

1521 Response of Long Staple Cotton to Phosphorus in Form of Diammonium Phosphate (DAP) in the vertisol of Sudan Gezira

Mr. Naiem Ali , Agricultural Research Corporation - ARC Sudan, Wad Medani, Sudan
Mr. Abdalla Elhassan , Agricultural Research Corporation -ARC- Sudan, Wad Medani, Sudan

Phosphorus is one of the major nutrients necessary for crop growth and development. Soil phosphorus availability for crop uptake is pH dependent and alkalinity can adversely affect its uptake.

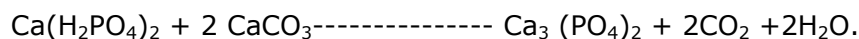
Seed cotton yield in Sudan Gezira is generally low and the response of the crop to phosphorus fertilization in form of triple super phosphate(TSP) was negative presumably due to fixation as insoluble calcium phosphate $\text{Ca}_3(\text{PO}_4)_2$

Researcher managed experiments were conducted at the Gezira Research Station Farm for two consecutive seasons to test the response of long staple cotton variety" Barakat-90" to phosphorus fertilization in form of DAP in combination with either urea or ammonium sulphate nitrate (ASN) as nitrogen sources. The results obtained indicated that fertilization of cotton with DAP improved the uptake of NPK, increased the dry matter production and seed cotton yield. From this it can be concluded that fertilization with DAP is effective in seed cotton yield promotion under Sudan Gezira conditions and soil with similar properties.

Introduction

Sudan Gezira soil is classified as vertisol characterized by a high clay content, poor in nitrogen and available phosphorus, with low organic matter, alkaline in reaction with considerable calcium carbonate (CaCO_3) percentage (Table1).

Phosphorus (P) is one of the major plant nutrients necessary for crop growth and development. It is absorbed from the soil in form of H_2PO_4^- and $\text{HPO}_4^{=}$. P availability for crop uptake is pH dependent and can be adversely affected by alkalinity. Although the available phosphorus content of the Gezira soil is very low (2- 4 ppm) many experiments (Ibrahim,1998) indicated the lack of response of cotton to P when applied in form of triple super phosphate(TSP) with the formula $\text{Ca}(\text{H}_2\text{PO}_4)_2$. This is presumably due to P fixation in the insoluble form, calcium phosphate $\text{Ca}_3(\text{PO}_4)_2$ according to the following equation:



The calcium carbonate content of the Gezira soil is adequate to initiate such a reaction.

Cotton is the major rotation cash crop in Gezira. The average yield of seed cotton is generally low and a number of factors were suspected for this yield depression including fertilization (Ali *etal*,2002 and 2003). The fertilization practice adopted in Gezira for cotton production is the application of 86kg N/ha in form of urea applied 6-8 weeks after sowing followed by green ridging. Recently, ammonium sulphate nitrate was recommended as a nitrogen source for cotton production(Ali *etal*,2002).

All crops including cotton require 13 nutrient elements to be absorbed from the soil for optimum growth and yield and the most important of these are N,P and K (Tandon,1994).

Fertilization with nitrogen only as practiced in Gezira may result in short term increase of yield and definitely deplete other nutrients including P resulting in permanent yield decline, a situation which is actually occurring in Gezira.

For balanced uptake of nutrients by crops from the soil, the phosphate anion can be effectively absorbed when in association with N in form of NH_4^+ . Diammonium phosphate or DAP $(\text{NH}_4)_2\text{HPO}_4$ contains 46% P_2O_5 similar to TSP and in addition it contains 18% $\text{NH}_4^+\text{-N}$. This unique combination is ideal for the uptake of both N and P.

