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EFFECT OF WATER SOLUBLE FERTILIZERS ON CHLOROPHYLL CONTENT AND NODULATION IN GROUNDNUT IN A VERTISOL OF NORTHERN TRANSITION ZONE OF KARNATAKA

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ABSTRACT

A field experiment was conducted at Main Agricultural Research Station (MARS), Dharwad to know the effect of water soluble fertilizers on chlorophyll content and nodulation in groundnut in a Vertisol of Northern transition zone of Karnataka. The experiment comprised of 10 treatments consisting of combination of FYM and various levels of recommended dose of NPK through soil application and foliar spray of soluble fertilizers at 30, 45 and 60 days after sowing (DAS). Chlorophyll content was increased with the foliar spray. At harvest, the treatment (T_6) receiving FYM + 100 % RDF + foliar spray of fertilizers recorded significantly higher chlorophyll content (47.26). After spray chlorophyll content of the leaf was more compared to before spray at all the growth stages. The maximum number of nodules were recorded in the treatment receiving FYM + 100 % RDF + foliar spray of fertilizers (31.75 and 39.35 at 45 and 60 DAS, respectively). But the results were on par with the treatment T_8 which received FYM + 85 % RDF + foliar spray of fertilizers at 30, 45 and 60 Days after sowing. Therefore, It was concluded that RDF can be reduced to 85 % by supplying nutrients through organics and foliar spray. soil application of organic and inorganic nutrients along with foliar spray of nutrient results in improvement in chlorophyll content and nodulation.

KEY WORDS
Water soluble fertilizers
Foliar spray
Chlorophyll content
SPAD value

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INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an annual legume. Commercially, groundnut is the world's fourth most important source of edible oil and third most important source of vegetable protein. The groundnut productivity in Karnataka is low which could be attributed to several production constraints, which include poor and imbalanced nutrition of crop and growing crop on marginal lands. Therefore, it is most essential to pay a great attention to the nutrition of the groundnut to enhance its productivity. Groundnut is called a self fertilizing crop, nevertheless, it is very exhaustive crop compared to other legumes because a very little portion of the plant residue is left in the soil after harvest (Varade and Urkude, 1982). An average crop of groundnut yielding 19 q ha^{-1} removes about 170 kg N, 30 kg P, 110 kg K, 39 kg Ca and 15 kg S from the soil (Aulakh *et al.* 1985). Therefore, cultivation of groundnut depletes the soil fertility rapidly unless the crop is adequately fertilized. So, balanced use of macro and micronutrients is must for enhancing the groundnut production.

True to the name "Unpredictable legume", the response of groundnut to applied fertilizers has always been highly varying in respect of location, season and soil. Groundnut being an oil seed crop, is considered heavy feeder of nutrients. To realize the higher yields, it is very much essential to supply adequate but balanced amounts of major and micronutrients. The nutrient requirement of groundnut is high especially at pegging and pod development stages. The requirement at these stages cannot be fulfilled merely by soil application alone and need to be supplemented through foliar application.

Applied Fertilizers are subjected to different losses viz., Nitrogenous fertilizer is subjected to leaching losses along with other basic cations. Secondly, the bulk of the applied P fertilizer is fixed and is rendered unavailable to plants. Thirdly, the use efficiency of applied micronutrients is also low due to their precipitation into insoluble forms. Because of these reactions, the use efficiency of applied fertilizers is low and soil application of nutrients may not produce desirable yields. Under these conditions foliar application seems to be promising for ensuring use efficiency of applied nutrients. Foliar spray enables plants to absorb the applied nutrients from the solution through their leaf surface and thus, may result in the economic use of fertilizer. Foliar absorption is most effective when plants grow vigorously and the rate of absorption is generally higher in younger points of branches or stem tips (Mitsui., 1967).

Groundnut being a leguminous crop, fixes substantial quantity of atmospheric nitrogen. So, the application of full dose of N may not be required. Usually phosphorus requirement is high at initial stages particularly for root development. But the response of crops to the applied P fertilizers is not encouraging particularly in medium to high P status soils. University farm soils receive full dose of fertilizers

every year. So, there is a buildup of nutrient status in soil. Therefore, application of P fertilizers can be reduced in medium to high P status soils. Moreover, this experiment was conducted in potash rich soils, application of full dose of potassic fertilizers may not be required. Application of recommended dose of FYM also leads to the supply of all essential nutrients in minute quantities besides improving the soil physical properties. Further, foliar application ensures the supply of nutrients as and when they are required by crop. So, application of full dose of fertilizers may be reduced to reduce cost of cultivation. Keeping this in view, the present investigation was planned to study the effect of water soluble fertilizers on chlorophyll and nodulation in groundnut in a Vertisol of Northern transition zone of Karnataka.

