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GROWTH AND MINERAL COMPOSITION RESPONSE OF AGAVE (AGAVE AMERICANA) TO FERTILIZER RESIDUE AND SHADE LEVEL

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ABSTRACT

Agave is an ornamental plant which is used in landscape for beautification. The experiment was conducted at Student Field School, Ladoke Akintola University of Technology, Ogbomoso, Oyo State. The research site lies between latitude 8° 10'' N and longitude 4° 16'' E in the Southern Guinea savannah zone of Nigeria. A pot experiment of 2 X 3 factorial fitted into Completely Randomized Design (CRD) with three replications was conducted. The factors considered were residual compost (0, 5 and 10 t/ha) and shade level (shade and no shade). Data were collected on the following parameters; plant height, number of leaves, canopy diameter, leaf area, fresh biomass, dry biomass, light intensity, chlorophyll content and mineral composition which were subjected to analysis of variance (ANOVA) using GENSTAT 12th edition and separation of treatment means was done by the use of standard error at 5% level. The results showed that Agave raised under no shade had higher number of leaves, leaf area, fresh and dry biomass, calcium, magnesium, nitrogen, phosphorous and chlorophyll B content while Agave raised under shade had wider canopy and higher chlorophyll A content. Agave from residual compost of 10 t/ha had taller plant, higher number of leaves, wider leaves, higher fresh and dry biomass, more calcium, magnesium, nitrogen and chlorophyll A contents when compared with 0 and 5 t/ha compost. Agave from residual compost of 5 t/ha gave higher potassium and chlorophyll B contents than 0 and 10 t/ha compost. Plant raised under shade and from residual compost of 10 t/ha had higher calcium, magnesium, nitrogen and chlorophyll A and B contents than other treatment combinations. In conclusion, Agave raised under no shade had better growth and chlorophyll content. The higher the rate of compost application the higher the residual effect on growth of Agave. Plant raised under no shade or shade and with compost residue from 10 t/ha compost had better growth and chlorophyll content.

Keywords: *Ornamental horticulture, Agave, organic fertilizer, residual effects*

INTRODUCTION

Agave (*Agave americana*) belongs to the family Asparagaceae. It is a native of Central and South America especially Mexico. It is one of the most important perennial flowers cultivated in India. Many agave species can be grown in pots and can be cultivated for ornamental purposes, adding architectural interest to garden, landscapes, and indoor settings. Their striking rosettes, architectural forms, and drought tolerance make them popular choices for xeriscaping and arid gardens. (Saldaña and Colín, 2014). Unlike refined sugar, agave contains a small amount of fiber, which can help slow down the absorption of sugars into the bloodstream and prevent blood sugar spikes. It also contains a variety of vitamins and minerals, including potassium, magnesium, and calcium. However, it is important to consume it in moderation as it is still a sweetener and excessive consumption can lead to health issues such as weight gain and increased blood sugar levels. (Colunga-Garci´aMarin *et al*., 2017).

Organic fertilizers are derived from animal manure and plant. The use of organic inputs such as compost, crop residue and manures have great potential for improving soil productivity and plant yield through improvement of the physical, chemical and microbiological properties of the soil as well as nutrient supply (Dauda *et al.,* 2008; Bakht *et al.,* 2009; Sun *et al.,* 2015; Li *et al.,* 2017). Nutritional management through organic fertilizer is helpful for enhancing growth, yield and quality of ornamental plants (Anu and Sunil Kumar, 2020). The fertilizer efficiency of organic fertilizer is more lasting and creates a healthy environment for the soil over a long period of time.

Residual effects of manure or compost application can maintain crop performance for several years after manure or compost application ceases since only a fraction of the N and other nutrients in manure or compost become plant available in the first year after application (Motavalli et al., 1989; Eghball et al., 2002).

