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PERFORMANCE OF TOMATO TO COMBINED APPLICATION OF FOLIAR ALGIFOL AND GRANULAR NPK FERTILIZERS ON A TYPIC HAPLUSTALF OF NIGERIAN SAVANNA

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ABSTRACT

In a greenhouse study conducted in 1999 and 2000 with soils from the Institute of Agricultural Research Experimental Farms, Samaru, (Latitude 11°11'N and Longitude 7°38'E) in the northern guinea savanna (NGS) agro-ecological zone of Nigeria, the effects of different levels of foliar fertilizer (Algifol) and in a combination of granular NPK fertilizers on tomato cultivar, Roma - VF, were determined. Observations were made on plant height, number of leaves and fresh fruits yield per plant. The results showed that treatments effect on plant height at 6 and 10 weeks after transplant (WAT) were not significant (P=0.05) in 1999 but was highly (P=0.01) significant at 10WAT in 2000. Leaves per plant were not significantly (P=0.05) different against treatments at 6WAT in both years but at 10WAT, the effect was highly significant (P=0.01). Fresh fruits yield/plant in 1999 was significant (P=0.05) and highly significant (P=0.01) in 2000. Combined application ranked best in growth and yield of tomato than with either single Algifol or NPK in view of its greater nutrient resources to meet crop needs.

KEYWORDS: Foliar, savanna, conventional NPK, Algifol, combined application.

INTRODUCTION

Northern guinea savanna agro-ecological zone of Nigeria has remained a veritable area for tomato cultivation over the years owing to its suitable soil type and tolerable climatic conditions. However, the impact of continuous cultivation and the inherent low fertility of the soils have seriously contributed to reducing annual harvested tonnage of the crop thereby necessitating the application of inorganic fertilizers.

NPK fertilizers have been used extensively in the savanna to boost crop growth and yield, however their use efficiency has continued to decline over time especially nitrogen which is rapidly used to stimulate early vegetative growth as in cereals (Lombin, 1987 and Jones, 1987) in addition to crop removal, thus the amount left in the soil may not be adequate to complete the life cycle of the crop. Phosphorus is easily fixed on the spoil colloid being predominantly kaolinitic (Ojanuga, 1979). Leaching of nitrate and K are not uncommon among Nigerian savanna soils (Uyovbisere and Lombin, 1991). In view of these, it became imperative to introduce a foliar fertilizer source "Algifol" which apart from complementing the soil applied NPK, also furnishes the needed micronutrients towards a more efficient crop performance.

Algifol is sourced from brown algae in the ocean and processed into concentrated solutions. Literature available says the product is rich in micronutrients, plant hormones and enzymes (Timbilla, 1998). In China, Turkey, England and Egypt where the climate is generally temperate, Algifol has produced enormous results (Fleming, 1996). However, under tropical soil systems of generally low fertility, it became necessary to apply it in suitable combination with the conventional NPK. The objectives of the study were therefore, to evaluate the responses of tomatoes to the combined effect of Algifol and NPK and to determine a suitable rate of application of Algifol.

MATERIALS AND METHOD

The experiment was conducted in a greenhouse in 1999 and 2000. Soil samples were collected from the Institute of Agricultural Research Experimental Farms at Ahmadu Bello University, Samaru, Zaria. The soil is classified as Typic Haplustalf by the USDA Soil Taxonomy (Valette and Ibanga, 1984) and is reported as formed on drift materials overlying basement complex rocks with some recent aeolian deposits. The soil samples were bulked, mixed thoroughly and scooped into a 15 litre clean perforated plastic pots. Representative samples were taken, air-dried and sieved through a 2mm mesh for soil analysis. There were sixteen treatments having four levels of foliar Algifol (½, 1, 1½ and 2 Alg) at the rate of 5:10:15:20ml per 100ml of water for dilution. Four sprays were applied at an interval of 20 days beginning from 4 weeks after transplant (WAT). NPK levels were equally four (¼, ½, ¾ and Full NPK) at the rate of 125:50:50kgha^{-1} for N, P_2O_5 and K_2O respectively being the optimum recommendation for tomato in the savanna zones of Nigeria (Adepetu et al, 1989). However, the recommendation was increased four folds as 125:250:375:500 kgNha^{-1}; 50:100:150:200 kgP_2O_5 and K_2O ha^{-1} respectively. The combined fertilizer levels were ½ Alg + Full NPK, ½ Alg + ¼ NPK, 1Alg + ½ NPK, 1Alg + ¾ NPK, 1Alg + Full NPK, 1½ Alg + ½ NPK and 2 Alg + ¼ NPK which were applied at the same rates for Algifol and NPK. Nitrogen was split applied first at transplanting, then at 3 and 6WAT while phosphate and K were applied once at transplanting. The treatments were completely randomised with two replications each with one control.

