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NUTRIENT UPTAKE - POD YIELD RELATIONSHIP DUE TO MACRO AND MICRONUTRIENTS IN RAINFED SPANISH GROUNDNUT

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Two field experiments were conducted on rainfed Spanish groundnut to study the individual and combined effects of P, Ca and S in addition to B and Mo on the yield of unshelled nuts and nutrient uptake. Among the P sources, single super phosphate was superior to dihydrogen sodium phosphate in increasing the yield of unshelled nuts. Either a farm mixture of CaO + elemental S or gypsum was equally effective as a source of Ca and S. The synergistic effect of Ca + S was more pronounced than their individual effect on yield and nutrient uptake. Application of a farm mixture of Ca + S or gypsum to NPK increased the yield and nutrient uptake significantly. Maximum nutrient uptake was with DHSP + NK + gypsum or with SSP + NK at the same level of Ca + S. Fertilization of B and Mo neither increased the uptake of nutrients nor yield of unshelled nuts. It was observed that the crop yield was closely related to the nutrient uptake. The nutrients removed for production of one tonne of unshelled nuts and one and half tons of haulm were 71.5, 8 0, 16.5 27.9, and 5.5 kg of N, P, K, Ca and S respectively.

Groundnut (*Arachis hypogea* L) being a legume and an oilseed, requires not only adequate, P, Ca and S but also B and Mo for incr.asing the activity and multiplication of bacteria to fix the atmospheric nitrogen in the root nodules (Pandey, 1969). Groundnut crop removed 63.0 kg N, 4.8 kg P, 38.2 kg K, 27.0 kg CaO and 14.0 kg MgO for every one tonne of unshelled nuts and two tonnes of haulm (Collins and Morris, 1941). Sichmann *et al.* (1970) reported that from one hectare, unshelled nuts of groundnut crop removed 50.0 kg Ca and 7.5 kg S while they removed 11.3 kg Ca and 16.0 kg S. Uptake of nutrients by groundnut crop was shown to be related to the crop yield by Muralidharan and George (1974). Groundnut plant is rather sensitive to an imbalanced nutrient supply and this is responsible for conflicting results of fertiliser trials.

Research during recent years has provided an increasing evidence that substantial yield increase can be achieved through P, Ca and S fertilisation to groundnut. The source of P most commonly adopted in the expriments is single super phosphate (SSP) which not only contains 16% P_2O_5 but also 89.5% Ca, 12.5% S and micronutrients like B. Mo and a few others as impurities. It is often attributed that the increase in yield is due to P in SSP but no attention has been paid to separate out the effects of Ca and S.

Adequate Ca is absolutely essential to produce high yield of good quality nuts and its deficiency in groundnut is reflected by unfilled pods known as 'Pops' (Harls, 1968). Sulphur is more often deficient in soil for groundnut production than any other nutrient. Information are meagre on the requirements of Ca, S and micro-nutrients and also the combined and individual effects of P, Ca and S. Hence, an investigation was carried out to find out the individual and combined eff-

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ects of P, Ca, S and sources of these nutrients on yield and uptake of the major nutrients (N, P, K, Ca and S) in rainfed Spanish gronudnut (TMV 2).

MATERIALS AND METHODS

Field experiments were conducted at Tirupathi campus of the Andhra Pradesh Agricultural University during Kharif 1975 and 1976 under rainfed conditions. During the crop period, there was a rainfall of 559 mm in 33 days and 542 mm in 31 days in 1975 and 1976 respectively compared to 515 mm in 22 days and 565 mm in 29 days being the respective decennial average for the corresponding periods. A serious and a long drought spell occuried in 1976 between 6-9-1976 to 14-10-1976.

The soil was sandy loam (22.2% coarse sand, 55.0% fine sand, 10.0% silt and 1.5% clay) with low in organic carbon) 0.33 to 0.46%), low to medium in available P (9 to 15 kg/ha), low in available K (96 kg/ha), exchangeable calcium (2.20 m. e /100 g soil), acetate soluble sulphate (0.003%)) and available boron (1.7 ppm). The soil was having a pH of 6.0.