MATERIALS AND METHODS

A field experiment was conducted at Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad, (Karnataka) during rabi/summer season 2012. The soil was texturally clay, neutral in pH, non saline (0.61 dSm^{-1}), medium in organic carbon, low in available nitrogen (237 kg N ha^{-1}) medium in available phosphorus (34.6 kg P_2O_5 ha^{-1}) and high in available potassium (470 kg K_2O ha^{-1}). The soil was sufficient in all micro nutrients Fe (3.84 mg kg^{-1}), Cu (0.51 mg kg^{-1}), Mn (5.60 mg kg^{-1}) except zinc (0.58 mg kg^{-1}). A randomized complete block design with three replications for ten treatment combinations was followed by using the groundnut cultivar TAG24. Treatments include combination of various levels of recommended dose of NPK and FYM through soil application at the time of sowing and foliar spray of fertilizers at 30, 45 and 60 Days after sowing (DAS). Foliar application includes starter dose of water soluble grade fertilizer (11:36:24 + trace elements) @2 % at 30 days after sowing(DAS) + Foliar application of booster dose of water soluble grade fertilizer (8:16:39+ trace elements) @ 2 % at 45 DAS and 60 DAS. Trace elements in the foliar mixture were Fe - 800 ppm, Mn - 400 ppm, Zn - 200 ppm, Cu - 50 ppm and Mo-50 ppm. Treatments include T_1 = Absolute control (NO FYM, NO RDNPK and no foliar application of water soluble grade fertilizers, only water spray), T_2 = 100% Recommended dose of fertilizers(RDNPK) (25 kg N, 75 kg P_2O_5 and 25 kg K_2O / ha) + water spray, T_3 = Foliar application of water soluble grade fertilizers @ 2%, T_4 = 100% RDNPK+ foliar application of water soluble grade fertilizer @ 2 %, T_5 = FYM@ 7.5 t/ha + 100% RDNPK+ water spray, T_6 = FYM@ 7.5 t/ha + 100% RDNPK + foliar application of water soluble grade fertilizer @ 2 %, T_7 = FYM@ 7.5 t/ha + 85% RDNPK + water spray, T_8 = FYM@ 7.5 t/ha + 85% RDNPK+ foliar application of water soluble grade fertilizer @ 2 %, T_9 = FYM@ 7.5 t/ha + 60% RDNPK + water spray, T_{10} = FYM@ 7.5 t/ha + 60% RDNPK+ foliar application of water soluble grade fertilizer @ 2 %. Chlorophyll content was measured before and after each spray by using SPAD meter. Soil pH was measured by pH meter (1:2.5 soil: water suspension), electrical conductivity by conductivity meter (Sparks, 1996), organic carbon by rapid titration method (Sparks, 1996). Available N was estimated by alkaline permanganate method (Sharawat and Burford,1982), available P by Olsen's method, available K by ammonium acetate extraction method and available S was estimated by turbidimetric method as described by (Sparks, 1996). The Available micronutrients was extracted with DTPA and determined by atomic absorption spectrophotometer as described by (Lindsay and Norvell, 1978). The analysis of variance was carried out using the randomized complete block design (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Chlorophyll content of leaf (SPAD value)

The growth of groundnut is intense from 30 to 70 DAS (Bewali *et al.*, 1980) as evident from the growth partameters. Therefore, synchronizing the nutrient supply at these stages through foliar application resulted in higher growth and consequently higher accumulation of nutrients. The chlorophyll content of leaf differed significantly due to soil and foliar application of fertilizers at all the crop growth stages 30, 45, 60 DAS and at harvest. Chlorophyll content was increased with the foliar spray. At harvest, the treatment (T_6) receiving FYM + 100 % RDF + foliar spray of fertilizers recorded significantly higher chlorophyll content (47.26). It was lowest in the treatment (T_1) which received no fertilizer (36.33). However, the treatments T_8 (45.18) and T_4 (45.45) were on par with T_6 (Table 1 and Fig. 1).