At transplanting, two seedlings (ROMA-VF variety) were transplanted per hole at two holes per pot giving a population of four stands per pot and at 4WAT, thinned down to one plant per hole and 2 plants per pot at 8cm spacing. Plant height and number of leaves per plant were some of the agronomic parameters monitored at 2 weeks intervals and at harvest, fresh fruits yield per pot was determined.

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RESULTS AND DISCUSSION

Characterisation of Algifol foliar Fertilizer

From the results shown in Table 1, Algifol has a very low level of phosphorus and does not contain nitrogen which are essentially required by plants for their nutrition. The product however has higher levels of potassium, Na and Ca.

Table 1: **Chemical composition of Algifol liquid fertilizer**

Chemical Composition	Analytical Results
Macro nutrients	mgl^{-1}
Phosphorus	9.88
Potassium	3268
Sodium	647
Calcium	600
Micronutrients	$Mgkg^{-1}$
Zinc	3.75
Iron	20.00
Manganese	6.25
Copper	2.50

Soil Characterisation

Table 2 shows the initial physical and chemical characteristics of the soil used for the trial. The texture is loam and the soil is generally acidic in reaction. Total N and available P are low and indicate low amounts of residual organic mater content of the soil. Cation exchange capacity is low with a mean of 6.8 cmol(+)kg^{-1} clay accounting for the rather low values of the exchangeable cations. Similar observations have been made earlier by Singh et al (1983a) and Tarfa et al (2001) for soils of the area.

Table 2: Physical and chemical properties of soil used for the trial (0-20cm soil depth)

Soil Property	Analytical Results
Particle size	gkg^{-1}
Sand	371
	400
Clay	229
Texture	Loam
pH (H2O)	5.0
pH (0.01 M$CaCl_2$)	4.7
	gkg^{-1}
Organic Carbon	5.4
Total Nitrogen	1.27
	$Mgkg^{-1}$
Available P (Bray-1)	2.69
Exchangeable bases	cmol(+)kg^{-1}
Calcium	3.60
Magnesium	0.69
Potassium	0.47
Sodium	0.21
CEC	4.97
Micronutrients	$mgkg^{-1}$
Zinc	6.8
Copper	2.0
Iron	18.0
Manganese	18.0

Analytical procedures adopted for soil physical and chemical properties determination were: particle size analysis by the Bouyoucos hydrometer method, soil reaction in water and 0.01M $CaCl_2$ (1:2.5) soil to solution ratio with a glass electrode pH metre. Total nitrogen was determined by the micro Kjeldahl method (Bremner and Mulvaney, 1982; available P was determined by Bray No. 1 method (Bray and Kurtz, 1945); organic carbon content by the method of Walkley-Black (Nelson and Sommers, 1982) while the exchangeable bases were determined by extraction with 1 neutral NH_4OAc at a pH 7.0. The amounts of K and Na were determined using flame photometer; Ca and Mg on Atomic Absorption Spectrophotometer (AAS) and CEC was determined by displacement with 1N NH_4OAc at pH 7.0 (Page, 1982). All the data collected were subjected to statistical analysis of variance (ANOVA) at the 0.05 level of significance (Snedecor and Cochran, 1967).

Effect of Algifol, NPK and combined Algifol and NPK on tomato plant height

The various fertilizer treatments effect on plant height during the first cropping in 1999 was not statistically significant (P=0.05) at 6 and 10WAT, respectively. Even though there was no significant difference among the treatments means, there were some noticeable positive effect of the fertilizer treatments as tallest plant was recorded from 1 rate Alg (14.75cm) followed by 2 rate Alg (14.13cm) while the shortest height was 8.00cm from 1Alg + ¾NPK (Table 3). At 10WAT, 1Alg similarly recorded the tallest height but ¼ rate NPK had the shortest. Among the specific Algifol rates, 1Alg had the best performance at 6WAT, while ½Alg was the least in response. In the soil applied with solid NPK rates, ½NPK produced the tallest plant, while ¼NPK had the shortest though their treatment means were not significantly different. Among the combined foliar Algifol and NPK rates, the best performance was recorded from 1Alg + ¼NPK, while the least was obtained from 1Alg + ¾NPK but at 10WAT, the response was reversed where 1½Alg + ½NPK produced the tallest plant while 2Alg + ¼NPK had the least response. This trend indicates that at the early stage of the vegetative growth (6WAT) there is a less demand for nutrient which was met by the low nutrient levels compared to the later stage (10WAT) where nutrient requirement is higher in view of the commencement of the reproductive growth. However, combination with 2 Alg was found to be too concentrated as it resulted in leaf scorching.