There were 12 treatments (Table 1) in 1975 and 14 treatments Table 2) with two additions in 1976 to elucidate further information. The experiment was coducted in a randomised block design with four replications. The treatments were essentially designed to partition the individual effects of P, Ca and S because SSP which is generally considered as a source of P is also a source of Ca and S. Hence different sources of P with and without Ca + S were used. There was uniform application of 20 kg N and 17 kg K/ha to all the treatments. Wherever P, Ca and S were included, a dose of 20 kg P, 45 kg Ca and 30 kg S per ha was used. N and K were applied in the form of urea and muriate of potash respectively. P was applied through single super phosphate (SSP) and disodium hydrogen orthophosphate (DS-HP). The nutrient carriers for Ca, S, B and Mo were calcium oxide (71.4% Ca), elemental sulphur powder (99.4% S) borax and ammonium molybdate respectively. In addition, Ca+S mixture and gypsum were also used as a source of Ca and S. Groundnut TMV-2 was sown in rows with 15 x 15 cm spacing. The uptake of N. P. K. Ca and S was calculated.

RESULTS AND DISCUSSION

There was significant variation in N uptake due to application of different nutrients Maximum N uptake (121.4 and 75.6 kg/ha in 1975 and 1976 respectively was observed in NPK + gypsum in both the years and least (39.0 kg/ha) in no fertilization. The uptake in NP (SSP), K was on par with NPK + gypsum in both the years. Combined use of Mo or B with NPK had no effect over NPK on nitrogen uptake. Addition of any source of P to NK significantly increased the N uptake. Of the P sources, SSP was superior to DSHP during both the years. Application of farm mixture of Ca + S to NPK significantly increased the uptake in 1975 but during 1976 this did not. Individual application of Ca or S with NPK did not influence N uptake but NPK + gypsum was better during both the years. The differential response due to Ca and S in different sources may be due to differences in

Table 1 : Nutrient uptake (kg/ha) at maturity, pod and haulm yields of groundnut (1975)

Treatments	N	P	K	Ca	S	Yield (kg/ha)	
						Pod	Haulm
T_1—Control	38.5	4.7	7.9	16.9	3.0	578	670
T_2—NPK*	112.5	12.9	19.5	46.5	7.8	1467	1611
T_3—NPK	91.8	11.4	18.9	41.3	7.1	1305	1695
T_4—NPK+Ca	103.4	12.0	18.2	45.5	7.1	1298	1669
T_5—NPK+S	92.6	11 2	18.6	42 9	7.1	1314	1681
T_6—NPK+Ca+S	102 7	15.7	21.3	51.0	8.7	1587	1840
T_7—NPK+Gypsum at 150 kg/ha	121.4	13.7	21.8	52.9	8.7	1477	1888
T_8—NPK+Borax @ 5 kg/ha	87.2	11.1	20.0	38.8	6 9	1279	1597
T_9—NPK+Borax + 10 kg/ha	98.6	11.4	18.3	45.1	7.5	1423	1834
T_{10}—NPK+ammonium molybdate @ 0.5 kg/ha	91 8	10.6	17.9	40.5	6.9	1295	1701
T_{11}—NPK+ammonium molybdate @ 1.0 kg/ha	93.5	10.9	20.4	40.0	7.4	1304	1659
T_{12}—NK	70 4	7.8	14 5	31.6	5.4	977	1311
LSD (5%)	15.8	1.9	3.6	5.1	2.6	70	171

*SSP was the source of P in T_2

DSHP was the source of P in rest of the treatments.

Table II : Nutrient uptake (kg/ha) at maturity, pod and haulm yields of groundnut (1976)

Treatments	N	P	K	ca	S	Yield (kg/ha)	
						Pod	Haulm
T_1—Control	38.9	4 1	12.9	12.7	2.6	570	790
T_2—NPK*	70.8	7.7	19.5	20 6	5.2	893	1207
T_3—NPK	55.5	6 9	16 9	17.7	4.3	733	981
T_4—NK+Ca	39.6	4 4	12.7	12.6	2.7	576	823
T_5—NPK+Ca	61.9	7.2	18.3	18 3	4.7	822	1069
T_6—NK+S	38.5	4.7	12.4	12.7	2.9	546	732
T_7—NPK+S	54.8	6 6	16.8	16.9	4.1	763	1060
T_8—NK+Ca+S	44.4	5 1	13.2	13.5	2.1	595	897
T_9—NPK+Ca+S	61.5	7 7	18.3	19.2	4.6	822	1189
T_{10}—NK+Gypsum @ 150 kg/ha	46 9	4.9	14.2	15.5	4.0	644	917
T_{11}—NPK+gypsum @ 150 kg/ha	75.6	8.8	20 9	23.6	6.2	915	1216
T_{12}—NPK+gypsum @ 300 kg/ha	75.9	8.9	20.0	24.4	6.1	965	1274
T_{13}—NPK+borax @ 10 kg/ha	58.3	6 4	16.9	17.3	4.2	750	1016
T_{14}—NPK*+Borax @ 10 kg/ha	71.1	8.4	18.9	20.1	5.2	910	1201
LSD (5%)	11.3	1.6	2.1	5.3	1.0	160	183

*SSP was the source of P in T_2 and T_{14}

DSHP was the source of P in rest of the treatments.

solubility, availability, microbial activity and other soil factors further influenced by variation in rainfall and dry spells. Increased N uptake with P, Ca and S application have been reported by Nephape (1970) and Pasricha *et al.* (1972).

