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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(3): 1166-1169

www.thepharmajournal.com
Received: 02-12-2021
Accepted: 08-01-2022

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Foliar application of urea and micronutrients on growth, yield and soil chemical properties after harvest of groundnut in loamy sand

DK Patel, JK Malav, GI Chaudhari and DM Patel

Abstract
A field experiment entitled "foliar application of urea and micronutrients on growth, yield attributes and yields of groundnut in loamy sand" was conducted at Agronomy Instructional Farm, C. P. College of Agriculture, S.D. Agricultural University, Sardarkrushinagar, Gujarat during summer season of 2019-20. Total eight treatments *viz*., Control/RDF (T_1), T_1 + 1.5% Urea spray at 35 DAS (T_2), T_1 + 1.5% Urea spray at 50 DAS (T_3), T_1 + 1.5% Urea spray at 35 DAS and 50 DAS (T_4), T_1 + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS (T_5), T_1 + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS and 50 DAS (T_6), T_1 + 1.5% Urea spray + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS (T_7), T_1 + 1.5% Urea spray + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS and 50 DAS (T_8) were laid out in randomized block design with four replications. The results reveal that application of RDF + 1.5% Urea spray + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS and 50 DAS significantly increased the no. of pods/ plant, pod yield/ plant (g), pod yield (kg ha^{-1}) and haulm yield (kg ha^{-1}). Available nitrogen, P_2O_5, K_2O, DTPA extractable Fe & Zn content in soil after harvest of crop did not differ significantly due to by foliar application of urea and micronutrients.

Keywords: Urea, $FeSO_4$, $ZnSO_4$, groundnut, yield

Introduction
Groundnut (*Arachis hypogaea* L.) is an important summer oilseed crop and food grain legume, groundnut cultivation occurs in 108 countries around the world, which is grown in all tropical and sub-tropical countries. It is a valuable cash crop planted by millions of small farmers because of its economic and nutritional value. About two thirds of world production is crushed for oil and remaining one third is consumed as food. It is important oilseed crop belong to family leguminosae and popularly called as POOR MAN'S ALMOND. Groundnut cakes obtained after oil extraction is a high protein animal feed. It contains about 50 per cent oil, 25 to 30 per cent protein, 20 per cent carbohydrate and 5 per cent fiber and ash which make a substantial contribution to human nutrition. Besides, it's a valuable source of vitamins 'E,' 'K' and 'B.' It is the richest plant source of thiamine and is also rich in niacin, which is low in cereals. Commercially, groundnut is the world's fourth most important sources of edible oil and third most important sources of vegetable protein. The groundnut crop is grown over an area of 26.62 million ha spread over 84 countries with an annual production of 35.66 million tonnes of pods with a productivity of 1348 kg ha^{-1}. In India, it is being cultivated in 11 states, the area, production and productivity of groundnut is 4.56 million hectares, 6.77 million tonnes and 1486 kg ha^{-1}, respectively. Whereas, the area, production and productivity of groundnut in Gujarat is 1.4 million hectares, 2.36 million tonnes and 1668 kg ha^{-1}, respectively (Directorate of Economics and Statistics, DAC and FW, 2016) [2]. Foliar nutrition is an effective method for correcting deficiencies and overcoming the soil's inability to transfer nutrients to the plant. Availability of essential nutrients and trace minerals from the soil may be limited at times by root distribution, soil temperature, soil moisture, nutrient imbalances, *etc.*, foliar nutrition helps to maintain a nutrient balance within the plant, which may not occur with soil uptake (Meena *et al.*, 2007) [9]. The effectiveness of foliar applied nutrients is determined by the type of formulation and the time of application. Foliar nutrition is 8 to 10 times more effective than soil application. Foliar spray stimulates chlorophyll production, cellular activity and respiration. It also triggers a plant response to increased water and nutrient uptake from the soil (Veeramani *et al.*, 2012) [13].
Nitrogen is an essential component of many compounds of plant, such as chlorophyll, nucleotides, proteins, alkaloids, enzymes, hormones and vitamins (Marschner, 1995) [8].

It increases the photosynthesis rate, metabolites synthesized and translocated assimilates to the seed. Nitrogen deficiency generally results in stunted growth, chlorotic leaves because lack of N limits the synthesis of proteins and chlorophyll, this leads to poor assimilate formation and results in premature flowering and shortening of the growth cycle.

Zinc is one of the most important essential nutrients required for plant growth. It acts as an activator of several enzymes in plants and is directly involved in the biosynthesis of growth substances such as auxin which is involved in plant growth and cell division. Zinc increases the resistance of plants to pathogens by bringing changes in anatomy and physiology of host plant. One of the major roles of micronutrients in plants is to associate with many enzyme systems which were involved in defense mechanism within plants against pathogens. In plant, the deficiency of zinc arises mainly due to alkaline soil pH, calcareousness, low organic matter, exposed sub soil, Zn free fertilizers and flooding induced electrochemical changes. Iron plays an important role in legume for nodulation and nitrogen fixation.

