VALIDATING THE EFFECTS OF PLANT CATALYST IN FERTILIZER REDUCTION ON YIELD AND QUALITY OF BURLEY TOBACCO, GROUNDNUT AND MAIZE IN MALAWI

OBJECTIVES

To determine the effects of PlantCatalyst® (at 30 ml/16l knapsack sprayer and 60 ml/16l knapsack sprayer at 14 days' spray interval) on fertilizer use efficiency on Maize / Groundnuts/ Tobacco yield and yield components.

To undertake economic analysis on different treatments of each crop.

INTRODUCTION

PlantCatalyst® is a 47-year old, Rapid, City, South Dakota-based, international and climate smart, food security company that empowers smallholder farmers in developing countries and throughout the United States to sustainably increase profit-per-hectare by increasing crop yield, reducing reliance on expensive, toxic fertilizers, and reducing deforestation. Specifically, PlantCatalyst® helps farmers improve their agricultural yield by 30%, reduce fertilizer use by 50%, reduce grow times by 1 - 7 days, provide greater resistance to diseases and drought, increase germination rates, and expand root growth. Since 1973, small and large farmers, gardeners, and professional growers all over the world have been using PlantCatalyst® to grow crops in a more sustainable way and to increase profit per-hectare by increasing crop yield and reducing CO2 emissions and fertilizer amounts.

As greenhouse gas emissions rise, global temperatures increase, weather patterns change, and our global water sources rise and become more acidic, farmers and their crops continue to be impacted. PlantCatalyst® is committed to helping farmers address these challenges through continued climate-smart development. Since PlantCatalyst® also helps plants better absorb and utilize nutrients found in soil, microbes, and micronutrients – less nitrogen-based fertilizers are needed, which reduces the overall acidity in both soil and water source. Climate change continues to be a critical challenge for food production around the world, and farmers and growers have found that using PlantCatalyst® on plants not only helps stimulate plant health and growth but has also been proven to increase overall yield by a minimum of 10 percent and as much as 50 percent in a natural and climate-friendly way. Other benefits of PlantCatalyst® include larger and/or greener plants; more blooms and/or plants blooming earlier; sturdier stocks and/or more extensive root systems; greater resilience in stressful growing environments; and more

yield per plant, larger fruit/flowers and enhanced flavour and aroma. PlantCatalyst® can help provide a solution to the world's food problems that is cost-effective for governments and NGO's, puts more money in the pockets of small shareholder farmers, and is also climate-smart

There has been extensive tests of PlantCatalyst® on multiple crops, such as maize, tobacco, groundnuts, cotton, and other crops. *The American Journal of Plant Nutrition and Fertilizer Technology* published a peer-reviewed study about the benefits of applying PlantCatalyst®. During the last few years, numerous partners of PlantCatalyst® have conducted multiple field trials in developing nations, such as Zambia and Mozambique, to demonstrate the positive impact that PlantCatalyst® produces for smallholder farmers.

Specifically, the Zambian Ministry of Agriculture's research department, the Zambia Agricultural Research Institute (ZARI), and NGO partners have conducted research trials and demonstration plots throughout Zambia and Mozambique. The findings have been consistent and conclusive: PlantCatalyst® empowers smallholder farmers to reduce fertilizer by up to 50%, substantially reduce up-front costs due to reducing or replacing fertilizer with the more cost effective PlantCatalyst®, increase crop yield by significant margins, and – most importantly – increase profit margins by as much as 40%.

MATERIALS AND METHODS

The experiment was conducted in Central Malawi at Mpale Commercial Farm during the 2019/20 cropping season. Mpale Farm is near Madisi trading centre the GPS grid reference is 13°24'30.73"S 33°37'04.36"E at 1,115m above sea level. The average annual rainfall is 700mm from late November to Early April. Mpale Soils are sandy loams with heavier orange clay sub soil.
The trials for burley tobacco (BRK4), groundnuts (CG7) and maize (SC719) were planted at pH. 5.2, well-drained sandy loamy soil. The factorial trial had fifteen treatments arranged in a complete randomised block design with three replications. On all the crops three-plant catalyst rates 0 mls, 30 mls, 60mls and five different fertiliser rates namely 0, 1/3, ½, 2/3 and full rates. **Tobacco** gross plot consisted four rows spaced at 1.2 and 7.2 m in length. Plants were spaced at 46cm. The net plot consist of two rows with each plant at both ends of the ridge discarded during data collection to avoid border effects. **Groundnut** gross plot consisted four rows spaced at 0.52 and 6.0 m in length and plants was spaced at 10cm. On groundnuts, one set of the experiment was planted under commercial production (early planting, 250kg/ha of fertiliser, fungicide applied) while other set was planted under smallholder scenario (planting at the onset of rains, 100kg/ha fertiliser, no fungicide). **Maize** gross plot consisted ten rows spaced at 0.75m and 10.0 m in length and plants was spaced at 40cm on two plants per planting station. The net plot consist of eight middle rows. All other cultural practices were implemented in accordance with recommendations. The pH values were taken at ploughing, 7 weeks after transplanting, and soon after harvesting (Final). Main field data was collected as per below:

Tobacco
Yield - kg/ha, pH and Full soil chemical analysis values

Groundnut
Flowering days, Dry pod yield, Kernel weight kg/ha, shelling%, 100 seeds weight (g)

Maize
Kernel wt./cob (g), maize yield - kg/ha, Cob weight after shelling (g), Cob length (cm), Number of kernels per cob, Cob weight before shelling (g), 1000 grains weight (g) and kernels weight per cob (g. The collected data were subjected to statistical analysis using standard ANOVA with Genstat Discovery 3 Edition and separation of means was done using the least significant difference (LSD) test procedure.

Table 1: Treatment details

Treatment	Fertilizer rate	PlantCatalyst (mm) per 16Lts knapsack (Spraying Regime after 14 days)
1	Full rate	0
2	Full rate	30
3	Full rate	60
4	Two third	0
5	Two third	30
6	Two third	60
7	Half rate	0
8	Half rate	30
9	Half rate	60
10	One third	0
11	One third	30
12	One third	60
13	Zero	0
14	Zero	30
15	Zero	60

