 0.41 dSm^{-1}. The soil was low in organic carbon, alkaline $KMnO_4$–N, and Olsen-P and medium in NH_4OAC-K. The experiment was conducted with 10 treatment combinations (Refer table). 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) @ 10 t 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 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 loamy sand soil as per the treatment schedule. At flowering and peg formation stages the growth character of DMP and at harvest yield characters viz., number of pods $plant^{-1}$, shelling per cent, 100 kernel weight and pod and haulm yields were recorded.

Results and discussion

Growth characters

Addition of organic and inorganic sources of nutrients with different levels of RDF combinations caused significant effect on dry matter production at all stages of crop growth (Table1). Among 75% RDF treatment combination and overall, 75% RDF + HA combination showed increase in DMP throughout crop growth. The 75% RDF + FYM + Boron + $ZnSO_4$ + HA treatment (T_8) recorded maximum DMP of 2105, 3335 and 6032 kg ha^{-1} at flowering, peg formation and harvest stages respectively. The treatment T_6 and T_7 were on par. The 75% RDF + FYM + Boron + HA treatment (T_7) recorded DMP values of 2089, 3304 and 5958 kg ha^{-1} at flowering, peg formation and harvest stages respectively. At 100% RDF with micronutrient combinations, 100% RDF + FYM + $ZnSO_4$ + Boron recorded maximum DMP values of 2025, 3291 and 5894 kg ha^{-1} at flowering, peg formation and harvest stages respectively. It was followed by T_3 and T_4 treatments. Treatments T_9 and T_{10} were on par. Treatment T_1 caused lowest DMP values at all stages of crop growth. The results of the field experiment also proved the validity of the treatment, application of 75% RDF + $ZnSO_4$ + Boron + FYM+HA in increasing the growth characters of dry matter production of groundnut in loamy sand soil. Further, the organic manures incorporated in to the soil undergo mineralization, during this process proteins and carbohydrates are broken down to polysaccharides, polyurenoids, amino acids and humic acids resulted in the production of accelerated growth components. The growth characters might be attributed to the auxin and gibberllin like activity of humic substances as confirmed by Muscolo *et al.* (1998) [11].

Table 1: Effect of organic and inorganic sources of nutrients on growth characters of groundnut in loamy sand soil

Treatments	DMP (kg ha^{-1})		
	FS	PFS	HS
T_1-Absolute control	1540	2422	4676
T_2-RDF	1653	2655	5030
T_3- RDF + Boron	1686	2785	5091
T_4- RDF + $ZnSO_4$ + Boron	1710	2840	5179
T_5- RDF+ FYM + Boron	1994	3163	5696
T_6-RDF + FYM + $ZnSO_4$ + Boron	2025	3291	5894
T_7-75% RDF + FYM + Boron + HA	2089	3304	5958
T_8-75% RDF + FYM + $ZnSO_4$ + Boron + HA	2105	3335	6032
T_9-75% RDF + FYM + Boron + LFA	1887	3013	5512
T_{10}-75% RDF + FYM + $ZnSO_4$ + Boron + LFA	1902	3089	5611
SED	50	79.2	143.5
CD (P=0.05)	105	166.5	301.5

Yield characters

Among 75% RDF treatment combination and overall, 75% RDF, micronutrients, HA and FYM combination treatments, T_8 (RDF% RDF + FYM + $ZnSO_4$ + Boron + HA) recorded (Table 2) maximum number of 21.2 pods $plant^{-1,}$ shelling per cent (73.78) and 100 kernel weight (47.02g). Treatment T_6 and T_7 were on par. In respect of 100% RDF treatments, 100% RDF + FYM + $ZnSO_4$ + Boron (T_5) recorded maximum number of 20.2 pods $plant^{-1,}$ shelling per cent of 72.11 and 100 kernel weights (46.22g). However, this treatment was on par with T_3 and T_4. Treatments received 75% RDF + LFA combinations had no significant influence on shelling per cent, number of pods $plant^{-1}$ and 100 kernel weight.

High yield characters of groundnut might be attributed to increased dry matter accumulation in the reproductive parts and formation of higher sink capacity with the addition of organics. An adequate supply of plant nutrients enhanced the metabolic activity. Not only amount of nutrients present in the soil but also their availability in meeting out the needs of crop at critical growth stages resulted in increased plant growth and yield characters. These results are in agreement with Revathy *et al.* (1997) [14] and Subramaniyan *et al.* (2001) [18].