Chlorophyll content of the leaf before and after spray also differed significantly due to foliar application at 30, 45 and 60 DAS. After spray chlorophyll content of the leaf was more compared to before spray. The treatment (T_6) receiving FYM + 100 % RDF + foliar spray of fertilizers recorded significantly higher chlorophyll content both before spray (37.99, 41.60 and 47.92 at 30, 45 and 60 DAS, respectively) after spray (38.23, 43.87 and 49.22 at 30, 45 and 60 DAS, respectively). It was lowest in the treatment (T_1) which received no fertilizer. The chlorophyll content increased due to foliar application of fertilizers. The treatment receiving (T_6) FYM + 100 % RDF + foliar spray of fertilizers produced higher chlorophyll content at harvest (47.26) compared to 100 % RDF (39.65). However, the treatments T_8 (45.18) and T_4 (45.45) were on par with T_6. This might be due to foliar application of iron might have helped in formation of chlorophyll and increased the enzyme activities which resulted in higher photosynthesis. Paliwal *et al.* (2004) opined that iron serves as catalyst in the formation of chlorophyll. Importance of zinc and iron in increasing

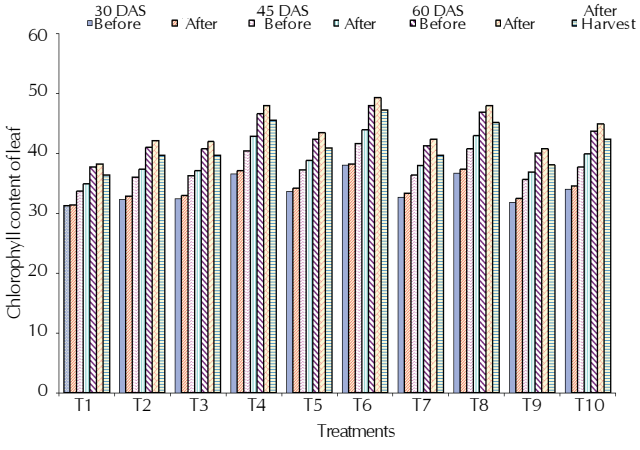

Figure 1: Chlorophyll content of leaf of groundnut as influenced by soil and foliar application of fertilizers at different growth stages

Table 1: Chlorophyll content of groundnut leaf (spad values) as influenced by soil and foliar application of fertilizers at different growth stages

Treatment details	Chlorophyll content of leaf						
	30 DAS		45 DAS		60 DAS		Harvest
	Before spray	After spray	Before spray	After spray	Before spray	After spray	
T_1 : Absolute control	31.25 b	31.32 c	33.69 c	34.90 d	37.65 d	38.13 d	36.33 e
T_2 : 100% RDF	32.27 ab	32.83 bc	35.94 c	37.33 b-d	40.94 cd	42.05 b-d	39.65 c-e
T_3 : Foliar application of water soluble grade fertilizers @ 2%	32.38 ab	32.94 bc	36.18 c	37.12 cd	40.79 cd	41.96 b-d	39.60 c-e
T_4 : 100% RDF + foliar spray	36.53 ab	37.09 ab	40.35 ab	42.78 a-c	46.62 ab	47.89 ab	45.45 ab
T_5 : FYM + 100% RDF + water spray	33.61 ab	34.16 abc	37.27 bc	38.84 a-d	42.28 b-d	43.37 a-d	40.84 cd
T_6 : FYM + 100% RDF + foliar spray	37.99 a	38.23 a	41.60 a	43.87 a	47.92 a	49.22 a	47.26 a
T_7 : FYM + 85% RDF + water spray	32.71 ab	33.27 bc	36.38 c	37.91 b-d	41.23 cd	42.28 b-d	39.70 c-e
T_8 : FYM + 85% RDF + foliar spray	36.72 ab	37.28 ab	40.74 ab	42.98 ab	46.82 ab	47.98 ab	45.18 ab
T_9 : FYM + 60% RDF + water spray	31.80 ab	32.50 bc	35.61 c	36.87 d	39.96 cd	40.70 cd	38.09 de
T_{10} : FYM + 60% RDF + foliar spray	33.98 ab	34.54 abc	37.65 bc	39.89 a-d	43.73 a-c	44.89 a-c	42.36 bc
Mean	33.9	34.4	37.5	39.2	42.8	43.8	41.4
SEm ±	1.93	1.41	1.18	1.72	1.47	1.96	1.24
LSD (p=0.05)	5.74	4.20	3.51	5.10	4.38	5.84	3.68