Treatment Details Tobacco

Treatment	Treatment Code	Treatment Details
1	0 frt X 0 PC	Nil fert + Nil plant catalyst
2	0 frt X 30 PC	Nil fert + 30ml plant catalyst per 16L sprayer
3	0 frt X 60 PC	Nil fert + 60ml plant catalyst per 16L sprayer
4	I/3 frt X 0 PC	10.8g Super D per plant +4g urea + 2.6g CAN + Nil plant catalyst
5	I/3 frt X 30 PC	10.8g Super D per plant +4g urea + 2.6g CAN + 30ml plant catalyst per 16L sprayer
6	I/3 frt X 60 PC	10.8g Super D per plant +4g urea + 2.6g CAN + 60ml plant catalyst per 16L sprayer
7	1/2 frt X 0 PC	32.4g Super D per plant + 6g urea + 4g CAN + Nil plant catalyst
8	1/2 frt X 30 PC	16.2g Super D per plant + 6g urea + 4g CAN + 30ml plant catalyst per 16L sprayer
9	1/2 frt X 60 PC	16.2g Super D per plant + 6g urea + 4g CAN + 60ml plant catalyst per 16L sprayer
10	2/3 frt X 0 PC	16.2g Super D per plant + 8g urea + 5.3g CAN + Nil plant catalyst
11	2/3 frt X 30 PC	21.6g Super D per plant + 8g urea + 5.3g CAN +30ml plant catalyst per 16L sprayer
12	2/3 frt X 60 PC	21.6g Super D per plant+ 8g urea + 5.3g CAN + 60ml plant catalyst per 16L sprayer
13	Full frt X 0 PC	32.4g Super D per plant + 12g urea + 8g CAN + Nil plant catalyst
14	Full frt X 30PC	32.4g Super D per plant + 12g urea + 8g CAN + 30ml plant catalyst per 16L sprayer
15	Full frt X 60PC	32.4g Super D per plant + 12g urea + 8g CAN + 60ml plant catalyst per 16L sprayer

Treatment Details for Maize

Treatment	Treatment Code	Treatment Details
1	0 frt X 0 PC	Nil fert + Nil plant catalyst
2	0 frt X 30 PC	Nil fert + 30ml plant catalyst per 16L sprayer
3	0 frt X 60 PC	Nil fert + 60ml plant catalyst per 16L sprayer
4	I/3 frt X 0 PC	4g 23:10: 5 per plant +4g urea + Nil plant catalyst
5	I/3 frt X 30 PC	4g 23:10: 5 per plant +4g urea + 30ml plant catalyst per 16L sprayer
6	I/3 frt X 60 PC	4g 23:10: 5 per plant +4g urea + 60ml plant catalyst per 16L sprayer
7	1/2 frt X 0 PC	6g 23:10: 5 per plant + 6g urea + Nil plant catalyst

8	1/2 frt X 30 PC	6g 23:10: 5 per plant + 6g urea + 30ml plant catalyst per 16L sprayer
9	1/2 frt X 60 PC	6g 23:10: 5 per plant + 6g urea + 60ml plant catalyst per 16L sprayer
10	2/3 frt X 0 PC	8g 23:10: 5 per plant + 8g urea + Nil plant catalyst
11	2/3 frt X 30 PC	8g 23:10: 5 per plant + 8g urea + 30ml plant catalyst per 16L sprayer
12	2/3 frt X 60 PC	8g 23:10: 5 per plant + 8g urea + 60ml plant catalyst per 16L sprayer
13	Full frt X 0 PC	12g 23:10: 5 per plant + 12g urea + Nil plant catalyst
14	Full frt X 30PC	12g 23:10: 5 per plant + 12g urea + 30ml plant catalyst per 16L sprayer
15	Full frt X 60PC	12g 23:10: 5 per plant + 12g urea + 60ml plant catalyst per 16L sprayer

Treatment Details for Groundnut under Commercial Production

Treatment	Treatment Code	Treatment Details
1	0 frt X 0 PC	Nil of 6:20:24:3S:0.1B:0.5Zn 13% Lime + Nil plant catalyst
2	0 frt X 30 PC	Nil of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 30ml plant catalyst per 16L sprayer
3	0 frt X 60 PC	Nil of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 60ml plant catalyst per 16L sprayer
4	I/3 frt X 0 PC	26g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + Nil plant catalyst
5	I/3 frt X 30 PC	26g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 30ml plant catalyst per 16L sprayer
6	I/3 frt X 60 PC	26g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 60ml plant catalyst per 16L sprayer
7	1/2 frt X 0 PC	39g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + Nil plant catalyst
8	1/2 frt X 30 PC	39g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 30ml plant catalyst per 16L sprayer
9	1/2 frt X 60 PC	39g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 60ml plant catalyst per 16L sprayer
10	2/3 frt X 0 PC	52g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + Nil plant catalyst
11	2/3 frt X 30 PC	52g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 30ml plant catalyst per 16L sprayer
12	2/3 frt X 60 PC	52g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 60ml plant catalyst per 16L sprayer
13	Full frt X 0 PC	78g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime of 6:20:24:3S:0. + Nil plant catalyst
14	Full frt X 30PC	78g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 30ml plant

		catalyst per 16L sprayer
15	Full frt X 60PC	78g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 60ml plant catalyst per 16L sprayer

Treatment Details for Groundnut under Smallholder Production

Treatment	Treatment Code	Treatment Details
1	0 frt X 0 PC	Nil fert of 6:20:24:3S:0.1B:0.5Zn 13% Lime + Nil plant catalyst
2	0 frt X 30 PC	Nil fert of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 30ml plant catalyst per 16L sprayer
3	0 frt X 60 PC	Nil fert of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 60ml plant catalyst per 16L sprayer
4	I/3 frt X 0 PC	10g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + Nil plant catalyst
5	I/3 frt X 30 PC	10g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 30ml plant catalyst per 16L sprayer
6	I/3 frt X 60 PC	10g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 60ml plant catalyst per 16L sprayer
7	1/2 frt X 0 PC	15g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + Nil plant catalyst
8	1/2 frt X 30 PC	15g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 30ml plant catalyst per 16L sprayer
9	1/2 frt X 60 PC	15g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 60ml plant catalyst per 16L sprayer
10	2/3 frt X 0 PC	20g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + Nil plant catalyst
11	2/3 frt X 30 PC	20g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 30ml plant catalyst per 16L sprayer
12	2/3 frt X 60 PC	20g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 60ml plant catalyst per 16L sprayer
13	Full frt X 0 PC	31g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + Nil plant catalyst
14	Full frt X 30PC	31g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 30ml plant catalyst per 16L sprayer
15	Full frt X 60PC	31g/6m of 6:20:24:3S:0.1B:0.5Zn 13% Lime + 60ml plant catalyst per 16L sprayer

Table 2: Threshold Values for Some Chemical Parameters in the Soil

Element	Status of each range				
	Very low	**low**	**Adequate**	**High**	**Excessive**
pH	<4.0	4.0-5.4	5.5-6.0	6.0-8.0	>8.0
Nitrogen %	<0.08	0.08-0.12	0.12-0.20	0.20-0.30	>0.30
Phosphorus ppm	0-5	6.0 -10.0	11.00- 45.0	45-65	>65
Potassium meq%	<0.10	0.10-0.20	0.20 - 0.60	0.60-1.00	>1.00
Calcium meq%	<1.00	1.00-2.50	2.50 - 5.00	5.00-10.00	>10.00
Magnesium Meq%	<1.00	1.00-1.50	1.50- 2.50.	>2.50	>>2.50
Organic matter %		<1.50	1.50 - 4.00	4.0	>>4.00
Organic Carbon %		<0.87	0.87 - 2.32	2.32	>>2.32

RESULTS AND DISCUSSION

Effects of PlantCatalyst on Soil Properties Analysed

There was an increase in all the soil properties that were analysed. Soil samples were collected two times during the trial – before the crop was planted and soon after harvest. Soil chemical analysis showed that the soil at catalyst trial site had an initial pH value of 5.2, indicating that the soils were acidic in reaction to optimum growth of tobacco, Groundnut and maize, these crops favours soil pH of between 5.5 and 6.2. Generally, PlantCatalyst had positive influence on soil nutrients and caused the low pH levels at initial soil analysis of soil complex to increase after applications (Table 3). PlantCatalyst caused the pH of the topsoil solution to change from initial low values of 5.2 to increase to 6.0 for maize field, 5.82 for groundnut field and 5.94 for tobacco field.

