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Effect of NPK Fertilizer Combined with Magnesium Sulphate on Nutrient Content and Uptake of Wheat (*Triticum aestivum* L.) in Maiduguri, Borno State, Nigeria

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Abstract
The study was conducted to determine the effect of NPK fertilizer combined with Magnesium Sulphate on nutrient content and uptake of wheat under screen house condition at the Faculty of Agriculture, University of Maiduguri. Five kilogram of virgin soil was measured into pots and moistened and wheat seeds were sown. The experiment consisted of twelve treatments in three replicates. These treatments were, TRT 1 (0g NPK + 0g $MgSO_4$), TRT 2 (0g NPK + 0.25g Mg SO_4), TRT 3 (0g NPK + 0.50g $MgSO_4$), TRT 4 (0.50g NPK + 0g Mg SO_4), TRT 5 (0.50g NPK + 0.25g Mg SO_4, TRT 6 (0.50g NPK + 0.50g Mg SO_4), TRT 7 (0.75g NPK + 0g Mg SO_4), TRT 8 (0.75g NPK + 0.25g Mg SO_4), TRT 9 (0.75g NPK + 0.50g Mg SO_4), TRT 10 (1g NPK + 0g Mg SO_4), TRT 11 (1g NPK + 0.25g Mg SO_4), TRT 12 (1g NPK + 0.50g Mg SO_4). The results showed that, the application of NPK combined with Magnesium Sulphate had significant influence on the nutrient content and uptake of wheat. The application of treatment 12 (1g NPK + 0.50g Mg SO_4), TRT 10 (1g NPK + 0g $MgSO_4$) and TRT 7 (0.75g NPK + 0g $MgSO_4$) showed to have the overall best result for N, P content and N uptake, P and K uptake and K content.

Keywords:*Wheat, Magnesium Sulphate, NPK Fertilizer*

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I. Introduction

Wheat (*Triticum aestivum* L.) is a cereal crop grown worldwide on a large scale for its grains. It performs best in temperate environments with sufficient rainfall or adequate irrigation. In 2016, world production of wheat was 799 million tonnes, making it the second most produced cereal after maize (1.03 billion tonnes), with more than rice (499 million tonnes)[5]. This grain is grown on more land area than any other commercial food crop (220.4 million hectare)[5].

Globally, wheat is the leading source of vegetable protein in human food, having a protein content of about 13% which is relatively high compared to other major cereal, and staple food. It is consumed as food, bread, cakes, biscuits and as part of many other confectioneries. The straw, brans and offal are used for livestock feed.

In Nigeria, wheat is grown under irrigation in the northern region of the country from November to March during the cold harmattan periods which provides the much needed low temperatures (20^0C– 30^0C) for its production. Only early maturing spring varieties can be cultivated because of the short period of the cold harmattan[15]

In 1987, the Nigeria government banned the importation of wheat and implemented wheat production programme aimed at stimulating local production. However, several

challenges scuttled the burst of energy to produce locally. Nigeria currently imports four tonnes of wheat, spending four billion dollars on the commodity every year, a figure expected to reach 10 billion dollars by 2030 when Nigerians are predicted to consume over 10 million metric tonnes of imported wheat to satisfy their growing demand for nontraditional food like pasta, noodles and bread[8]

Magnesium Sulphate is an inorganic salt containing magnesium, sulfur and oxygen. It is mostly in the form; heptahydrate ($MgSO_4.7H_2O$). It is used in agriculture to correct a magnesium or sulfur deficiencies in soil, mostly in gardening. Magnesium is an essential element in the chlorophyll molecule and sulfur is an important second macronutrient[14]

NPK fertilizer is a three component fertilizer providing multiple nutrient; Nitrogen, phosphorus and potassium. They are referred to as multinutrient or complex or complete fertilizers. Nitrogen, Phosphorus and Potassium are primary nutrients essential for crop growth and development. Nitrogen is an Integral component of amino acid, chlorophyll, DNA and RNA, phosphorus is an integral component of ATP and potassium is important in osmoregulation.

The objective of the study is to determine the optimum level of NPK Fertilizer combined with Magnesium Sulphate for wheat nutrient content and uptake.