Note : Recommended dose of fertilizers : 25: 75:25 kg N, P_2O_5, K_2O/ha. FYM : 7.5 t/ha. Foliar application of starter dose of water soluble grade fertilizer (11:36:24 + Trace elements) @2.00% at 30 days after sowing (DAS) + Foliar application of booster dose of water soluble grade fertilizer (8:16:39+ Trace elements) @ 2.00% at 45 DAS and 60 DAS. In a column mean values followed by the common letter are not significantly different at p = 0.05 level (DMRT at 5 % level). **DAS**: Days after sowing

Table 2: Number of nodules and dry weight of nodules of groundnut as influenced by soil and foliar application of fertilizers at different growth stages

Treatment details	Number of nodules plant^{-1}		Dry weight of nodules (g plant^{-1})	
	45 DAS	60 DAS	45 DAS	60 DAS
T_1 : Absolute control	21.75 g	28.85 g	0.24 a	0.35 a
T_2 : 100% RDF	25.28 d-f	32.95 d-f	0.28 a	0.40 a
T_3 : Foliar application of water soluble grade fertilizers @ 2%	22.83 f-g	30.77 fg	0.25 a	0.37 a
T_4 : 100% RDF + foliar spray	29.43 a-c	36.42 a-c	0.33 a	0.44 a
T_5 : FYM + 100% RDF + water spray	27.88 b-d	35.55 b-d	0.31 a	0.43 a
T_6 : FYM + 100% RDF + foliar spray	31.75 a	39.35 a	0.35 a	0.47 a
T_7 : FYM + 85% RDF + water spray	26.58 c-e	34.25 c-e	0.30 a	0.41 a
T_8 : FYM + 85% RDF + foliar spray	30.58 ab	37.92 ab	0.34	0.46 a
T_9 : FYM + 60% RDF + water spray	23.67 e-g	31.25 e-g	0.26 a	0.38 a
T_{10} : FYM + 60% RDF + foliar spray	24.58 e-g	32.08 ef	0.27 a	0.39 a
Mean	26.4	33.9	0.29	0.41
S.Em ±	1.00	1.46	0.01	0.02
LSD (p=0.05)	2.98	4.33	NS	NS

Note : Recommended dose of fertilizers : 25: 75:25 kg N, P_2O_5, K_2O/ha. FYM : 7.5 t/ha. Foliar application of starter dose of water soluble grade fertilizer (11:36:24 + Trace elements) @2.00% at 30 days after sowing (DAS) + Foliar application of booster dose of water soluble grade fertilizer (8:16:39+ Trace elements) @ 2.00% at 45 DAS and 60 DAS. In a column mean values followed by the common letter are not significantly different at p = 0.05 level (DMRT at 5 % level). DAS: Days after sowing.

chlorophyll content in leaves was reported by Wu and Xiao (1995).

Nodulation

Number of nodules

The number of effective nodules differed significantly due to soil and foliar application of fertilizers to groundnut. The maximum number of effective nodules was recorded in the treatment receiving FYM + 100 % RDF + foliar spray of fertilizers (31.75 and 39.35 at 45 and 60 DAS, respectively). Number of nodules was lowest (21.75 and 28.85 at 45 and 60 DAS, respectively) in the treatment (T_1) which received no fertilizer. However, the treatments T_8 and T_4 were on par with T_6 (Table 2). This may be due to combined application NPK and FYM as reported by Rayar (1986), Geethalakshmi *et al*. (1993) and Manisha Basu *et al*. (2008). The increased nodules plant^{-1} may be due to application of molybdenum through foliar spray reported by Das (1993). He observed that the foliar application of Zn, B, Mo to groundnut at 30 and 45 DAS increased the vegetative growth, Mo increased nodule number and Zn increased the flower number, pod number, pod weight and kernel weight.

Dry weight of nodules (g plant^{-1})

The dry weight of nodules differed numerically due to soil and foliar application of fertilizers at 60 DAS and at harvest. But the differences among the treatments were statistically non significant.

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