The available P was 8.00 (Table 3), thus suggesting that in this very acidic soils the available P was very low and below the minimum threshold available P value of 10 ppm. In acid tropical soils, particularly those that are highly weathered, oxides and hydroxides of Al and Fe in acidic soils dominantly fix P. There were significant differences Mehlich 3-available P. Generally, Plant Catalyst caused an increase in the Mehlich 3-available P in the soil from initial low value levels of 9.0 to higher levels of 19.65 for maize field, 21.62 for groundnut field and 20.26 at the end of harvest. Higher pH promotes higher uptake of phosphate and improved nutrient use efficiency.
Initial exchangeable potassium, calcium and magnesium contents were low (Table 3.) Plant Catalyst caused an increase in exchangeable Ca, K and Mg in the soil from initial low values (Table 3) to higher levels at the end of harvest. There was a significant effect on nutrient availability in the soils treated with Plant Catalyst.

Table 3: Influence of Plant Catalyst on soil pH, P, Mg, K and Ca in 2019 – 2020 Growing Season

	pH ($cacl_2$)		P (ppm)		Mg meq%		K meq%		Ca meq%		OC %		Est. Nitrogen %		OM %	
Treatment	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
Maize catalyst	5.2	6.0	8	19.65	1.04	1.51	0.08	1.57	2.39	7.53	0.49	0.80	0.09	0.15	1.1	1.70
Tobacco Catalyst	5.2	5.94	8	20.26	1.04	2.01	0.08	1.49	2.39	8.88	0.49	0.87	0.09	0.16	1.1	1.64
Groundnut Catalyst	5.2	5.82	8	21.62	1.04	2.10	0.08	1.56	2.39	11.98	0.49	0.79	0.09	0.17	1.1	1.78

Reaction of Tobacco PlantCatalyst

Plant Catalyst had a significant influence on the tobacco yields ($p \leq 0.05$) (Table4, Fig 1). There was significant increase in the yield per hectare in plots that received 60ml of Catalyst and half rate of fertiliser ($P \leq 0.05$). The highest yields from this combination was 2476kg/ha. The second on the ladder was the plot that received 60ml of Catalyst and three quarter fertiliser ($P \leq 0.05$), the yields were 2207kg/ha. It was further observed that the highest Plant Catalyst of 60ml translated into high yields in all the fertilizer rates, indicating that yield was a function of Plant Catalyst and fertilizer rates. The yield of 60ml was not optimum there is need to increase the Plant Catalyst rates from the 60ml to other higher rate.

Table 4: Influence of Combining PlantCatalyst and Inorganic Fertiliser on the Tobacco Yield at Mpale during 2019- 20120 Growing Season

TREATMENT	YIELD KG/HA
1/2 FRT X 60PC	2476a
2/3 FRT X 60PC	2207b
FULL RATE X 30PC	1892c
FULL RATE X 60PC	1884c
FULL RATE X OPC	1512d
1/2 FRT X 30PC	1328e
2/3 FRT X 30PC	1309e
2/3 FRT X 0PC	1154f
1/2 FRT X 0PC	1007g
1/3 FRT X 60PC	1006g
1/3 FRT X 0PC	999g
1/3 FRT X 30PC	986g
0 FRT X 60PC	975g
0 FRT X 30PC	968g
0 FRT X 0PC	808h
MEAN	1367.4
SED±	35.46
CV(%)	3.2
F-Prob	<.001
$LSD_{0.05}$	72.63

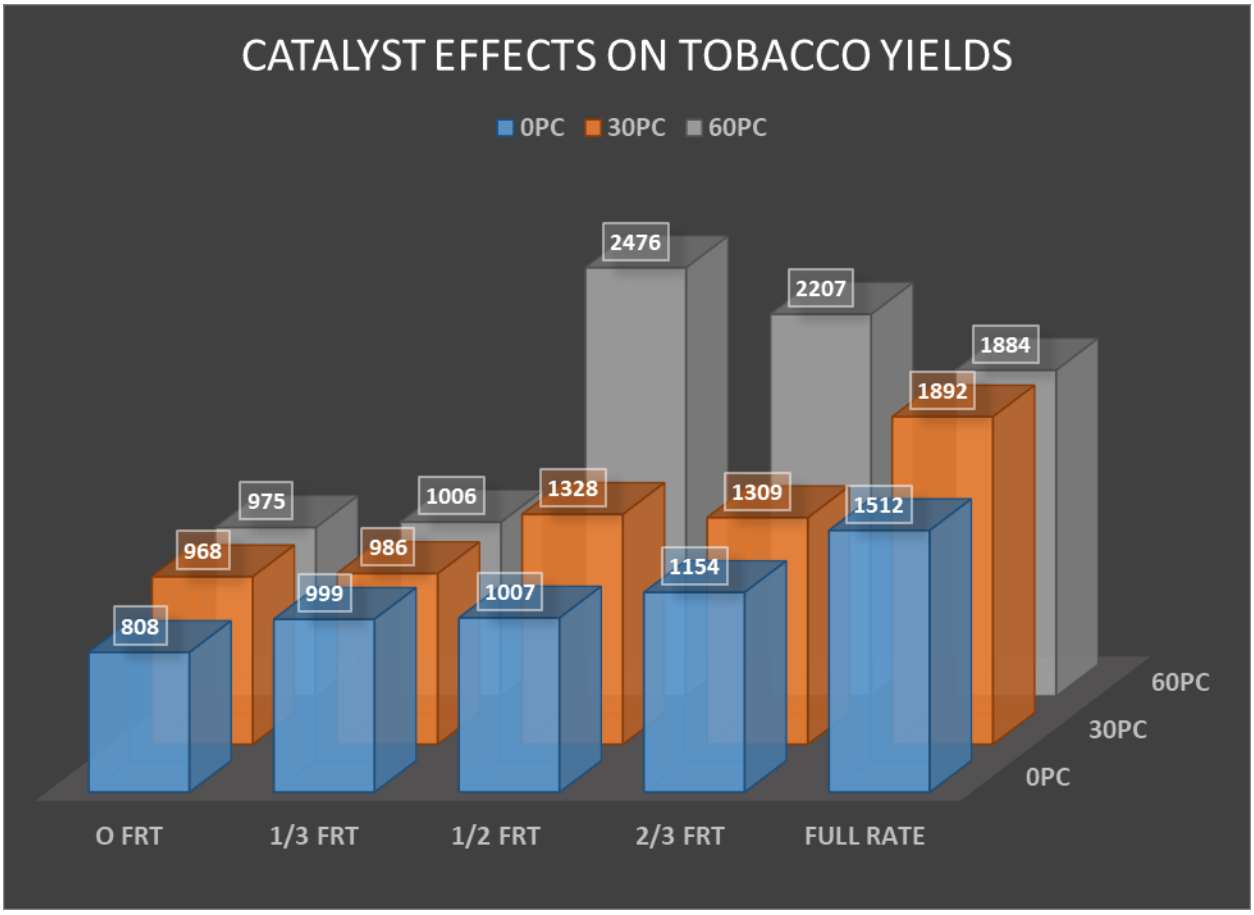

Figure 1: ***Effect of*** **Fertiliser Rate by Plant Catalyst on Tobacco Yields**