The objective of this work is to test the efficiency of DAP as a source of P for cotton yield promotion under the Gezira conditions

Material and Methods

Long staple cotton, variety "Barakat 90" was grown at the Gezira Research Station Farm for two successive seasons. The effective sowing date of the first season was 27th July 2005 and that of the second season was 1st August 2006. All cultural practices were done as recommended by ARC except fertilization which included the following treatments (kg/ha):-

1. No fertilizer (control)
2. 86 kg urea- N (standard)
3. 86 kg ASN-N
4. 86 kg N+43 kg P(urea + DAP)
5. 86 kg N +43 kg P (ASN+DAP)
6. 86 kg N +86 Kg P (urea +DAP)
7. 86 kg N +86 kg P (ASN +DAP)

The total N of treatments receiving DAP is the summation of N from both DAP and either urea or ASN. DAP was broadcasted before the second irrigation to minimize fertilizer run- off through the soil cracks. Urea and ASN were applied 7 weeks after sowing followed by green ridging. The treatments were arranged in RCBD replicated four times. Plant samples were taken at physiological maturity for NPK analyses and seed cotton yield data were recorded and statistically analyzed

Results and Discussion

From table (1) it is evident that the Gezira soil is deficient in nitrogen and cotton production depends on nitrogen application at a rate of 86 kg N/ha in form of urea. In this experiment, nitrogen was applied to cotton in two forms urea and ASN (26%N).

Table (2) and (3) show the results of NPK uptake by the cotton plant for season 2004/05 and 2005/06 respectively . The results of uptake were expressed on a per area basis to reflect the actual uptake and eliminate artifacts arising from dilution caused by vigorous growth or concentration caused by stunted growth. From table (2) and (3),it is clear that P application in form of DAP improved the uptake of the three elements NPK. The uptake of P in treatments receiving no fertilizer(control) or receiving N only in form of urea or ASN is lower compared to those receiving DAP. It is of interest to observe that no significant difference in the P uptake between treatments receiving either 43 or 86 kg P_2O_5 /ha. The reason for this remains obscure and can not be ascribed to fixation or luxurious supply i.e

more than the plant need. From this it can be concluded that fertilization of cotton with P should not exceed the rate of 43kg P₂O₅/ha equivalent to 93kg of the fertilizer DAP. The results of the two seasons are in conformity.

Tables (4) and (5) show the dry matter (DM) production, seed cotton yield, nitrogen utilization efficiency (N.U.E.) and percent seed cotton yield increase over the control for the two seasons. The N.U.E. is an important agronomic parameter in reflecting the efficiency of the fertilizer in supplying N to the crop to produce the final yield. This was calculated by subtracting the yield of the control from that of the fertilizer treatment and then dividing the remainder by the amount of N supplied in form of fertilizer. This parameter is almost doubled when applying DAP. Significant increase in seed cotton yield is observed for the treatment receiving DAP. This is mainly due to the improvement in the uptake of NPK. The results of the two seasons are in full agreement.

Conclusions:

1. DAP can be an effective source of P for cotton production in soils with similar properties to those of the Sudan Gezira soil (table 1).
2. Under similar conditions the rate of P application should not exceed 43kg P₂O₅ equivalent to 93 kg of DAP fertilizer.
3. ASN alone or in combination with DAP gave higher yield compared to that of urea presumably due to its readily available form N in addition to the presence of the SO₄⁻ ion.

References

Ali, Naiem A, Abdelaziz A Hashim , Elfadil A , Babiker, Mirghani Saeed , Kamal Hamid , Mustafa A.M. Idris , Mohamed M. Omer and Abdalla A. M. Elhassan (2002). Response of irrigated cotton to fertilizer form and rate. A paper submitted to and passed by the crop Husbandry Committee in June 2002.

Ali, Naiem A, Asim F. A/Sarra, M. saeed, K. Hamid, Abbas E. M. Elamin, M. M. Omer, M. A. M. Idris and Neima H. Osman (2003). Effects of fertilizer form on cotton production in Gezira, Rahad and New Halfa. A paper submitted to and passed by the crop Husbandry Committee in (2003).

Ibrahim, H. S. (1998). Research on cotton nutrition with macro-nutrients- Review- first Scientific Work shop. Land and Water Research Center (ARC), Wad Medani, 19-20 Sep. 1998. (in Arabic)

Tandon, HLS (1994). Fertilizer Guide. Fertilizer Development and Consultation Organization (FDCO) India.