II. Materials And Methods

Experiment Procedure

A study was conducted at the Faculty of Agriculture, University of Maiduguri screen house and the aim of the study was to determine: the effect Magnesium Sulphate on the early growth and nutrient uptake of wheat and to establish optimum level of NPK

Fertilizer combined with Magnesium Sulphate that is required by wheat. The experiment consisted of twelve (12) treatments with three (3) replicates: TRT 1 (0g NPK + 0g $MgSO_4$), TRT 2 (0g NPK + 0.25g Mg SO_4), TRT 3 (0g NPK + 0.50g $MgSO_4$), TRT 4 (0.50g NPK + 0g Mg SO_4), TRT 5 (0.50g NPK + 0.25g Mg SO_4, TRT 6 (0.50g NPK + 0.50g Mg SO_4), TRT 7 (0.75g NPK + 0g Mg SO_4), TRT 8 (0.75g NPK + 0.25g Mg SO_4), TRT 9 (0.75g NPK + 0.50g Mg SO_4), TRT 10 (1g NPK + 0g Mg SO_4), TRT 11 (1g NPK + 0.25g Mg SO_4), TRT 12 (1g NPK + 0.50g Mg SO_4). The experimental designed used was Complete Randomized Design (CRD).

The particle size distribution was determined using hydrometer method[2]. Soil pH was determined in 0.01M $CaCl_2$ (1:2.5) soil water ratio using glass electrode pH meter. The suspension used in the determination of pH were used for the determination of EC following the same process with the use of an EC meter. Percentage organic carbon of the soil was determined by the use of[16] dichromate wet oxidation method as described by [11]. Sodium and potassium were determined using flame photometric method. Exchangeable acidity was extracted with 1N KCl and measured according to the procedure of [7]. Total nitrogen was determined by micro-Kjeldahl digestion method[7], while available phosphorus was determined using Bray II method as described by [12]. Plant analysis was done following the method of [10]. Nitrogen, phosphorus and Potassium (NPK) content and uptake were determined.

STATISTICAL ANALYSIS

The data were subjected to ANOVA and the means were separated using least significant difference (LSD) at 0.05 level of significance using the software 'Statistix. The differences among the means were separated using Duncan Multiple Test Range (DMRT) at 5% level of significance as described by [6].

III. Results

Physco-chemical properties of the soil used

The physco-chemical properties of the soil used are showed in Table 1. The properties showed that the soil is neutral in reaction, low electrical conductivity, low potassium, medium magnesium, sodium and calcium, low organic carbon and has a sandy loam texture according to the fertility rating by [17].

Nutrient Content of Wheat

The results presented in Table 2 show the effect of NPK Fertilizer combined with Magnesium Sulphate on the nutrient content of wheat was positive. The results obtained for nitrogen (N) content showed significant difference between treatments with the application of 1g NPK + 0.25g $MgSO_4$ having the highest value of 4.15% and was statistically similar to application of treatments 0.50g NPK + 0.25g $MgSO_4$, 0.50g NPK + 0.50g $MgSO_4$, 0.75g NPK + 0g $MgSO_4$, 0.75g NPK + 0.25g $MgSO_4$, 0.75g NPK + 0.50g $MgSO_4$ and 1g NPK + 0.50g $MgSO_4$. The lowest value of 2.45% was recorded for the control 0g NPK + 0g $MgSO_4$ and was statistically similar to 0g NPK + 0.25g $MgSO_4$ and 0g NPK + 0.50g $MgSO_4$.

There was significant difference among the treatments in the phosphorus content and the highest percent (0.14) was recorded in plants treated with 0.75g NPK + 0g $MgSO_4$, 0.75g NPK + 0.25g $MgSO_4$, 0.75g NPK + 0.50g $MgSO_4$, 1g NPK + 0g $MgSO_4$, 1g NPK + 0.25g $MgSO_4$ and 1g NPK + 0.50g $MgSO_4$, but the lowest value 0.10% was recorded for 0g NPK + 0.50g $MgSO_4$.