Reaction of Groundnut to PlantCatalyst

For groundnuts there were two sets of experiments, one set of the experiment was planted under commercial production (early planting, 250kg/ha of fertiliser, fungicide applied) (Table5) while other set was planted under smallholder scenario (planting at the onset of rains, 100kg/ha fertiliser, no fungicide) (table 6). In groundnuts, Plant Catalyst had a significant influence on the groundnuts yields on both sets. For groundnut planted under commercial had higher yields compared to smallholder, but the trend on yield and yield components were similar. Plant Catalyst had a significant influence on the groundnut pod yields (Table 5-6, Fig 2-4). There was an increase in groundnut pod yield per hectare in plots that received 60ml of Catalyst and two third rate of fertiliser on both production practices. The highest pod yield per hectare in plots that received 60ml of Catalyst and two third rate of fertiliser were 5448kg/ha and 2881kg/ha under commercial and smallholder production respectively. Plant Catalyst had a significant influence on the groundnut Kernel yields (Table 6, Fig 5). There was an increase in kernel yield per hectare in plots that received 60ml of Catalyst and two third rate of fertiliser on smallholder production practice. The highest kernel yield per hectare in plots that received 60ml of Catalyst and two third rate of fertiliser was 1959 kg/ha.

Table 5: Influence of Combining Plant Catalyst and Inorganic Fertiliser on the Groundnut Yield and Yield Components at Mpale during 2019-2020 Growing Season under Commercial Production

Treatments	DAYS TO 50% FLOWER	DRY POD WT KG/HA	KERNEL WT KG/HA	HAULMS WT KG/HA	SHELLING%	100 SEED WT (G)
O FRT X 0PC	47.00	4006.41	2596	4887.82	64.80	61.00
O FRT X 30 PC	49.00	4166.67	2858	5427.88	68.60	66.00
O FRT X 60PC	50.00	4246.79	2667	6490.38	62.80	59.00
1/3 FRT X 0PC	47.00	4326.92	3029	6100.96	70.00	74.00
1/3 FRT X 30PC	47.00	4407.05	2821	6522.44	64.00	65.00
1/3 FRT X 60PC	47.00	4487.18	3204	5777.24	71.40	61.00
1/2 FRT X 0PC	47.00	4647.44	2881	4919.87	62.00	68.00
2/3 FRT X 0PC	48.00	4807.69	2933	5456.73	61.00	87.00
1/2 FRT X 30PC	51.00	4967.95	3189	6097.76	64.20	54.00
1/2 FRT X 60PC	50.00	4967.95	3478	4177.88	70.00	62.00
2/3 FRT X 30PC	47.00	5016.03	3431	6738.78	68.40	56.00
FULL RATE X OPC	50.00	5064.10	3545	5456.73	70.00	53.00
2/3 FRT X 60PC	47.00	5448.72	3498	6097.76	64.20	47.00
FULL RATE X 30PC	50.00	5128.21	3169	6741.99	61.80	56.00
FULL RATE X 60PC	47.00	5128.21	3333	6100.00	65.00	73.00

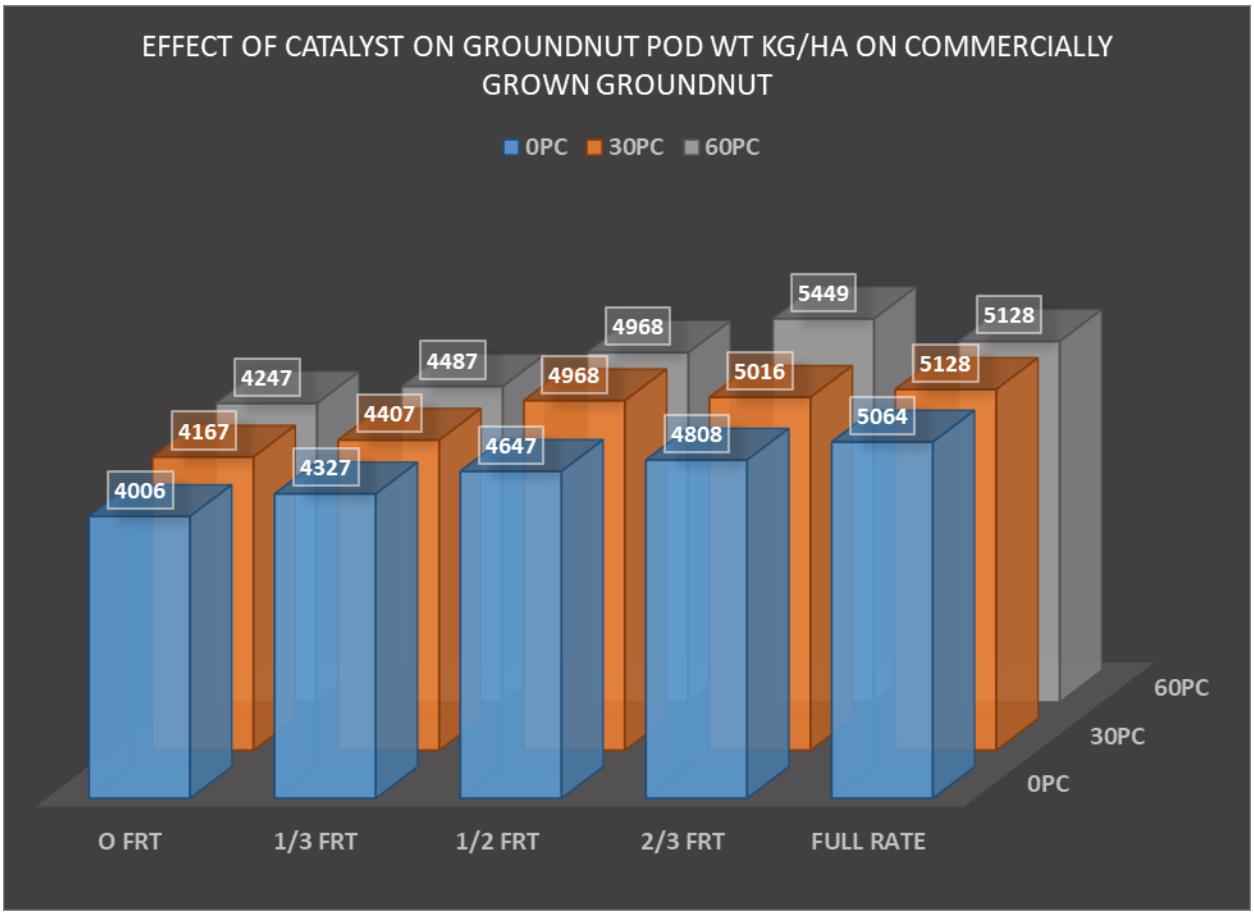

Figure 2: *Effect of* Fertiliser Rate by Plant Catalyst on Groundnut Pod Yields under commercial production