Materials and Methods

A field experiment was conducted at Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, Gujarat soil of experimental field was loamy sand in texture with slightly alkaline in reaction, electrical conductivity within safe limit (0.14 dSm^{-1}). The soil was low in organic carbon (0.23%), available nitrogen (158 kg ha^{-1}) and DTPA-extractable Zn (0.47 mg kg^{-1}); medium in available P_2O_5 (37.9 kg ha^{-1}), K_2O (186.0 kg ha^{-1}) and DTPA-extractable Fe (5.19 mg kg^{-1}). Total eight treatments *viz*., Control / RDF (T_1), T_1 + 1.5% Urea spray at 35 DAS (T_2), T_1 + 1.5% urea spray at 50 DAS (T_3), T_1 + 1.5% Urea spray at 35 DAS and 50 DAS (T_4), T_1 + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS (T_5), T_1 + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS and 50 DAS (T_6), T_1 + 1.5% Urea spray + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS (T_7), T_1 + 1.5% urea spray +0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS and 50 DAS (T_8) were laid out in randomized block design with four replications.

The experimental field was cultivated by tractor drawn cultivator and it was followed by harrowing and planking to obtain fine seedbed. Iron and zinc were applied in the form of ferrous sulphate and zinc sulphate, respectively as per the treatments. Recommended dose of nitrogen and phosphorus (25-50-00 kg NPK ha^{-1}) in the form of DAP and urea were commonly applied for all the plots. Full dose of phosphorus and nitrogen were applied as basal dose.

Groundnut cultivar TG 37-A was sown on 7th March, 2019 with recommended seed rate of 120 kg ha^{-1} by maintaining 10 cm distance within the rows. The seeds were sown manually to a depth of 3 to 4 cm in the previously opened furrows at a distance of 45 cm a part and covered properly with the soil and irrigated immediately.

Result and Discussion

Growth, yield attributes and yield

The data presented in Table 2 indicated that Plant height and number of branches per plant were not significantly influenced by foliar application of urea and micronutrients at all periodical growth stages. Number of pods per plant, pods yield per plant, pod yield and haulm yield of groundnut were found significant as influenced by foliar application of urea and micronutrients. Results revealed that significantly the highest number of pods per plant (43.97), pods yield per plant (34.54 g), pod yield (2173 kg ha^{-1}) and haulm yield (3797 kg ha^{-1}) were noted by the application of RDF + 1.5% urea spray + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS and 50 DAS (T_8); but, it was at par with the treatment T_6 (T_1 + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS and 50 DAS) and T_7 (T_1 + 1.5% Urea spray + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS). Application of RDF (T_1) registered lower number of pods per plant (33.13) and pod yield per plant (25.90 g), pod yield (1768 kg ha^{-1}) and haulm yield (3141 kg ha^{-1}) of groundnut. Application of RDF + 1.5% urea spray + 0.5% $FeSO_4$ and $ZnSO_4$ at 35 DAS and 50 DAS (T_8) has resulted in the increase in mean pod and haulm yields by 22.90 and 17.51 per cent, respectively over control.

The increase in the plant height in all the foliar nutrition treatments was due to increased cell division and cell elongation at higher level of nutrients. The micro nutrients that the plant needs in small amounts play an important role in the metabolic processes that take place inside the plant. Therefore, it is important not only to improve plant growth but also to improve human health. The combined spray of N, P and K resulted in greater mobilization of macro nutrients in groundnut as reported by Manasa (2013) [7]. Kobraee *et al*. (2011) [4] reported that Fe foliar application increased grain yield by influencing amount of seeds per plant and seed weight of soybean. Urea spray improves the permeability of the cuticle and favours diffusion conditions. Hence, it reduces the flower drop and ultimately enhances pegging and pod development.

The similar observations were made by Naveen Kumar (2012) [10], who noticed that basal application of NPK along with foliar spray of urea at 45 DAS recorded improvement in yield components such as number of pods $plant^{-1}$, pod dry weight, 100 pod weight and higher 100 kernel weight. Application of recommended dose of fertilizers along with foliar application of nutrients at critical stages boosted the growth and yield components (Chandrasekaran *et al*., 2008) [3]. Iron is a structural component of porphyrin molecules: cytochromes, hemes, haematin, ferrichrome and leghemoglobin. These substances are involved in oxidation reductions in respiration and photosynthesis. It performs an essential role in nucleic acid metabolism. It is essential, for many of the enzymatic transformations. Thus iron helps indirectly in crop production. Likewise, zinc is also involved in many enzymatic activities. It is important in the synthesis of tryptophan, a component of some proteins and a compound needed for the production of growth hormones like indole acetic acid. Foliar application resulted in greater absorption, assimilation, translocation of nutrients and photosynthesis. Increased production of dry matter and its efficient translocation to its economic parts ultimately reflected in the final pod yield. The quantity of nutrients absorbed by roots at peak period of nutrient requirement may not be sufficient to meet the needs at pod development stage. Supplementing nutrients through foliage might have resulted in better nutrient balance in the plants leading to increased yield components. Economic benefits ultimately are the matters for farmers. The maximum improvement in grain and biological yields with all the foliar sources might be associated with increased yield attributes due to concomitant increase in dry matter accumulation (Kumawat *et al*., 2009) [5].