There was significant difference between treatments in the potassium content with the highest value of 2.29% for treatment of 0.75g NPK + 0g $MgSO_4$ which is statistically similar to 0.50g NPK + 0g $MgSO_4$, 0.50g NPK + 0.25g $MgSO_4$, 0.50g NPK + 0.50g $MgSO_4$, 0.75g NPK + 0.25g $MgSO_4$, 0.75g NPK + 0.50g $MgSO_4$, 1g NPK + 0g $MgSO_4$, 1g NPK + 0.25g $MgSO_4$ and 1g NPK + 0.50g $MgSO_4$ but treatments 0g NPK + 0g $MgSO_4$, 0g NPK + 0.25g $MgSO_4$ and 0g NPK + 0.50g $MgSO_4$ had the lowest with value of 1.48%. These findings agreed with that of [4] who recorded increase in nutrient uptake in wheat sprayed with magnesium.

Nutrient Uptake of Wheat

The results presented in Table 3 shows the effect of NPK Fertilizer combined with Magnesium Sulphate on the nutrient uptake of wheat. There was significant difference between treatments in the uptake of nitrogen with the highest value of 17.13g/pot from pot treated with 1g NPK + 0.50g $MgSO_4$ and was statistically similar to 0.75g NPK + 0g $MgSO_4$, 0.75g NPK + 0.25g $MgSO_4$, 0.75g NPK + 0.50g $MgSO_4$, 1g NPK + 0g $MgSO_4$ and 1g NPK + 0.25g $MgSO_4$. The lowest value (4.90g/pot) was for the control (0g NPK + 0g $MgSO_4$) and was statistically similar to the rest of the treatments.

There was significant difference between treatments in the uptake of phosphorus. The highest value of 0.71g/pot was for pot treated with 0.75g NPK + 0g $MgSO_4$, but was statistically similar to 0.75g NPK + 0.25g $MgSO_4$, 1g NPK + 0.25g $MgSO_4$ and 1g NPK + 0.50g $MgSO_4$. The lowest value recorded (0.22g/pot) was for the control but was statistically similar to 0g NPK + 0.25g $MgSO_4$, 0g NPK + 0.50g $MgSO_4$, 0.50g NPK + 0g $MgSO_4$, 0.50g NPK + 0.25g $MgSO_4$ and 0.50g NPK + 0.50g $MgSO_4$.

The result for potassium uptake showed significant difference between the treatments with the highest value of 11.54g/pot for treatment of 1g NPK + 0g $MgSO_4$. This was statistically similar to treatments 0.75g NPK + 0.25g $MgSO_4$, 1g NPK + 0.25g $MgSO_4$ and 1g NPK + 0.50g $MgSO_4$. The lowest values (3.57g/pot) was recorded for pot treated with 0g NPK + 0.50g $MgSO_4$, and was statistically similar to the control.

Table 1: Physico-chemical properties of the soil used

Parameter	Value
% sand	69.75
% silt	20.00
% clay	10.25
Textural class	Sandy Loam
pH	7.08
E.C (dsm^{-1})	0.05
O.C (g/kg)	0.20
Total N (g/kg)	0.98
Available P (mg/kg)	15.05
K^+ (cmol/kg)	1.74
Ca^+ (cmol/kg)	1.60
Mg^{2+} (cmol/kg)	1.60
Na^+ (cmol/kg)	0.24
CEC (cmol/kg)	5.18
ECEC (cmol/kg)	5.98
% B.S	86.62
E.A (cmol/kg)	0.80

Table 2: Effect of NPK Fertilizer combined with Magnesium Sulphate on nutrient content of wheat

	Nutrient content		
Treatments	%N	%P	%K
0g NPK + 0g $MgSO_4$	2.45^{e}	0.11^{de}	1.87^{c}
0g NPK + 0.25g $MgSO_4$	2.88^{e}	0.12^{cde}	1.89^{bc}
0g NPK + 0.50g $MgSO_4$	2.90^{de}	0.10^{e}	1.48^{d}
0.50g NPK + 0g $MgSO_4$	3.53^{cd}	0.13^{abc}	2.11^{abc}
0.50gNPK + 0.25g $MgSO_4$	3.90^{ab}	0.13^{abcd}	2.17^{ab}
0.50g NPK + 0.50g $MgSO_4$	3.84^{ab}	0.12^{bcd}	2.14^{abc}
0.75g NPK + 0g $MgSO_4$	3.92^{ab}	0.14^{a}	2.29^{a}
0.75g NPK + 0.25g $MgSO_4$	4.06^{ab}	0.14^{a}	2.21^{a}
0.75g NPK + 0.50g $MgSO_4$	3.87^{ab}	0.14^{a}	2.22^{a}
1g NPK + 0g $MgSO_4$	3.69^{bc}	0.14^{a}	2.21^{a}
1g NPK +0.25g $MgSO_4$	4.15^{a}	0.14^{a}	2.24^{a}
1g NPK + 0.50g $MgSO_4$	3.81^{ab}	0.14^{a}	2.04^{abc}
Mean	3.57	0.13	2.07
SE ±	0.22	8.39E-03	0.14
LSD (0.05)	0.45	0.02	0.29