During the second trial in 2000, treatment effects on plant height was not significant (P=0.05) at 6WAT but highly (P=0.01) significant at 10WAT (Table 4). At 6WAT, best performance was obtained from ¾NPK while the least came from control though their treatment means were not significantly different. The performance at 10WAT indicates that 1Alg + ¼NPK performed best followed by another combined rate of 1½Alg + ½NPK though its mean was not significantly different from that of 1Alg, 1Alg + ¾NPK, 1Alg + ½NPK and ½Alg + Full NPK respectively (Table 4). It is generally observed that as the WAT progressed from 6 to 10, especially as it approaches plant maturity stage, nutrient demand by the plant became increased which was met by the combined fertilizer ratios than with either single Algifol or NPK.

Effect of Algifol, NPK and combined Algifol and NPK on tomato leaves per plant

Response of number of leaves to the fertilizer treatments in the first cropping in 1999 was not significant (P=0.05) at 6WAT but at 10WAT the response was highly significant (P=0.01). At 6WAT, 1Alg + ½NPK produced the highest number of leaves per plant followed by 1Alg while treatment with the fewest leaves per plant was obtained from ¼NPK. At 10WAT, 1½Alg + ½NPK however performed best followed by 1Alg as was the case at 6WAT while control recorded the fewest leaves per plant (Table 3).

In the single Algifol levels, 1Alg had the best performance followed by 2Alg while ½Alg had the least at 6WAT though their treatment means were not significantly different. ½ rate NPK had the best response followed by ¾

Table 3: **Effect of Algifol, NPK and combined Algifol and NPK on tomato performance in the greenhouse house (1999)**

Trt rate	Plant height/plant		No. of leaves/plant		Fresh fruit yield/plant (g)
	WAT				
	6	10	6	10	
Control	10.43	21.38	44.00	93.50^{de}	118.5^{bcde}
½ Alg	8.63	25.50	44.00	138.00^{cde}	501.0^{ab}
1Alg	14.75	37.63	71.50	212.50^{ab}	197.0^{abcde}
1½Alg	12.00	27.38	48.50	118.50^{cde}	40.0^{de}
2Alg	14.13	33.13	67.00	128.00^{cde}	78.5^{cde}
¼NPK	10.13	14.00	40.50	67.00^{e}	15.5^{e}
½NPk	11.63	27.00	50.50	69.50^{e}	574.0^{a}
¾NPK	10.50	24.25	49.00	88.00^{e}	73.0^{cde}
Full NPK	10.63	27.00	46.00	141.50^{cde}	129.5^{bcde}
½Alg + Full NPK	10.90	31.38	51.00	162.50^{bcd}	484.5^{abc}
1Alg + ¼ NPk	12.75	36.25	62.50	167.50^{bcd}	482.5^{abc}
1Alg + ½NPK	12.33	31.75	72.00	171.00^{bc}	450.0^{abcd}
1Alg + ¾NPK	8.00	28.75	48.00	137.50^{cde}	164.0^{abcde}
1Alg + Full NPK	9.23	24.13	45.50	128.50^{cde}	198.0^{abcde}
1½Alg + ½NPK	12.13	37.00	52.50	270.50^{a}	264.5^{abcde}
2Alg + ¼NPK	8.13	21.75	50.00	99.00^{cde}	69.0^{cde}
F ratio	NS	NS	NS	**	*
SE ±	2.12	5.88	10.85	21.65	122.22
LSD	6.38	17.66	32.53	64.92	172.85

Means with the same letter(s) are not significantly different at 5% level of probability.
NS = Not significant; * = *Significant at 5%*; ** = *Significant at 1%*

rate NPK among the single NPK rates, while the least response was obtained from ¼NPK. But at 10WAT, Full rate NPK performed best while ¼NPK similarly ranked last. The trend set by 1Alg at 6WAT in recording the highest number of leaves per plant was consistent at 10WAT. This may indicate the effectiveness of the mild foliar Algifol rate in boosting vegetative growth of tomato as against the relatively more concentrated rates. At both 6 and 10WAT, combined Algifol and NPK rates performed slightly better than with single Algifol levels presumably due to their higher nutrient status while single NPK doses had the least response.

In the second trial in 2000, number of leaves per plant at 6WAT was similarly not significant (P=0.05) but at 10WAT, it was highly significant (P=0.01). At 6WAT, highest number of leaves per plant was obtained from 1Alg + ¼NPK followed by 1½Alg + ½NPK while the least performance was obtained from control (Table 4). At 10WAT, 1½Alg + ½NPK had the best performance, while ¼NPK was least. Also at 10WAT, 1Alg, Full NPK and 1½Alg + ½NPK had the best response respectively among foliar Algifol, NPK and combined rates. Combined fertilizer treatments performed best compared to either single Algifol or NPK and this result is generally consistent with that obtained in the previous trial in 1999.