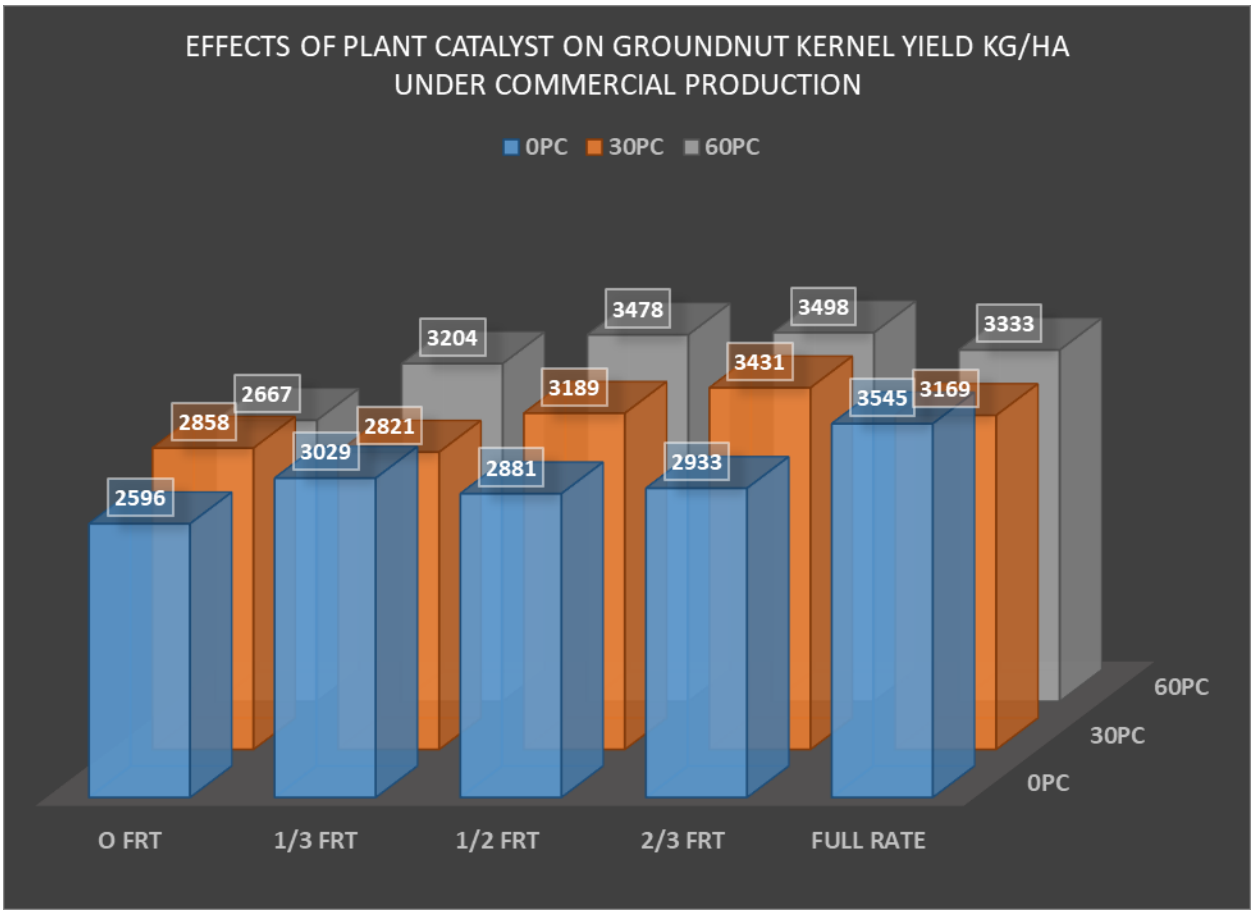

Figure 3: *Effect of* Fertiliser Rate by Plant Catalyst on Groundnut Kernel Yields under commercial production

Table 6: Influence of Combining Plant Catalyst and Inorganic Fertiliser on the Groundnut Yield and Yield Components at Mpale during 2019-2020 Growing Season under Smallholder Production

TREATMENT	DAYS TO50% FLOWER	DRY POD WT KG/HA	KERNEL WT KG/HA	HAULMS WT KG/HA	SHELLING %	100 SEED WT KG/HA
O FRT X 0PC	63	1615	790	5071	57	52
O FRT X 30 PC	66	1609	896	7878	64	56
O FRT X 60PC	67	1446	636	7811	55	57
1/3 FRT X 0PC	60	974	679	6670	56	47
1/3 FRT X 30PC	73	1282	676	8191	59	43
1/3 FRT X 60PC	62	1292	830	6617	59	55
1/2 FRT X 0PC	60	2237	1175	8372	56	58
2/3 FRT X 0PC	73	1769	1151	9899	70	57
1/2 FRT X 30PC	48	2256	1304	8220	67	56
1/2 FRT X 60PC	59	2093	1053	9795	59	61

2/3 FRT X 30PC	67	1913	1215	8369	66	59
2/3 FRT X 60PC	48	2881	1959	11803	68	58
FULL RATE X 30PC	63	2240	1523	8548	68	58
FULL RATE X 30PC	55	2577	1567	14688	68	61
FULL RATE X 60PC	67	2269	1430	10234	63	51