Shade refers to as areas with reduced or filtered sunlight. Shade-loving ornamental plants have adaptation to thrive in lower light conditions, such as broader leaves to capture more-light or a tolerance for less direct sunlight. Providing the right amount of shade can help maintain the health and vigor of ornamental plants. Shade, not only influence the amount of light received by plants but also changes other small environmental conditions, such as air and ground temperature, humidity, carbon dioxide (CO_2) concentrations which are important for plant growth (Song *et al*.,2012).

MATERIALS AND METHODS

Pot experiment was conducted between May and September, 2023 at Student Field School, Ladoke Akintola University of Technology, Ogbomoso, Oyo State. The research lies between 8° 10''N and longitude of 4° 16''E and is located within Southern Guinea-Savannah agro-ecological zone of Nigeria with two distinct bimodal seasons. Pots of 5L capacity were perforated with the use of soldering iron to allow drainage of excess water and aeration to the root. Five kilograms of dried and sifted soil was mixed with well cured Tithonia based compost at 0, 5 t/ha (11.16 g) and 10 t/ha (22.33g) which was used to plant Marigold for five months. Agave seedlings were transplanted into the pots at one seedling/pot. A pot experiment of 2 X 3 factorial fitted into Completely Randomized Design (CRD) with six replications was conducted. The Factors considered were Compost (0, 5 and 10 t/ha.) and Shade level (no shade and shade). Data collection began 5 weeks after transplanting (WAT) at a week interval for 13 weeks. Light intensity and temperature of the two growing conditions (shade and no-shade) were measured (Table 1). Data were collected on number of leaves, canopy diameter, leaf area, fresh biomass, dry biomass, chlorophyll content and mineral composition. Data collected were subjected to analysis of variance (ANOVA) using GENSTAT 12th and separation of treatment means was done by the use of standard error at 5% level

RESULTS

Shade levels

There was a significant difference in the growth parameters measured by Agave under Shade levels. Number of leaves produced by Agave raised under no shade was higher when compared with shade from 7 to 13 weeks after transplanting (WAT) but were at par from 5 to 6 WAT (Table 2).

Canopy diameter of Agave raised under shade was wider than no shade from 5-13 WAT (Table 3).

Agave grown under shade was observed to have the lesser leaf area than no shade from 10 to 13 WAT (Table 4).

In Table 5, it was observed that plant raised under no shade had higher dry and fresh weight than shade (Table 5).

There was a significant difference in the nutrient content of Agave grown under shade levels. Higher content of Nitrogen, Magnesium, Calcium and Chlorophyll B was observed from Agave raised under no shade compared with shade. However, similar Phosphorous, Potassium and Chlorophyll A contents were observed between Agave grown under no shade and shade (Table 6).

Residual effects of Compost

The number of leaves of Agave from 10 t/ha residual compost was significantly higher than 0 and 5 t/ha compost from 5 to 13 WAT except at 7 WAT where Agave from 5 t/ha residual compost produced more leaves than control (Table 2).

Residual effects of compost at the rate of 0, 5 and 10 t/ha with respect to canopy diameter were similar from 5 - 13 WAT (Table 3).

There was significant residual effects of compost on the leaf area of Agave. 10 t/ha residual compost gave widest leaves followed by 5 t/ha compost and no compost had the least leaf area (Table 4).

Both fresh and dry weight of Agave were significantly affected by residual compost. Plants from residual compost at the rate of 5 and 10 t/ha had higher fresh and dry weight when compared with 0. However, Agave from 5 and 10 t/ha residual compost were comparable (Table 5).

Agave from 0 t/ha residual compost had higher Calcium, Nitrogen and Chlorophyl B contents when compared with of 5 t/ha but comparable with 10 t/ha (Table 6). Conversely, residual compost of 10 t/ha gave the highest Magnesium and Phosphorus contents followed by no compost and the least was 5 t/ha compost (Table 6).