Table (1) Some physical and chemical Properties of Sudan Gezira soil

Item	Quantity
Clay content (%)	55-70
Bulk density (g/cm ³)	1.4- 1.7
Wetting front (cm)	20 -25
pH	8 - 9
Total nitrogen(%)	0.02 - 0.04
Organic carbon (%)	0.3-0.4
Total phosphorus (ppm)	400-800
Available phosphorus (ppm)	3- 4
Calcium carbonate (%)	3- 4

Table (2): NPK uptake (kg/ha) season 2004/05

Treatment		N	P (P ₂ O ₅)	K
A) Control		96 c	30 d	30 b
B) 86 kg urea-N(standard)		138 b	36 c	31 b
C) 86 kg ASN-N		151 ab	36 c	38 b
D)86kgN+43kgP(urea+DAP)		155 ab	56 a	49 a
E)86kgN+43kgP(ASN+DAP)		175 a	57 a	50 a
F)86kgN+486kg(urea+ DAP)		150 ab	50 b	40 b
G)86kgN+86kg DAP)		150 ab	53 ab	39 b
Mean		145	45	40
SE (±)		10.3	1.7	3.2
C.V (%)		14.2	7.5	15.9
Sig.		***	***	***

*Figures within the same line with the same letter are not significantly different according to DMRT.

Table (3): NPK uptake (kg/ha); season 2005/06

Treatment		N	P (P ₂ O ₅)	K
A) Control		67 c	28 c	32 c
B) 86 kgurea-N (standard)		102 b	31 bc	47 b
C) 86kg ASN-N		110 b	40 ab	53 ab
D)86kgN+43kgP(urea+DAP)		133 a	47 a	53 ab
E)86kgN+43kgP(ASN+DAP)		139 a	49 a	59 a
F)86kgN+86kgP(urea+ DAP)		133 a	47 a	57 ab
G)86kgN+86kgP(ASN+DAP)		150 a	51 a	57 ab
Mean		119	42	51
SE (±)		6.0	3.8	3.5
C.V (%)		10.3	18.3	13.6
Sig.		***	***	***

*Figures within the same line with the same letter are not significantly different according to DMRT.

Table (4): Dry matter (DM) production(t/ha), seed cotton yield (t/ha), NUE (Kg yield/Kg N) and % yield increase season 2004/05

Treatment	DM	Yield	NUE	% yield increase	
A) Control	6.44d	1.28 c	-	-	
B) 86urea-N (standard)	7.30cd	2.02 b	9	57	
C)86kg ASN-N	7.77bc	2.11 b	10	65	
D)86kgN+43kgP(urea+DAP)	8.74ab	2.90 a	19	127	
E)86kgN+43kgP(ASN+DAP)	9.28a	2.94 a	19	129	
F)86kgN+86kgP(urea+ DAP)	8.12bc	2.97 a	20	132	
G)86kg+86kgP(ASN+ DAP)	8.12bc	3.00 a	20	134	
Mean	7.97	2.46			
SE (±)	0.322	0.078			
C.V (%)	8.1	6.3			
Sig.	***	***			

*Figures within the same line with the same letter are not significantly different according to DMRT.

Table (5): Dry matter (DM) production(t/ha), seed cotton yield (t/ha), NUE (Kg yield/Kg N) and % yield increase season 2005/06

Treatment	DM	Yield	NUE	% yield increase	
A) Control	6.18c	1.35 c	-	-	
B)86kg urea-N	8.26b	2.31 b	11	71	
C)86kg ASN-N	8.88ab	2.54 b	14	88	
D)86kgN+43P(urea+DAP)	9.49ab	3.33 a	23	146	
E)86kgN+43P(ASN+DAP)	9.64a	3.34 a	23	147	
F)86kgN+43kgP(urea+DAP)	9.67a	3.41 a	24	152	
G)86kgN+43kgP(ASN+DAP)	9.71a	3.57 a	28	164	
Mean	8.83	2.83			
SE (±)	0.914	0.083			
C.V (%)	9.50	5.9			
Sig.	***	***			

*Figures within the same line with the same letter are not significantly different according to DMRT.