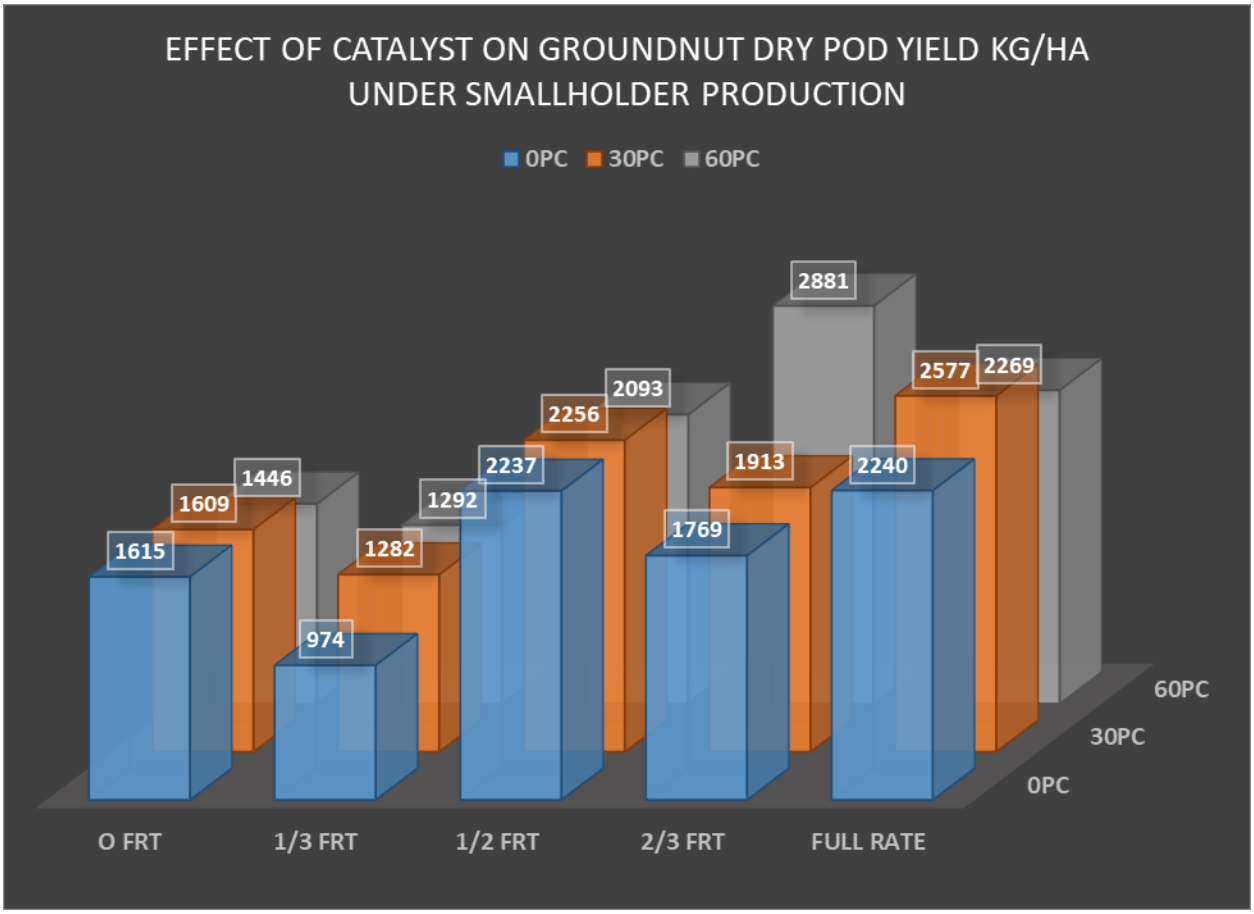

Figure 4: ***Effect of*** **Fertiliser Rate by Plant Catalyst on Groundnut Pod Yields under Smallholder production**

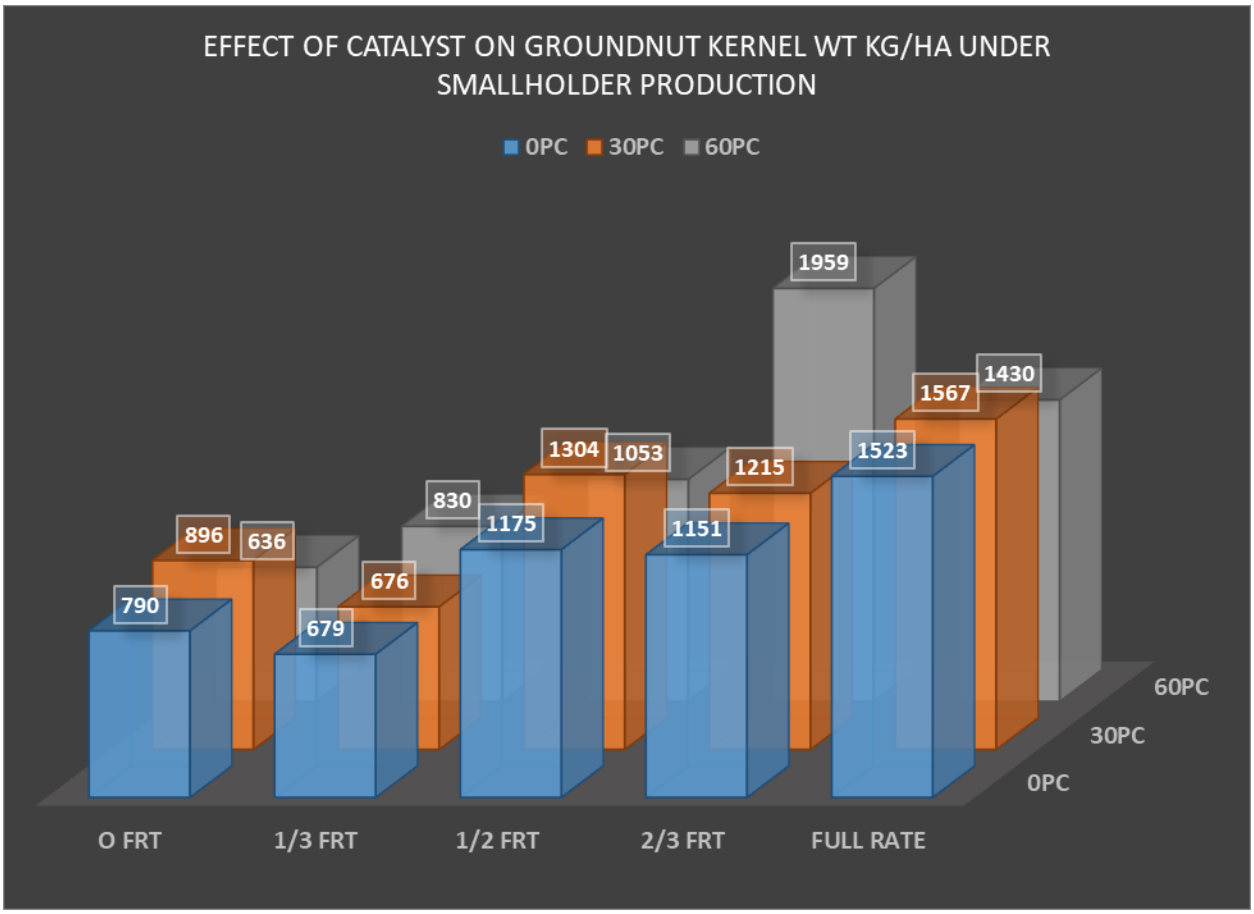

Figure 5: ***Effect of*** **Fertiliser Rate by Plant Catalyst on Groundnut Kernel Yields under Smallholder production**

Reaction of Maize to PlantCatalyst

Plant Catalyst had a significant influence on Maize yields (Table 7, Fig 6, 7, 8).

The Plant Catalyst of 60ml by 2/3 Fertilizer rate gave the highest maize yields (8390Kg/ha), highest 100 seed weight (367g), highest in cob weight before shelling(217g) highest Kernel weight after shelling(179g).