Table 2: Effect of organic and inorganic sources of nutrients on yield characters of groundnut in loamy sand soil

Treatments	No. of pods $plant^{-1}$	Shelling per cent	100 kernel weight (g)
T_1-Absolute control	16.2	68.02	40.02
T_2-RDF	17.5	69.33	41.18
T_3- RDF + Boron	18.0	69.43	42.99

T_4- RDF + $ZnSO_4$ + Boron	18.3	69.71	43.22
T_5- RDF+ FYM + Boron	20.3	71.89	45.55
T_6-RDF + FYM + $ZnSO_4$ + Boron	20.5	72.11	46.22
T_7-75% RDF + FYM + Boron + HA	20.9	72.45	46.85
T_8-75% RDF + FYM + $ZnSO_4$ + Boron + HA	21.2	73.78	47.02
T_9-75% RDF + FYM + Boron + LFA	19.6	69.85	44.16
T_{10}-75% RDF + FYM + $ZnSO_4$ + Boron + LFA	20.0	70.00	44.37
SED	0.5	1.75	1.11
CD (P=0.05)	1.05	3.68	2.35

Table 3: Effect of organic and inorganic sources of nutrients on pod and haulm yield of groundnut in loamy sand soil

Treatments	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
T_1-Absolute control	1961	2715
T_2-RDF	2086	2944
T_3- RDF + Boron	2105	2986
T_4- RDF + $ZnSO_4$ + Boron	2130	3049
T_5- RDF+ FYM + Boron	2318	3378
T_6-RDF + FYM + $ZnSO_4$ + Boron	2412	3482
T_7-75% RDF + FYM + Boron + HA	2433	3525
T_8-75% RDF + FYM + $ZnSO_4$ + Boron + HA	2452	3580
T_9-75% RDF + FYM + Boron + LFA	2295	3255
T_{10}-75% RDF + FYM + $ZnSO_4$ + Boron + LFA	2297	3316
SED	58.3	85.2
CD (P=0.05)	122.5	179

Pod and haulm yield

Among 75% RDF and HA treatment combination and overall, application of 75% RDF + FYM + Boron + HA (T_8) recorded (Table 3) the highest pod and haulm yield of 2452 and 3580 kg ha^{-1} in loamy sand soil. This was followed by T_7 recorded pod and haulm yield of 2433 and 3525 kg ha^{-1}. Regarding 100% RDF treatment combination, application of 100% RDF + FYM + $ZnSO_4$ + Boron (T_6) recorded maximum pod and haulm yield of 2412 and 3482 kg ha^{-1}. The treatment T_3 and T_4 values were found to be on par with each other. Application of 100% RDF alone (T_2) recorded pod and haulm yield of 2086 and 2944 kg ha^{-1}. Among 75% RDF levels with addition of LFA treatment combination, 75% RDF + FYM + $ZnSO_4$ + Boron + LFA (T_{10}) recorded maximum pod and haulm yield of 2297 and 3482 kg ha^{-1}. Among 10 treatment combination, treatment T_1 (absolute control) recorded the lowest pod and haulm yield of 1961 and 2715 kg ha^{-1}. The increase in pod yield of groundnut due to recommended dose of fertilizer application with combination of organic and inorganic sources of nutrients may be attributed to enhanced synthesis of carbohydrates and proteins. Similar results were obtained by Das *et al*. (2009) [4]. Conjunctive use of organics and inorganics produced better pod and haulm yields than only chemical fertilizers. This effect was attributed to an overall improvement in the physical properties of soil and increased availability of nutrients throughout the life cycle of crop. Mehta *et al*. (1996) [9], Balasubramanian (1997) Kathmale *et al*. (2000) [8], Kachot *et al* (2001) [7], Singaravel *et al*. (2006) [15] and Elayaraja and Singaravel (2007) [6] reported similar observations in groundnut.

The highest yield observed in the treatment T_8 might be due to mineralization of organic form of nutrients and better utilization of both macro and micronutrients fertilizers in the presence of organics. The application of micronutrients and organics helped in the slow and steady rate of nutrient release in to soil solution to match the required absorption pattern of groundnut there by increased the yield. This corroborates the earlier report of Srivastava (2002) [17]. The production of organic acids and growth promoting substances during decomposition of organics might have facilitated easy availability of macro as well as micronutrients. Adequate supplies of nutrients in turn were utilized for the formation of protoplasam, resulting in higher cell division and cell elongation. Thus an increase in yield parameters might have been obtained on account of overall improvement in the vegetative growth of the plant and ultimately reflected on the yield. Similar results in groundnut were also reported by Mehta *et al*. (1995), Anumarry *et al* (2000), Kachot *et al* (2001) [7], Devi *et al* (2003) [5] and Rajinikanth *et al* (2008) [13].

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