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Combined effect of phosphorus and molybdenum on above-ground growth parameters of groundnut (*Arachis hypogaea* L.)

Israel Sesugh Myina

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ABSTRACT

A controlled experiment was conducted on a randomized block design in three blocks with three levels of phosphorus (P) and molybdenum (Mo). P and Mo were applied in nine combinations, sixty days after planting, the flower counts, plant heights, fresh and dry weights were obtained. It was observed that the application of P and Mo in combination significantly influenced the flower count and fresh vegetative weight. However, only P application had a maximum positive effect on dry vegetative weight and there was no significant effect on plant height.

INTRODUCTION

In any sustainable agricultural practice, obtaining high quality and quantity in yield is always the major objective: the farmer desires to get more with less but more than often, these desires are hardly met due to extreme soil conditions (Sturgul 2010). Groundnut (*Arachis hypogaea* L.) is an important oil seed(s) ranking 13th globally (Ganesh et al. 2015) with significant economic importance due to its use directly in food, animal feeding, confectionery industries and in the production of biodiesel (Tasso Júnior et al. 2004), and one of most important leguminous crops in north eastern Nigeria as well as in many parts of the world. It is an important cash crop for farmers of the region and plays an important agronomical role in the traditional farming system as a source of nitrogen (nitrogen fixer) for cereals (Ustimenko-Bakumovsky 1993; Shiyam 2010).

Phosphorus (P) significantly affects plant growth and metabolism. It stimulates growth of young plants, giving them a good and vigorous start but, in low nutrient environment of the sub-Saharan Africa it can greatly limit yield (Buresh et al. 1997; Kandil et al. 2013). Molybdenum (Mo) is required for normal plant growth, reduction supply and general metabolism (Togay et al. 2008). Micronutrients like Mo positively influences the growth and development of groundnut (Melo et al. 2015) and Singh et al. (2006) reported that molybdenum had a significant beneficial effect on vegetative growth. This is not odd since as a trace element found in the soil, it is required for growth of most biological organisms including plants and animals. The deficiencies of such a micronutrient is most likely caused by soil conditions that render the element unavailable to the plants particularly, on soils with conditions outside the optimum range for a specific crop (Sturgul 2010). Nutrient limitations to legume production result from deficiencies of not only the macro-nutrients but also micronutrients such as Mo (Bhuiyan et al. 1997). Mo is found predominantly in most biological systems and in 4 plant enzymes (namely Nitrate reductase, aldehyde oxidase, xanthine dehydrogenase and sulphite oxidase) responsible for catalyzing diverse redox reactions (Ralf Mendel and Robert Hansch 2002) as an integral part plus, it has a positive effect on yield as its application to soil influences P availability (Kandil et al. 2013).

In this research, we aim to determine if varying levels P and Mo combination would significantly improve the vegetative content of

c/o Myina O. M. Department of Chemical Sciences Bingham University P. M. B. 005, Koru Nassarawa State, Nigeria.
*Email: myinais@live.com

Table 1. Treatments of Phosphorus and Molybdenum.

Serial	Code	Treatment
1	Control	No treatment applied.
2	T1	40g Mo/ha
3	T2	80g Mo/ha
4	T3	8Kg P/ha
5	T4	8Kg P/ha + 40g Mo/ha
6	T5	8Kg P/ha + 80g Mo/ha
7	T6	16Kg P/ha
8	T7	16Kg P/ha + 40g Mo/ha
9	T8	16Kg P/ha + 80g Mo/ha

groundnut at the early stage of growth. Plus, to define which of the levels have the maximum positive effect.

MATERIALS AND METHODS

The experiment was conducted in a Screen house at a latitude of 9^o 21' 15.68" N and longitude 12^o 30' 09.94" E, and at an altitude of 552m above sea level. A screen house is a structure with walls made from screens (i.e. net-like material) and designed to keep animals and insects out. The plants are affected by the same climatic conditions (such as solar intensity, relative humidity, temperature and precipitation) as field crops but with a level of protection. In this region, maximum temperatures of about 42^{o}C have been observed with minimum temperature as low as 18^{o}C between December and January and annual mean temperature are between 26.9 and 27.8^{o}C. The relative humidity is very low between January to March (20 – 30%) as it starts increasing from April and reaches its peak in August and late September (80%). Rainfall commences sometime in May to last through September, with a mean annual rainfall of 959mm, while the cool dry harmattan starts in November to last through to February (Adebayo 1999; Jamala et al. 2013).

Soil was carefully fetched from the field into pots which the plants were to be sown and samples collected for laboratory analysis. The soil was filtered for stone particles, plant debris and residue and packed 10Kg/pot into 27 pots with a 5cm top allowance for water retention. The pots were arranged randomly in three (3) blocks, properly labeled and saturated with water for 24 hours before planting. With the "Ex Dakar" groundnut variety in each pot, nine combinations i.e. nine (9) treatment levels of phosphorus and molybdenum (Table 1) were applied at randomized block design. No herbicides were applied, weeds were uprooted to eliminate competition for available but limited nutrients (and water) and to prevent allelopathy. The experiment was partly rain fed with minimal watering required plus, the soil pulverized periodically using hand fork for aeration and proper drainage.

Data collection started at the onset of the study with physico-chemical analysis of the soil sample and then at 60 days after planting. The only physical properties of interest were the soil color and particle size: the dry and moist soil sample color was determined using the Munsell color chart

Table 2. Some physical and chemical properties of the soil used in the experiment.