Interaction of shade level and compost

There was a significant interaction on the growth of Agave raised under shade with compost residue effects. Number of leaves Agave raised under shade or no shade with 10 t/ha compost residue were more when compared with 0 and 5 t/ha compost from 5 to 15 WAT except at 11 and 13 WAT, where agave grown under shade and received 0 and 10 t/ha compost had similar number of leaves (Table 2).

Agave raised under shade with 10 t/ha residual compost had higher leaf area when compared with other treat combinations from 5 – 13 WAT. Conversely, leaf area of Agave from no shade x 5 and 10 t/ha residual compost was higher when compared with no compost (Table 4).

Agave raised under shade with 5 and 10 t/ha residual compost had more fresh weight when compared with no compost (Table 5). Plant grown under no-shade with 5 and 10 t/ha compost gave higher fresh and dry weight when compared with no compost (Table 5).

Treatment combination, 10 t/ha residual compost x shade, gave more Magnesium, Phosphorus and Potassium contents when compared with 0 and 5 t/ha residual compost (Table 6). However, Agave grown under shade with 5 t/ha residual compost had higher Nitrogen content when compared with 0 and 10 t/ha compost .

Highest calcium content was recorded in Agave that received 0 t/ha compost and raised under no-shade when compared with agave that received 5 t/ha compost (Table 6). Agave grown under no-shade with 10 t/ha residual compost was observed to have highest Magnesium and Nitrogen contents followed by no-compost and 5 t\ha compost gave the lowest content. Conversely, plant raised with 10 t/ha residual compost and under no-shade had highest Potassium content when compared with no compost (Table 6).

Agave raised under shade with 5 t/ha residual compost had the highest chlorophyll B content followed by control and 10 t/ha compost gave the lowest (Table 6).

It was observed that Agave grown under no-shade with 0 t/ha residual compost had the highest chlorophyll B content followed by 10 t/ha and 5 t/ha was observed to have the lowest (Table 6).

DISCUSSION AND CONCLUSION

Plants grown under shade may experience low competition for resources such as water, nutrients, and light, allowing them to allocate more resources towards growth and canopy diameter development. Agave raised under shade had wider canopy diameter which might be as a result of reduced competition in shade. This was similar with the findings of Zhang et al. (2022) who reported that when soil moisture is high, increasing radiation and temperature may result in higher growth rate of plants, the solar radiation and the rich nutrients provided by the soil may therefore have protected the etiolation effect that the shade could have on the baobab seedlings.

Agave raised under no-shade produced more leaves, wider leaf area, higher fresh weight and dry weight, higher calcium and magnesium and chlorophyll B content which might be as a result of higher light levels in no shade environments which can stimulate greater rates of photosynthesis, leading to increased biomass accumulation, as evidenced by higher fresh and dry weight. It was in conformity with the report of Chaudhry et al. (2004) that, some plants do not need shade. Agave naturally grows in arid and semi-arid environments in sub-Saharan Africa (Fischer et al. 2020).

The plant is therefore adapted to harsh conditions, which may explain the superior performance of the plant under the full sun which were able to utilize the high nutrients in the soil.

Compost multiple positive effects on the physical, chemical and biological soil properties, contributes to the stabilization and increase of crop productivity and crop quality (Tayebeh et al., 2010 and Amlinger et al., 2007). Long-term field trials proved that compost has an equalizing effect of annual/seasonal fluctuations regarding water, air and heat balance of soils, the availability of plant nutrients and thus the final crop yields (Amlinger et al., 2007).

Compost as an organic fertilizer improves nutrient retention by increasing the soil's cation exchange capacity (CEC) and then it delivers needed food for the plant in the form of nitrogen, phosphorus and potassium, hence it improves the yield and quality of plant (Molineux *et al*., 2009 and Jayasinghe, 2012a). Residual effects from 5 and 10 t/ha compost resulted in the production of higher leaves, fresh weight, dry weight and leaf area when compared with plant treated with no compost. This was in agreement with Laila, 2011 who reported that plant performance was significantly increased due to the application of compost and Soheil et al., 2012 who documented that compost increases available form of nutrients for plant in soil and then increases root growth and nutrient uptake by plant.