Table 7: Influence of Combining Plant Catalyst and Inorganic Fertiliser on the Maize Yield and Yield Components at Mpale during 2019- 2020 Growing Season

Plot	TREATMENT	Stalks Count Net	Stalks kg/ha	Cob Length	No of Kernel Per Cob	Cob Weight B4 Shelling (g)	Cob Weight/Cob after Shelling (g)	Kernel Weight /cob after Shelling (g)	1000 Seed Weight (g)	Maize Yield Kg/ Ha)
1	O FRT X 0PC	280	4103	12	344	95	15	80	100	1000
2	O FRT X 30 PC	298	4200	11	347	86	13	73	150	1500
3	O FRT X 60PC	284	4014	10	350	90	16	74	156	1600
4	1/3 FRT X 0PC	290	4165	11	352	80	17	63	175	2000
5	1/3 FRT X 30PC	344	4852	14	451	163	25	137	299	4385
6	1/3 FRT X 60PC	296	5160	13	373	138	21	117	315	4870
7	1/2 FRT X 0PC	318	5303	14	428	179	28	151	334	4885
8	2/3 FRT X 0PC	312	5853	12	444	150	25	126	308	5684
10	1/2 FRT X 30PC	314	5888	13	444	160	30	130	311	5700
9	1/2 FRT X 60PC	368	6310	13	400	159	24	134	320	6051
11	2/3 FRT X 30PC	298	6619	14	366	149	24	124	327	6204
12	FULL RATE X OPC	356	7020	13	360	169	27	143	342	6567
13	2/3 FRT X 60PC	314	9199	15	549	217	38	179	367	8390
14	FULL RATE X 30PC	298	8296	13	411	173	29	148	331	7267
15	FULL RATE X 60PC	296	8364	15	440	195	30	165	359	7870

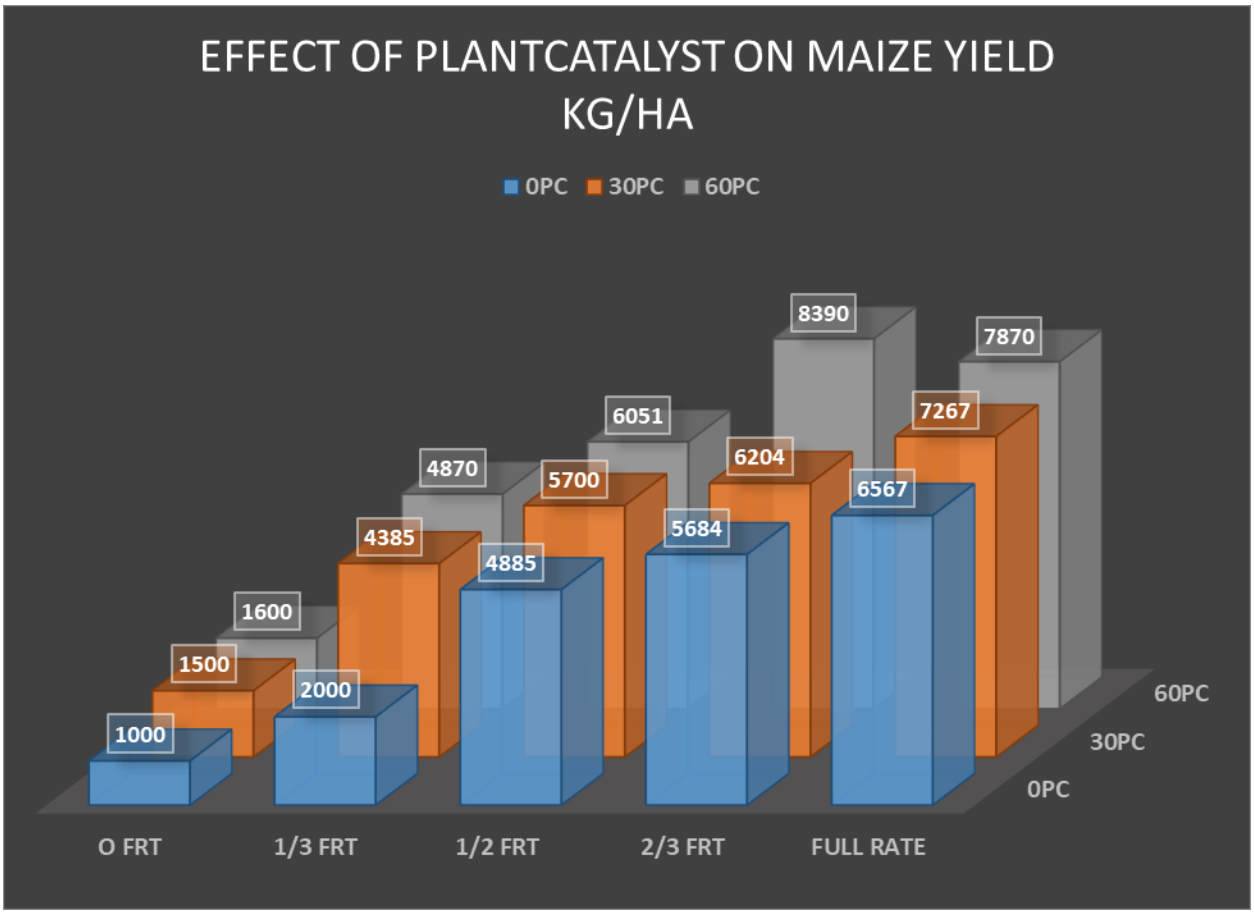

Figure 6: ***Effect of*** **Fertiliser Rate by Plant Catalyst on Maize Yields Kg/ha**