Parameters	Values
Physical Properties	
Color (Dry)	10YR 3/3 Dark Brown
Bulk Density (gcm^{-3})	1.8
Texture	Loamy Sand
Structure	Weak, medium, sub angular blocky
Consistency	None
Mottles	None
Chemical Properties	
pH	6.42
EC (cmol/Kg)	0.27
CEC (cmol/Kg)	4.70
Total N (%)	0.06
Available P (mg/Kg)	12.4
K (cmol/Kg)	0.07
Organic Carbon (g/Kg)	1.10
Na (cnol/Kg)	0.25
Ca (cmol/Kg)	0.23
Mg (cmol/Kg)	0.15

whereas the particle size of the soils was determined using the hydrometer method as described by IITA (1979). The soil chemical properties of interest were pH, Electrical Conductivity, Organic Carbon, Available Phosphorus, Total Nitrogen and Potassium and were determined in accordance to IITA (1979) methodologies (Table 2). Sixty (60) days after planting, the following data (Flower count, Plant Height, Fresh Vegetative Weight and Dry Vegetative Weight) were obtained and subjected to Analysis of Variance and Duncan's new multiple range test in R Statistics (R Development Core Team 2015) with the Agricolae (de Mendiburu 2015) .

RESULTS AND DISCUSSION

The data in Table 3 represented the effect of P and Mo combination on some above-ground growth parameters of groundnut. The effect of P and Mo combination on these parameters was found to be positive and significantly increased the growth parameters with increasing levels of P and Mo.

Flower Count

The flower count was significantly ($p<0.05$) influenced by the levels of P and Mo combination with the maximum mean value of 13.00 at T8. It was observed that Mo had a significant influence on flower count in absence of P (i.e. at T2 which was statistically different) but, in combination with P (at T8) significantly increased flower count which can be attributed to the effect of P in hastening meristematic activity (Praven et al. 2012 as cited by Ganesh et al 2015). The positive and significant influence of P and Mo on flower count therefore implies a high probable yield since yield is largely dependent on the basic reproductive organs i.e. the flowers (Lim and Hamdam 1984 as cited Kaba et al. 2014).

Plant Height

The analysis of variance revealed no significant variation in height as affected by levels of P and Mo combination. This implies that P and Mo combination had no significant influence on the height of the plant. This is in line with Shiyam (2010) report that different levels of P do not significantly affect plant height. The lack of significant variation in plant height further implies that Mo has no significant influence on height either. This is not unusual since Mo is not known to influence directly plant above-ground growth parameters as height but rather, influences the availability of P. The significance in plant height variation with varying levels of P as reported by Salve and Gunjal (2010) for instance were attributed to Potassium (K) levels (Iman et al. 2014).

Fresh Vegetative Weight

The analysis of fresh vegetative weight revealed that the levels of P and Mo combination significantly ($p<0.05$) affected their weight. It was observed that Mo (in absence of P) at T2 significantly influenced the fresh vegetative weight: Since micro-nutrient such as molybdenum increase vegetative growth due to the synthesis of growth indorsing hormones such as Auxin which in turn stimulates efficient uptake of nutrients (Uzmal et al. 2010), the high fresh vegetative weight of groundnut at T2 is not bizarre: Maximum mean values 23.85 for fresh vegetative weight were observed at T8 (i.e. the highest levels of P and Mo combination). The high fresh vegetative weight at T8 can be ascribed to the effect of P in hastening meristematic activity and the availability of ample P for rapid vegetative growth (Praven et al 2012 as cited by Ganesh et al 2015) which is in agreement with the report of Kandil et al. (2013).

Dry Vegetative Weight

The dry vegetative weight was positively and significantly ($p<0.01$) affected by the P and Mo levels.

It was observed that P in the absence of Mo (i.e. T6) had the most influence on dry vegetative weight with a maximum mean value of 6.10 than the combination of P and Mo (i.e T8) of 5.75 (Table 3) which, is in contrast to the result of flower count and fresh vegetative weight. However,

Table 3. Means of studied treatments for flower count, fresh and dry weight of groundnut

	Means		
Treatments	**Flower Count**	**Fresh Vegetative Weight**	**Dry Vegetative Weight**
Control	7.00 ± 0.00^{c}	15.70 ± 7.90^{cd}	4.60 ± 1.90^{abcd}
T1	8.50 ± 1.50^{bc}	17.75 ± 4.65^{bcd}	3.75 ± 3.75^{de}
T2	11.50 ± 3.50^{ab}	22.90 ± 0.20^{ab}	5.50 ± 0.30^{abc}
T3	7.50 ± 0.50^{c}	15.45 ± 8.25^{d}	2.70 ± 0.20^{e}
T4	8.00 ± 8.00^{c}	21.55 ± 7.35^{abc}	4.50 ± 2.50^{abcd}
T5	9.50 ± 0.50^{bc}	17.90 ± 5.80^{abcd}	4.20 ± 1.10^{bcde}
T6	9.00 ± 1.00^{bc}	21.95 ± 2.15^{ab}	6.10 ± 0.90^{a}
T7	8.50 ± 1.50^{bc}	14.35 ± 3.45^{d}	3.95 ± 0.95^{cde}
T8	13.00 ± 3.00^{a}	23.85 ± 0.23^{a}	5.75 ± 0.35^{ab}

Kabir et al. (2013) reported that, increase in dry weight because of P application can be accredited to the fact that P is essential in the development of more extensive root systems (Gobarah et al. 2006) that would aid in assimilation and development. In the presence of Mo, dry vegetative weight was influence positively and statistically different: Since the application of Mo influences the availability of P, it is not unusual to have Mo application therefore influence dry weight at T8.

CONCLUSION

The application of P and Mo significantly influences above-ground growth parameters for groundnut. The combination of P and Mo showed a higher influence on flower count and fresh vegetative weight but P application only showed a higher influence on dry vegetative weight. Neither P nor Mo had any significant influence on plant height.

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