CONCLUSION

The study concludes that, Agave raised under full sun had better growth and chlorophyll content. The higher the compost rate the higher the residual effects on the growth of Agave. Agave raised under full sun or shade and treated with 5 and 10 t/ha compost showed positive effect on the growth and chlorophyll content.

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Table 1: Light intensity and temperature of the two growing conditons

		am			pm		
		8	10	12	2	4	6
L	Shade	189.0	330.0	684.5	221.5	178.0	178.0
	No shade	244.0	373.0	888.0	529.5	259.0	252.5
	SE	24.3	20.7	19.4	18.5	11.4	10.5
T	Shade	26.9	28.0	29.7	30.5	30.6	28.9
	No shade	27.3	28.2	34.8	31.6	30.0	29.6
	SE	ns	ns	0.2	0.3	ns	ns

L= light intensity, T= temperature

Table 2: Number of leaves of agave plant as affected by shade levels and compost rates

		Weeks after transplanting								
		5	6	7	8	9	10	11	12	13
Shade levels	Shade	7.22	7.61	7.61	8.22	8.22	7.89	8.22	8.39	8.56
	No shade	7.11	7.11	8.33	8.89	8.89	8.89	10.11	10.89	10.89
SE (P ≤ 0.05)		0.46	0.48	0.49	0.49	0.49	0.48	0.50	0.60	0.58
Compost (t/ha)										
	0	6.67	6.67	6.83	8.17	8.17	8.17	8.83	9.00	9.25
	5	6.83	7.00	7.67	8.17	8.17	7.67	8.75	9.25	9.25
	10	8.00	8.42	9.42	9.33	9.33	9.33	9.92	10.67	10.67
SE (P ≤ 0.05)		0.56	0.59	0.60	0.61	0.61	0.59	0.62	0.74	0.71
Shade levels x Compost										
Shade	Compost									
	0	7.00	7.00	7.00	8.00	8.00	8.00	8.00	8.00	8.50
	5	6.67	7.00	7.00	7.67	7.67	6.67	7.83	7.83	7.83
	10	8.00	8.83	8.83	9.00	9.00	9.00	8.83	9.33	9.33
No Shade										
	0	6.33	6.33	6.67	8.33	8.33	8.33	9.67	10.00	10.00
	5	7.00	7.00	8.33	8.67	8.67	8.67	9.67	10.67	10.67
	10	8.00	8.00	10.00	9.67	9.67	9.67	11.00	12.00	12.00
SE (P ≤ 0.05)		0.79	0.83	0.85	0.86	0.86	0.84	0.87	1.04	1.00

SE= standard error

Table 3: Canopy diameter of agave as affected by shade levels and compost rates

		Weeks after transplanting								
		5	6	7	8	9	10	11	12	13
Shade levels	Shade	14.63	17.83	19.25	20.41	20.89	21.32	21.75	22.22	22.87
	No shade	11.73	14.49	14.96	15.82	16.42	16.85	17.30	17.82	18.48
SE (P ≤ 0.05)		0.972	1.44	1.478	1.346	1.336	1.328	1.337	1.33	1.316
Compost (t/ha)										
	0	13.22	15.69	17.48	18.42	19.07	19.52	19.93	20.45	21.13
	5	13.69	15.62	16.35	17.24	17.85	18.27	18.70	19.18	19.8
	10	12.64	17.17	17.49	18.68	19.04	19.47	19.94	20.45	21.10
SE (P ≤ 0.05)		ns	ns	ns	ns	ns	ns	ns	ns	ns
Shade levels x Compost										
Shade	Compost									
	0	14.15	16.45	19.35	20.62	21.23	21.7	22.07	22.57	23.27
	5	15.96	17.16	18.53	19.14	19.64	20.05	20.45	20.93	21.56
	10	13.79	19.88	19.88	21.45	21.8	22.22	22.72	23.16	23.78
No shade										
	0	12.28	14.93	15.62	16.22	16.92	17.33	17.78	18.32	18.98
	5	11.42	14.08	14.18	15.33	16.07	16.49	16.95	17.42	18.05
	10	11.48	14.47	15.09	15.91	16.27	16.73	17.17	17.74	18.41
SE (P ≤ 0.05)		1.684	ns	ns	ns	ns	ns	ns	2.304	ns