It was observed that in two years, irrespective of sources, addition of P resulted in its increased uptake. While application of Ca + S or gypsum to NPK increased uptake over NPK in first year but not in the second year. Maximum P uptake (8.9 kg/h) was in NPK + gypsum at 300 kg/ha which did not differ with NPK + gypsum at 150 kg/ha (8.8 kg/ha) or NP (SSP) K (7 7 kg/ha). There was no appreciable difference in uptake due to individual application of Ca or S to NPK but combined Ca + S application had more uptake. Hilgard (1970) reported increased availability of P with Ca application. In both the years, addition of Mo or B did not influence P uptake. SSP or gypsum application to NPK influenced more favourably the uptake which showed the superiority of chemically combined source of Ca and S in gypsum and SSP especially in a season of soil moisture deficiency due to illdistributed rainfall.

Potassium uptake was higher in NPK 18.9 and 16.9 kg/ha) than in no fertilization (7.9 and 12 9 kg, in 1975 and 1976 respectively. In 1975, individual and combined application of Ca + S or gypsum to NPK did not influence K uptake but P application was positive in increasing K uptake. In 1976, either application of a farm mixture of Ca + S or gypsum or P through SSP resulted in higher uptake of potassium. This may be due to lesser leaching of K in 1976, a season of ill-distributed rainfall. The increased uptake of K due to fertilization with P and Ca + S is not in consonance with the reports of Gidden and Perkins (1960).

Boron application had no effect in 1975 and year of well distributed rainfall but during 1976 where distribution of rainfall was not favourable, B application with NPK increased the K uptake probably due to lesser leaching.

There was no significant increase in Ca uptake (45.5 and 13.3 kg/ha) in 1975 and 1976 respectively due to Ca application with NPK in both the years over NPK (41 3 and 17.7 kg/ha). Sources of P did not influence Ca uptake appreciably in both the years. But application of Ca + S or gypsum to NPK considerably increased Ca uptake over NPK in both the years. However, the effect was significant only in 1975.

Individual application of Ca or S to NPK had no influence on Ca uptake in both the years. A consistant result could not be obtained due to lack of P which reduced Ca uptake considerably. The higher Ca uptake may be to higher Ca requirements for pod development. Micronutrient application did not influence calcium uptake.

It was observed that Ca uptake was increased only due to synergistic action of Ca + S and these results are in accordance with those reported by Pathak and Pathak (1972).

Sulphur uptake was significantly increased (7.1 and 4.3 kg/ha) due to NPK over fertilization (3.0 and 2.6 kg/ha) in 1975 and 1976 respectively, but not due to sulphur addition to

NPK (7.1 and 4.1 kg/ha). SSP and gypsum application resulted in higher uptake of sulphur but not due Ca application. There was significant increase in sulphur uptake due to gypsum application in 1976 where there was uneven distribution of rainfall. This indicates that gypsum was better source for sulphur in the year of restricted moisture supply. These results are in accordance with the reports of Pathak and Pathak (1972). Mo and B application had no effect on sulphur uptake

The yield and uptake of nutrients showed that the highest yield (1587 kg/ha) was obtained in the first year with NPK + Ca + S and in the second year with NPK + gypsum (965 kg/ha). The uptake of all the nutrients were higher in these treatments. In general there was a direct association between pod yield and nutrients uptake. The uptake of P, Ca and S were more wherever pod yield was higher. This was due to the synergistic influence of these on nutrient uptake and pod yield SSP was superior to DSHP in increasing the pod yield. Individual application of Ca or S to NPK neither increased the pod yield nor the uptake but either mixed Ca + S or gypsum application positively increased the uptake and yield. The three major nutrients of P, Ca and S were more effective when supplied through SSP or P + gypsum. Mixed application of Ca and S with NPK gave higher nutrient uptake and pod yield during 1975 an year where there was better distribution of rainfall but in 1976 gypsum application was superior showing that in years of restricted moisture supply gypsum is a better source.

On an average, the groundnut crop removed 71.5, 8.0, 16.5, 27.9 and 5.5 kg N, P, K, Ca and S respectively for every 1000 kg of unshelled nuts and 1500 kg of haulm.

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