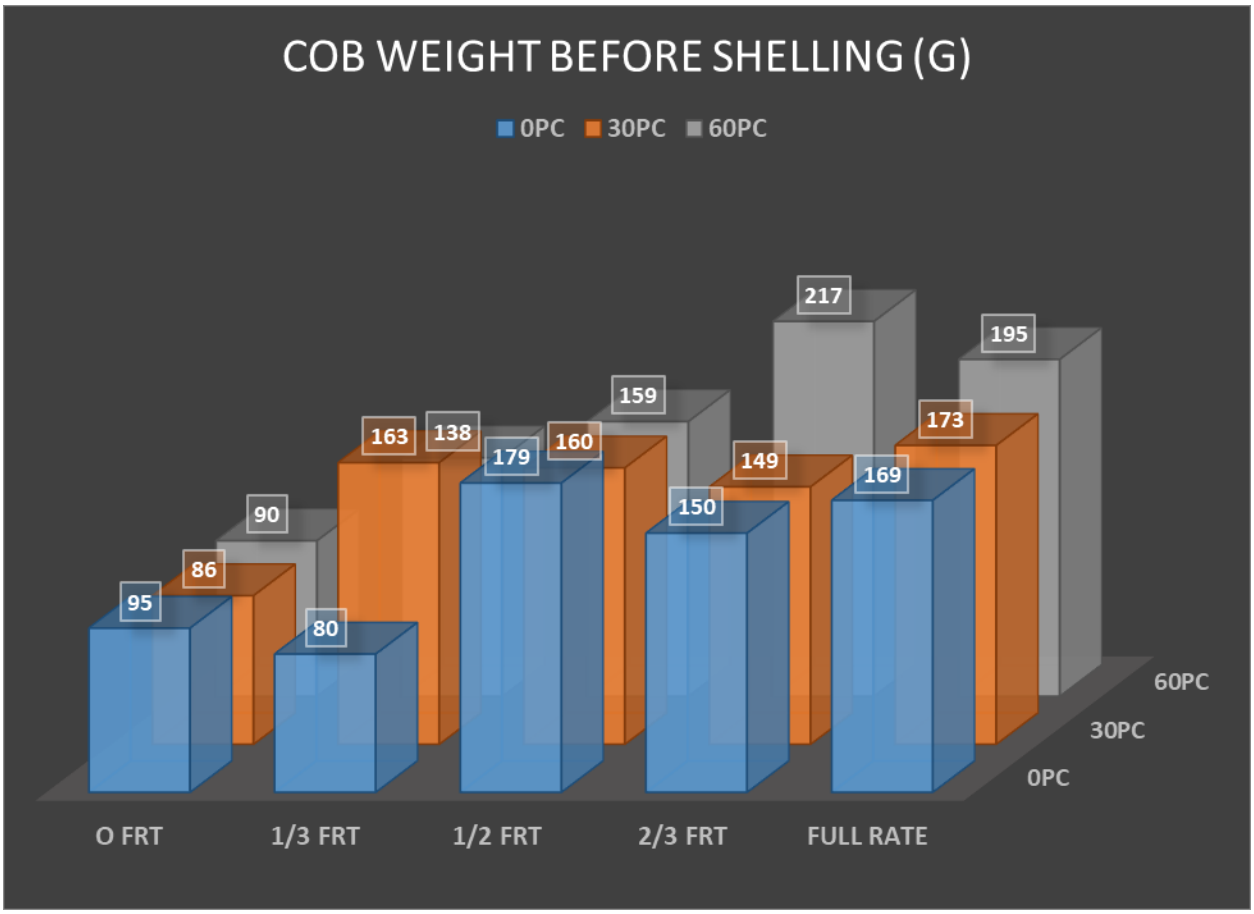

Figure 7: *Effect of* Fertiliser Rate by Plant Catalyst on Cob Weight before Shelling (G)

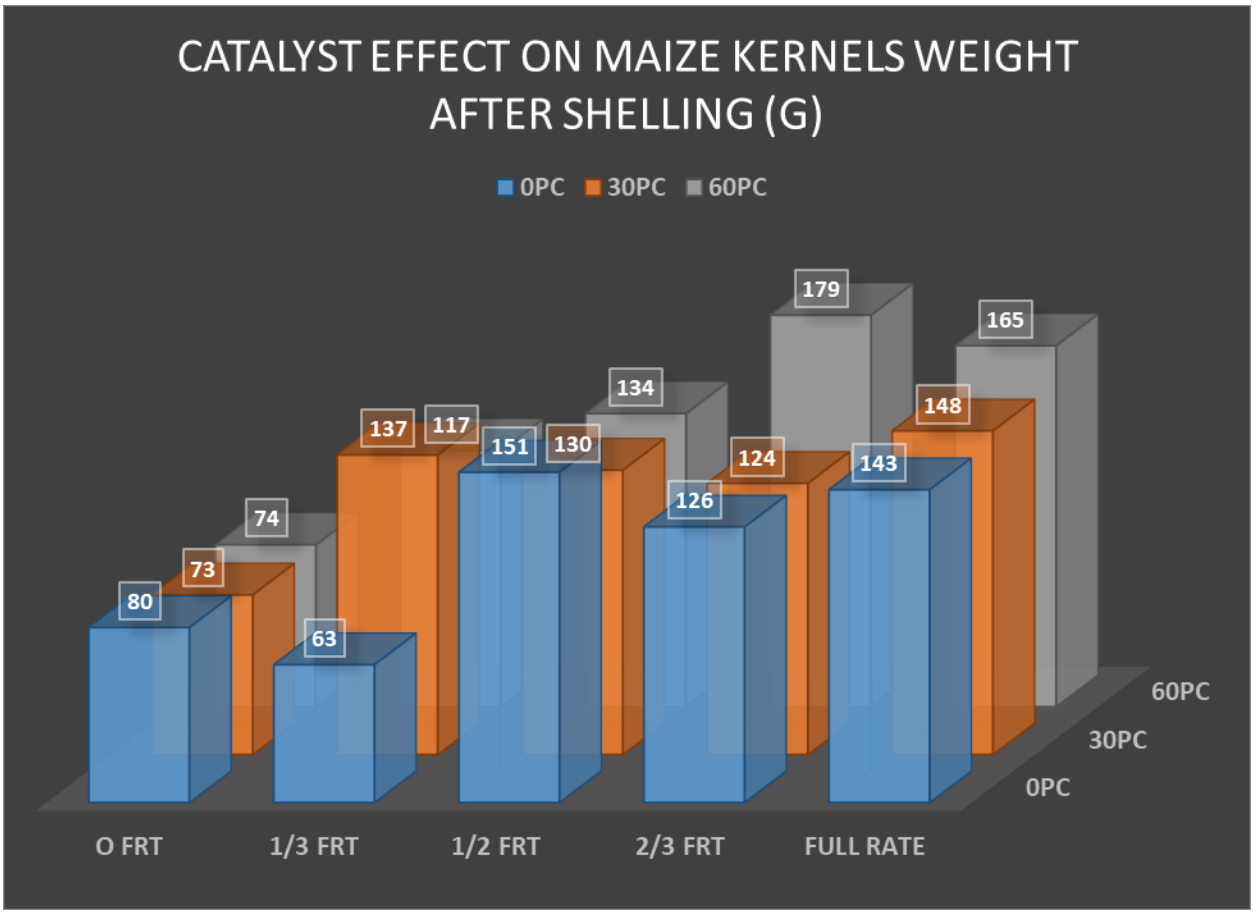

Figure 8: *Effect of* Fertiliser Rate by Plant Catalyst on Maize kernel weight after Shelling (g)

CONCLUSION

There was an increase in all the soil properties that were analysed. Generally, Plant Catalyst had positive influence on soil nutrients and caused the low pH levels at initial soil analysis of soil complex to increase after applications. Plant Catalyst caused an increase in exchangeable Ca, K and Mg in the soil from initial low values (to higher levels at the end of harvest. There was a significant effect on nutrient availability in the soils treated with Plant Catalyst. Plant Catalyst had a significant influence on the tobacco, groundnut and Maize yields ($p \leq 0.05$). The Plant Catalyst of 60ml by 1/2 Fertilizer rate gave higher yields on tobacco (2476kg/ha). The second on the ladder was the plot that received 60ml of PlantCatalyst and three quarter fertiliser ($P \leq 0.05$), the yields were 2207kg/ha. There was an increase in groundnut pod yield per hectare in plots that received 60ml of Catalyst and two third rate of fertiliser on both production practices. The highest pod yield per hectare were 5448kg/ha and 2881kg/ha under commercial and smallholder production respectively. The Plant Catalyst of 60ml by 2/3 Fertilizer rate gave the highest maize yields (8390Kg/ha), highest 100 seed weight (367g), highest in cob weight before shelling(217g) highest Kernel weight after shelling(179g).