Effect of Algifol, NPK and combined Algifol and NPK on tomato fresh fruit yield

Fresh fruit yield per plant during the first cropping in 1999 was significant (P=0.05) with ½ rate NPK recording the best performance (574.0g) followed by ½Alg (501.0g), while ¼NPK had the least yield. 2 Alg, ¾NPK and 2Alg + ¼NPK recorded means that were not significantly different (Table 3). In the single Algifol levels, ½Alg performed best while 1½Alg had the least effect. ½NPK performed best while ¾ rate NPK was least in fruit yield and among the combined rates, ½Alg + Full NPK recorded the best performance though its mean was not significantly different from 1Alg + ¼NPK while the lowest response was obtained from 2Alg + ¼NPK.

In the second trial in 2000, treatments effect on fruit yield was highly significant (P=0.01) with 1Alg + ¾NPK producing the best yield (757.5g) though its treatment mean was not significantly different from other treatments like 1Alg + ½NPK, ½Alg + Full NPK and ½NPK (Table 4). ½ rate Alg similarly recorded the best performance as was the case in the previous trial in 1999 while 2Alg was least effective. The trend established in the previous trial among the single NPK and combined rates was consistent during the second trial in which ½NPK and ½Alg + Full NPK respectively performed best. Similarly, Karlen (1985) obtained increased and large fresh tomato fruit yield with increasing N and K rates. This shows that combined application of the Algifol foliar fertilizer with NPK proved to be nutritionally adequate in enhancing an adequate fruit yield than the single doses of either Algifol or NPK. There is also an indication that the less concentrated solution of Algifol like ½ - 1Alg were more effective than the relatively higher levels such as 1½ - 2Alg as they initiated leaf burning and thereby limiting the photosynthetic sites of the crop and a consequent yield reduction.

CONCLUSION

In this study, the results show that single doses of Algifol and NPK were as effective as the combined application in enhancing the crop's vegetative growth, but on the basis of yield, combined Algifol and NPK application, especially, in moderate concentrations were most effective. In the two years of study, combined Algifol and NPK treatments comparatively recorded the best performance over the single doses of either foliar Algifol or NPK which is a proof of the low fertility status of the soil but a significant response was obtained when optimum

Table 4: **Effect of Algifol, NPK and combined Algifol and NPK on tomato performance in the greenhouse (2000)**

Trt rate	Plant height/plant		No. of leaves/plant		Fresh fruit yield/plant (g)
	WAT				
	6	10	6	10	
Control	10.80	25.13[de]	38.00	96.00[ef]	102.5[de]
½ Alg	15.93	43.63[abc]	57.00	134.00[bcdef]	525.0[abc]
1Alg	16.88	47.80[ab]	70.00	201.00[ab]	382.5[bc]
1½Alg	16.55	36.05[bcd]	62.50	115.00[cdef]	330.0[cd]
2Alg	16.13	41.25[bcd]	63.00	127.00[cdef]	97.0[de]
¼NPK	12.18	22.45[e]	52.50	75.00[f]	37.0[e]
½NPk	16.30	41.18[bcd]	61.50	101.00[ef]	677.5[a]
¾NPK	17.68	27.45[cde]	60.50	104.00[def]	78.0[de]
Full NPK	16.13	41.23[bcd]	54.50	142.50[bcdef]	308.5[cde]
½Alg + Full NPK	16.13	46.83[ab]	57.50	158.50[bcde]	665.0[a]
1Alg + ¼ NPk	16.63	59.25[a]	75.00	175.00[abc]	645.0[ab]
1Alg + ½NPK	15.08	49.20[ab]	65.50	171.00[abcd]	702.5[a]
1Alg + ¾NPK	15.98	46.45[ab]	56.50	142.50[bcdef]	757.5[a]
1Alg + Full NPK	13.63	39.00[bcd]	60.00	125.00[cdef]	492.5[abc]
1½Alg + ½NPK	15.80	49.35[ab]	71.50	235.00[a]	522.5[abc]
2Alg + ¼NPK	15.18	28.13[cde]	56.00	108.00[cdef]	48.5[e]
F ratio	NS	**	NS	**	**
SE ±	1.32	4.87	8.75	19.85	83.31
LSD	3.94	14.57	26.21	59.43	249.3

Means with the same letter(s) are not significantly different at 5% level of probability.
NS = Not significant; * = Significant at 5%; ** = Significant at 1%

levels of both foliar and soil applied conventional NPK combination was incorporated. Under the tropical soil systems where nutrient depletion is a common occurrence, there is therefore the need for increased nutrients balance for an effective plant growth and development towards a sustainable crop production.

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