Means in columns and rows followed by similar letter(s) are not significantly different at 5% probability level.

Table 3: Effect of NPK Fertilizer combined with Magnesium Sulphate on nutrient uptake by wheat

Treatments	Nutrient uptake N (g/pot)	P (g/pot)	K (g/pot)
0g NPK + 0g $MgSO_4$	4.90^{c}	0.22^{e}	3.74^{d}
0g NPK + 0.25g $MgSO_4$	6.32^{c}	0.25^{de}	4.16^{d}
0g NPK + 0.50g $MgSO_4$	6.48^{c}	0.22^{e}	3.57^{d}
0.50g NPK + 0g $MgSO_4$	6.51^{c}	0.24^{de}	3.99^{d}
0.50gNPK + 0.25g $MgSO_4$	9.97^{bc}	0.34^{cde}	5.72^{cd}
0.50g NPK + 0.50g $MgSO_4$	9.95^{bc}	0.30^{de}	5.21^{cd}
0.75g NPK + 0g $MgSO_4$	14.90^{ab}	0.38^{cd}	6.31^{cd}
0.75g NPK + 0.25g $MgSO_4$	14.53^{ab}	0.60^{ab}	9.70^{ab}
0.75g NPK + 0.50g $MgSO_4$	17.12^{a}	0.48^{bc}	7.78^{bc}
1g NPK + 0g $MgSO_4$	16.63^{a}	0.71^{a}	11.54^{a}
1g NPK +0.25g $MgSO_4$	17.03^{a}	0.60^{ab}	9.29^{ab}
1g NPK + 0.50g $MgSO_4$	17.13^{a}	0.65^{a}	9.36^{ab}
Mean	11.80	0.42	6.70
SE ±	2.60	0.07	1.34
LSD (0.05)	5.37	0.15	2.76

Means in columns and rows followed by similar letter(s) are not significantly different at 5% probability level.

IV. Discussion

Increasing the nutrient content of wheat is important as increasing the yield as human being are dependent on plants for their nutrient requirements. Improving quality is of great importance for the increasing human population [3]. Application of MgSO4 and NPK fertilizer resulted in positive significant effect on nutrient content and uptake of the macro nutrients determined. Superior results were obtained with 1g NPK + 0.5g MgSO4 which was best for wheat N content and uptake as well as wheat P content. Similar results was also obtained by [1] who stated that application of $MgSO_4$ amendment increased nutrients content of rice plant. This could be as a result of role played by magnesium in enzymatic processes, activation and increase of nitrogen and iron utilization by the plants [14]. Magnesium found also to enhance stomatal width, length and transpiration rate which may encourage the passive uptake of nutrients [13]. Similar findings regarding the increase in the uptake of nutrients by wheat straw when sprayed with magnesium were also reported by [4].

Same trend was found by [1] who determined the effect of Mg fertilization on the rice plants grown on artificial siltation soil. According to his results, the uptake of all nutrients in the straw was increased with Mg treatments. Magnesium positive effect on nutrients uptake may relate to its role in enzymatic processes activation and increase of nitrogen and iron utilization by the plants [14].

However, 1g NPK + 0g MgSO4 gave the best P uptake and content while K content was best obtained with 0.75g NPK + 0 MgSO4 amendment. This can be as a result of other factors and interaction which was not studied during the experiment.

V. Conclusion

Best results were obtained with 1g NPK + 0.5g MgSO4 which was best for wheat N content and uptake.

DISCLOSURE STATEMENT

The authors declare no competing interests

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