Ali and Mowafy (2003) [1] observed that application of foliar spray with Zn (2%) slightly improved peanut yield and it's attributes as well as quality. In addition, zinc application positively affects the start of root nodules formation of groundnut and influences root nodule's performance consequently in increase of biological nitrogen fixation. Also, zinc helps to better nitrogen absorption from soil by plant (Malewar *et al*., 1993 and Rekhi *et al.*, 2000) [6, 11].

The pod yield is an end product, which obviously depends upon the total dry matter production at different stages of crop growth and its partitioning into reproductive parts for higher production. The improvement in the dry matter production might be due to the instant assimilation of nutrients supplied through the foliar application meeting the required nutrient demand of the crop during flowering period of groundnut. Foliar application resulted in greater absorption, assimilation and translocation of nutrients for increased photosynthesis. Increased production of dry matter and its efficient translocation to its economic parts ultimately reflected on the final pod yield. Enhanced dry matter production might be due to improvement in nutrient uptake particularly iron and zinc along with NP that have favorably influenced on carbohydrate metabolism and favorable sustained availability of nutrients that increased transformation of photosynthetic activity towards growing plant parts. Similar findings were observed by Thomas *et al*. (2010) [12].

Table 1: Physico-chemical properties of the experimental field

[A]	Chemical properties			
	(a)	Soil $pH_{2.5}$	7.42	Potentiometry, Jackson (1973)
	(b)	$EC_{2.5}$ (dSm^{-1})	0.14	Conductometry, Jackson (1973)
	(c)	Organic carbon (%)	0.23	Modified Walkley and Black method Walkley and Black (1934)
	(d)	Available N (kg ha^{-1})	158.0	Alkaline $KMnO_4$ method Subbiah and Asija (1956)
	(e)	Available P_2O_5 (kg ha^{-1})	37.9	Olsen's method (0.5 M $NaHCO_3$, pH 8.5) Olsen *et al.* (1954)
	(f)	Available K_2O (kg ha^{-1})	186.0	Flame photometry method Jackson (1973)
	(g)	DTPA-extractable Fe (mg kg^{-1})	5.19	Atomic Absorption Spectroscopy method (0.005 M DTPA, pH 7.3) Lindsay and Norvell (1978)
	(h)	DTPA-extractable Zn (mg kg^{-1})	0.47	

Table 2: Growth, yield attributes and yields of groundnut as influenced by foliar application of urea and micronutrients

Treatments	Plant height (cm)			No. of branches/ plant	No. of Pods/ plant	Pod yield/ plant (g)	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
	30 DAS	60 DAS	At harvest					
T_1	8.48	18.37	43.38	6.09	33.13	25.90	1768	3141
T_2	10.11	19.13	45.38	6.20	34.68	29.24	1772	3203
T_3	9.72	20.55	48.82	6.40	37.06	29.05	1806	3268
T_4	10.04	19.45	50.25	6.71	36.80	28.04	1844	3293
T_5	9.96	19.06	48.54	6.30	37.23	29.95	1957	3284
T_6	10.36	20.04	50.42	6.90	42.19	31.71	2016	3450
T_7	10.52	20.46	50.95	7.07	43.04	32.91	2136	3691
T_8	10.83	20.70	51.16	7.38	43.97	34.54	2173	3797
S.Em.±	0.47	0.95	2.10	0.32	1.68	1.41	66	150
C.D. (P = 0.05)	NS	NS	NS	NS	4.94	4.16	195	440
C.V. (%)	9.43	9.62	8.64	9.51	8.71	9.38	6.84	8.83

Table 3: Available nitrogen, P_2O_5 and K_2O content, DTPA extractable Fe and Zn content in soil after harvest of groundnut as influenced by foliar application of urea and micronutrients

Treatments	Available macronutrients (kg ha^{-1})			DTPA extractable micronutrients (mg kg^{-1})	
	N	P_2O_5	K_2O	Fe	Zn
T_1	143.30	30.85	164	5.28	0.44
T_2	139.78	27.81	165	5.26	0.48
T_3	146.14	31.48	166	5.43	0.46
T_4	131.42	29.42	164	5.63	0.47
T_5	146.25	30.22	163	5.28	0.48
T_6	135.84	32.05	163	5.56	0.48
T_7	163.24	30.57	162	5.31	0.51
T_8	158.10	32.48	172	5.39	0.52
S.Em.±	7.39	1.70	10	0.31	0.02
C.D. (P = 0.05)	NS	NS	NS	NS	NS
C.V. (%)	10.16	11.10	12.03	11.65	9.13

Available nutrient status after the harvest of Ground nut

The data given in table 3 indicated that available macronutrients and micronutrients content in soil after harvest of groundnut were not significantly influenced by foliar application of urea and micronutrients.

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