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Combined effect of different plant nutrients of organic and inorganic sources on nutrient uptake and yield of groundnut crop

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Abstract A pot culture experiment was conducted to study the effect of combined use of organic manures with inorganic fertilizers on uptake of available nutrients and yield of groundnut crop at Tamil Nadu Agricultural College and Research Institute, Madurai during kharif season of 2008-2009. The experiment was laid out in completely randomized design (factorial) with two replications. Main pot treatments comprised of three types of manures *viz*, control (M_0), pressmud @ 5 t ha^{-1} (M_1), vermicompost @ 2 t ha^{-1} (M_2), farmyard manure @12.5 t ha^{-1} (M_3) and sub pot treatment comprised of 4 levels of K *viz*, 0 (K_0), 100 (K_1), 75 (K_2) and 50 kg of K_2O ha^{-1} (K_3) with a recommended dose of fertilizer (RDF) respectively. The results revealed that highest nitrogen, phosphorus and potassium uptake of 1.01, 0.96 and 0.80 g/pot was recorded in the treatment that received 75 kg K_2O ha^{-1} and Pressmud @ 5 t ha^{-1} (K_1M_1) and in the pots which treatment received K_1M_1 showed the highest Haulm and pod yield of (28.25 and 24.5 g/pot) of groundnut crop respectively.

Keywords: Groundnut crop, Inorganic plant fertilizers, organic manures, Uptake of nutrients Yield

INTRODUCTION

Groundnut being one of the important crops in Madurai district grows well in Madukkur soil series which happened to be the major soil series in the district. The bulk of oil production in India is derived from groundnut, rapeseed, sesame, sunflower, soyabean, sunflower and other minor oilseed crops, and among these crops, groundnut (*Arachis hypogaea* L) is the most dominant annual crop widely cultivated (Rathore and Kamble, 2008). From the nutritional point of view, oilseeds are important not only because they provide essential fatty acids mainly, but also due to their nutritive value in terms of other nutrients like carbohydrates, proteins, minerals and fat soluble vitamins (Singh *et al.*, 2011). About 76 per cent of the total oilseed production is used for edible purpose and the remaining for soap and lubrication products manufacture. Potassium occurs in the soil in varied form *viz*, water soluble K, exchangeable K (Kex), non-exchangeable K (Knex), mineral lattice K and total K. Because of the existence of different forms of K, compared to N and P its availability is reported to be complicated (Malligawad *et al.* 2000). The varied forms of potassium responsible for the availability and maintaining of potassium equilibrium in the soil, has been discussed by many scientists. Even though soils contain considerable amount of total K, the releasing and supplying power of soils in a given time is a limiting factor in most of the soils. The K releasing power of soils depends on number of factors, namely nature of soils, amount and type of clay minerals, CEC, soil pH and level of manuring. Keeping in view, the present investigation was undertaken to study the combined effect of different plant nutrients of organic and inorganic sources on nutrient uptake and yield of ground crop.

MATERIALS AND METHODS

A pot culture experiment was conducted at TamilNadu Agricultural College and Research Institute, Madurai during kharif season of 2008-2009 to study the release of K in soil in relation to organic manures in Groundnut (TMV.7). Earthen pots with top diameter of 35 cm, bottom diameter of 16 cm and height 28 cm were deaned and a layer of sand were placed at the bottom of each pot to provide drainage and aeration of roots. 20 kg of soil samples were transferred in those pots with gentle tapping on top 3" height for compacting the soil. A factorial completely randomized design was adopted with 4 levels of inorganic and organic each at 0, 50, 75, 100 kg ha^{-1}, randomized and replicated two times. Factor A. – 4 levels of K (Inorganic K fertilizers) 1.0 kg K_2O ha^{-1} (control) (K_0), 100 kg K_2O ha^{-1} (K_1), 75 kg K_2O ha^{-1} (K_2), 50 kg K_2O ha^{-1}(K_3), Factor B.- 4 levels of (compost) control (M_0), pressmud @5 t ha^{-1} (M_1), vermicompost @ 2 t ha^{-1} (M_2), farmyard manure

@ 12.5 t ha $^{-1}$ (M_3). A bunch type groundnut (TMV. 7) was used as test crop. All the pots received uniform doses of N (17g) and P_2O_5 (34g). The entire quantity of phosphorus and a part of nitrogen was applied in the form of diammonium phosphate and the balance of nitrogen as urea. The calculated quantities of K as KCl and organic sources as pressmud, vermicompost, and farmyard manure. The fertilizers were mixed properly and moistened at optimum level and left as such for 3 days attain equilibrium. Groundnut seeds (TMV.7) were sown in the pots at the rate of five seeds per pot and three plants alone are allowed to grow after germination. Each pot periodically received the water uniformly based on the soil wetting and drying. Prophylatic measures against pests and diseases were taken regularly. Stagewise collected plant sample were analysed in laboratory for nutrient content (Total N, P and K) and calculated the nutrient uptake expressed in kg ha^{-1}. The harvested pod yield were recorded and expressed in g/pot. The recorded data was statistically analysed (Gomez and Gomez ,1984).The Nutrient uptake was calculated as follows:

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Yield} \times \text{Nutrient content}}{100}$$

RESULTS AND DISCUSSION

Nutrient uptake at different stages of crop growth

Nitrogen uptake: The nitrogen uptake of groundnut was significantly influenced by the integrated and sole application of various organic sources. The highest nitrogen uptake of 1.01 g/pot was recorded in the treatment that received 75 kg K_2O ha^{-1} and pressmud @ 5 t ha^{-1} (K_1M_1) which was found to be on par when applied with (0.99 g/pot) 75 kg K_2O ha^{-1} along with farmyard manure @ 12.5 t ha $^{-1}$ (K_1M_2) and (0.98 g/pot) K_1M_3- 75 kg K_2O ha^{-1} along with vermicompost @ 2 t ha^{-1} whereas the lowest nitrogen uptake of 0.72 g/pot was recorded in control (Table.1). Significant increase in the uptake of nitrogen by plants was observed by the application of nutrients through pressmud and inorganic fertilizers. It might be due to the greater availability of nitrogen in soil which enhanced the growth of plants and ultimately led to higher accumulation of nutrients in their parts along with the highest total uptake. The enhanced release of nitrogen from the organic sources increases the nitrogen uptake by groundnut crop. The effect of K levels on the uptake of nitrogen in pod and haulm reveled that at K_1M_1 level favoured the uptake of N in pod and haulm respectively. This might be ascribed to the increased availability of N at these levels of K application. Increased level of K promoted the K uptake. Parihar and Pathan (2004) and Roy and Singh (2006) studied that application of organic and inorganic fertilizers were increased the nutrient uptake might be due to the combined effect of organic and inorganic fertilizers on the increased nutrient availability and microbial activity resulting in better nutrient absorption and growth of crops. Laxminarayanan (2004) reported that integrated application of organic and inorganic manures showed higher uptake of nitrogen, phosphorus and potassium compared to sole application of organic manure due to increased nutrient availability.

Phosphorus uptake: The highest phosphorus uptake of 0.96 g/pot was recorded in treatment which received (K_1M_1) 75 kg K_2O ha^{-1} and Pressmud @ 5 t ha^{-1} and it was found to be significantly superior to the rest of treatments involving integrated and sole application of organic sources (Table 1). The results of statistical analysis showed that the uptake of phosphorus by maize was significantly influenced by integrated and sole application of organic and inorganic sources. The result substantiates the findings of many researchers, Increase in soil available nutrients and nutrient (N, P and K) uptake were reported due to application of Pressmud along with the recommended dose of fertilizers (Rajkhowa *et al.*, 2000). Talathi *et al*. (2009) studied that total uptake of N, P, K by the crops increase significantly with the increased in the dose of fertilizers over control whereas combined use of inorganic fertilizers registered the highest value with organic manures.

Potassium uptake: The potassium uptake by maize

Table 1. Uptake of nitrogen, phosphorus, potassium by groundnut.

Treatments	Nitrogen uptake (g/pot)	Phosphorus uptake (g/pot)	Potassium uptake (g/pot)
K0M0	0.72	0.65	0.55
K0M1	0.75	0.68	0.58
K0M2	0.74	0.67	0.57
K0M3	0.73	0.66	0.56
K1M0	0.98	0.90	0.79
K1M1	1.01	0.96	0.80
K1M2	0.99	0.94	0.78
K1M3	0.98	0.92	0.76
K2M0	0.90	0.86	0.70
K2M1	0.94	0.89	0.72
K2M2	0.93	0.87	0.72
K2M3	0.92	0.85	0.71
K3M0	0.89	0.76	0.72
K3M1	0.88	0.78	0.70
K3M2	0.87	0.75	0.72
K3M3	0.86	0.74	0.71
SEd (K)	0.0021	0.0042	0.0012
CD(P = 0.05)	0.004	0.0834	0.0245
SEd (N)	0.0021	0.0042	0.0012
CD (P = 0.05)	0.0045	0.0834	0.0245
SEd (K X N)	0.0045	0.0834	0.0245
CD (P =0.05)	0.0086	0.1648	0.0438

Table 2. Haulm yield (g/pot) and pod yield (g/pot) of groundnut with different treatments.

Treatment	Haulm yield (g/pot)	Pod yield (g/pot)
K0M0	17.60	16.5
K0M1	20.08	17.5
K0M2	18.67	16.8
K0M3	19.59	16.5
K1M0	24.95	22.5
K1M1	28.25	24.5
K1M2	26.25	23.6
K1M3	26.65	22.8
K2M0	24.37	20.5
K2M1	25.45	21.4
K2M2	24.65	20.8
K2M3	24.58	19.5
K3M0	23.56	19.6
K3M1	23.89	19.4
K3M2	22.64	18.0
K3M3	22.72	18.5
SEd (K)	1.56	1.43
CD(P = 0.05)	2.96	2.80
SEd (N)	1.56	1.43
CD (P = 0.05)	2.96	2.83
SEd (K X N)	2.96	2.83
CD (P =0.05)	5.50	5.21