SE= standard error

Table 4: Leaf area of agave as affected by shade levels and compost rates

		Weeks after transplanting								
		5	6	7	8	9	10	11	12	13
Shade levels	Shade	548	685	773	958	1079	1153	1328	1437	1548
	No shade	546	600	757	971	1061	1347	1546	1676	1855
	SE (P ≤ 0.05)	ns	76	ns	ns	ns	145	158	168	190
Compost (t/ha)										
	0	429	483	555	779	866	946	1130	1224	1351
	5	523	616	756	914	1021	1241	1411	1538	1651
	10	690	830	985	1199	1323	1564	1770	1907	2103
	SE (P ≤ 0.05)	81	93	113	132	146	178	194	198	233
Shade levels x Compost										
Shade	Compost									
	0	502	569	635	843	943	928	1110	1193	1330
	5	446	571	651	826	947	1038	1180	1297	1379
	10	697	917	1033	1205	1348	1494	1694	1820	1936
No shade										
	0	356	396	476	716	789	964	1150	1256	1372
	5	600	661	860	1003	1096	1445	1641	1778	1923
	10	683	743	936	1193	1298	1633	1846	1993	2271
	SE (P ≤ 0.05)	114	130	159	186	206	252	274	280	330

SE= standard error

Table 5: Fresh and dry weight of agave as affected by shade levels and compost rates

		Fresh weight	Dry weight
		g/plant	
Shade levels	Shade	57.1	8.0
	No shade	128.0	25.4
	SE (P ≤ 0.05)	4.4	1.5
Compost (t/ha)			
	0	80.3	14.6
	5	98.4	17.6
	10	98.8	17.9
	SE (P ≤ 0.05)	5.4	1.8
	Shade levels x Compost		
Shade	Compost		
	0	46.6	7.8
	5	58.8	7.5
	10	65.8	8.5
No shade			
	0	114.0	21.4
	5	138.0	27.6
	10	131.9	27.2
	SE (P ≤ 0.05)	7.6	2.6

SE= standard error

Table 6: Mineral and chlorophyll content of agave as affected by shade levels and compost rates

		Ca mg/kg	Mg mg/kg	N %	P mg/kg	K mg/kg	ChlA mg/kg	Chl B mg/kg
Shade levels	Shade	2300	476	0.04	203	3067	539	273
	No shade	3155	1015	0.08	212	2950	523	289
	SE (P ≤ 0.05)	798.1	195	0.02	ns	ns	ns	3.40
Compost (t/ha)								
	0	3191	638	0.09	150	2708	521	392
	5	2170	392	0.08	134	3432	453	293
	10	2821	1207	0.02	340	2885	620	159
	SE (P ≤ 0.05)	977.5	240	0.02	184	ns	ns	4.20
Shade levels x Compost								
Shade	Compost							
	0	2148	314	0.03	80	3334	402	299
	5	2260	332	0.09	85	3741	535	422
	10	2491	783	0.01	445	2125	681	99
No shade								
	0	4235	961	0.15	220	2082	639	485
	5	2080	453	0.07	184	3122	370	164
	10	3151	1631	0.3	234	3645	559	219
	SE (P ≤ 0.05)	1382	339	0.03	260	1260	363	5.90

Ca= Calcium, Mg=magnesium, K=potassium, N=nitrogen, P=phosphorus, Chl A =chlorophyll A, Chl B =chlorophyll B SE= standard error