plant varied from 0.55 to 0.80 g/pot. The highest potassium uptake of 0.80 g/pot was recorded in the treatment that received (K_1M_1) 75 kg K_2O ha^{-1} and pressmud @ 5 t ha^{-1} and it was followed by the sole application 75 kg K_2O ha^{-1} with a value of 0.79 g/pot respectively. Lowest value recorded in the control pot **(**Table. 1). This could be ascribed to the accumulation of dry matter content in plant in the above treatment warranting higher potassium uptake. Availability of nitrogen increased the uptake of potassium. This particular treatment could have increased the exchangeable and water soluble potassium and by supplying inorganic nutrients too. Roy and Singh (2006) reported that treatments involving pressmud either alone or in combination with RDF were recorded significantly higher potassium uptake by wheat over RDF and burning of wheat straw + RDF. Singh *et al.* (2008) studied that application of enriched compost along with inorganic fertilizers were releasing N, P and K; and particularly improving potassium uptake in soil. Prasad *et al.,* 2010 reported that integrated nutrient management practices recorded significantly higher uptake of N, P and K by the kharif and rabi crops when compared to inorganic and organic nutrient management practices. The response of crops to integrated nutrient management is due to higher availability of these nutrients in soil reservoir besides the additional quantity of nutrients supplied by FYM and inorganic fertilizers. This was ascribed to continuous supply of N, P and K throughout the crop growth periods as the nutrients from inorganic sources were available to the crop in the early stages and in the later stages of the crop growth, the slow and continuous release of nutrients from the organic source made available.

Effect of organic and inorganic manures on yield of groundnut crop: The results of statistical analysis showed that the yield of groundnut significantly influenced by the application of organic and inorganic sources. The mean value of haulm ranged from 16.50 to 24.50 g pot^{-1}. The yield of groundnut was significantly influenced by application of various sources of organic manures. The result revealed that the pots which received 75 kg K_2O ha^{-1} and Pressmud @ 5 t ha^{-1} (K_1M_1) showed the highest haulm and pod yield of (28.25 and 24.5 g/pot) of groundnut crop respectively and it was followed by the application of 75 kg K_2O ha^{-1} (K_1M_0) with the value of haulm yield and in pod yield in (K_1M_2) 75 kg K_2O ha^{-1} (26.25) along with the application of vermicompost @ 2 t ha^{-1} (23.6 g/pot) (Table 2). The lowest value registered in the control pots. Addition of K to soils apart from increasing the available K status, also favour higher pod yield which might be mediated possibly due to the increased nitrogen use efficiency with increasing levels of K resulting higher biomass production was observed by Patel *et al.* (2010).The application of K had marked benefit in increasing the pod yield. Potassium helps in the synthesis of sugars and starch and also in the resistance to the crops against pest and diseases which in turn, increased the yield. It was evident from the results, the increasing level of K resulted in simultaneous increase of biometric and yield attributes except the number of unfilled pods which decreased considerably for the graded doses of K application. The different levels and split application of potassium

Table 3. Co- efficient of correlation between different forms of K.

Forms of K	H_2O sol K	Exchangeble K	Non-Exchangeable K	Lattice K	Total K
H_2O sol K	1	0.529*	0.394	NS	NS
Kex		1	0.736**	NS	NS
Knex			1	NS	0.407**
Lattice K				1	0.994***
Total					1

** Significant at 5% level, *** Highly significant at 5% level, NS – Non –significant.

was also found to increase the number of pods in plants Krishnappan *et al*. (1990). The supply of K to the crop during crop growth period is considered to be more beneficial increase the total number of pods dry matter accumulation and weight of pods. Meena *et al*. (2003) studied that groundnut yield increased with soil application of the higher doses of the fertilizers along with integrated application of manures.

Co-efficient correlation between different forms potassium: The lattice K was highly correlated (r^2 = 0.994***) with total K where the highest amount of K is fixed in the hexagonal cavities of the clay mineral and released when the non-exchangeable K source is depleted. Hence, the non-exchangeable K was positively correlated with lattice K (r^2 = 0.309*) and total K (r^2=0.407**).The exchangeable K and non-exchangeable are highly correlated (r^2= 0.736**), it denotes that dynamic equilibrium exists between these two forms of K in the soils. The similar dynamic equilibrium also exists between water soluble K and non-exchangeable K (r^2= 0.529*) and water soluble K and exchangeable K (r^2= 0.394) (Table. 3). The positive correlation results obtained from the forms of soil potassium indicates the existence of dynamic equilibrium among all the forms of soil potassium.

Conclusion

The present study, concluded that highest nitrogen, phosphorus, potassium uptake and haulm and pod yield was found supremacy with the treatment that received 75 kg K_2O ha^{-1} and pressmud @ 5 t ha^{-1} then rest of the treatment tried in groundnut crop respectively. Applying of organic plant nutrients along with inorganic fertilizers in the soil, the complexing properties of organic materials which prevented the precipitation and fixation of nutrients and kept them in soluble form. The solubilization action of organic acids produced during the degradation of organic materials resulted in better release of the essential nutrients in the soil ecosystem and effectively utilized by the plants for their growth and development and also sustaining the soil quality.

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