A comparative study of the effect of organic manure and inorganic fertilizer on germination and hydroponic production of *Amaranthus hybridus* (L.) in South Eastern Nigeria.

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Introduction

A significant problem facing world agriculture is the wide variation in crop yields from year to year due to variation in environmental stresses. Undoubtedly, hydroponics was called upon to play a key role in national and international food production due to these challenges. As urbanization expands, problems related to supply of certain food items, mainly vegetables, becomes critical. Increased transportation costs make the distribution of goods and services more expensive. In 1960s and 1970s, in response to various problems associated with soil (water supply, plant nutrition, lack of certain components that are essential for some crops), the developed countries focused on the search for other media or alternatives (substrates) that could replace soil for production of some crops(Laura, 2008). Some school of thought opine that the use of organic nutrient source(MNR) in hydroponic produces crops that are more nutritionally balanced, tastier with even better yield in comparison to the use of inorganic nutrient source (FTZ), and which could compare favourably with soil based plantings (Bhat *et al* .2013). The current study was designed to compare the effect of MNR and FTZ applied to different substrates for germination, hydroponic crop yield, and proximate content of fresh marketable leaves of *A. hybridus*(Fig. 1).

Figure 1. *Amaranthus hybidus plants*

Table 3: Effect of Treatments on Plant Growth

Treatments	NOL	COS	PLH	A OL 7	AOL 8
RS+ FTZ	3.00 ± 0.548^{ab}	1.02 ± 0.049^{ab}	13.36 ± 2.91^{a}	10.44 ± 1.45^{a}	11.37 ± 0.98^{a}
TS+ FTZ	2.50 ± 0.267^{a}	1.08 ± 0.108^{ab}	12.01 ± 1.11^{a}	13.07 ± 1.41^{a}	13.23 ± 1.30^{a}
RH+ FTZ	3.50 ± 0.342^{bc}	1.05 ± 0.022^{ab}	12.48 ± 0.82^{a}	26.01 ± 14.02^{ab}	12.61 ± 1.26^{a}
SD+ FTZ	2.80 ± 0.200^{ab}	0.96 ± 0.040^{a}	11.04 ± 1.48^{a}	12.40 ± 1.98^{a}	14.48 ± 1.43^{a}
RH + MNR	4.25 ± 0.35^{c}	1.40 ± 0.084^{c}	15.88 ± 1.42^{ab}	40.02 ± 4.824^{b}	39.37 ± 4.54^{b}
SD + MNR	3.16 ± 0.297^{ab}	1.30 ± 0.080^{bc}	12.46 ± 0.474^{a}	18.66 ± 2.162^{a}	18.24 ± 1.45^{a}
RS+ MNR	4.33 ± 0.225^{c}	1.55 ± 0.090^{c}	17.57 ± 1.488^{ab}	43.64 ± 5.631^{b}	41.58 ± 4.32^{b}
TS +MNR	4.25 ± 0.218^{c}	1.89 ± 0.114^{d}	22.65 ± 1.221^{c}	65.04 ± 5.985^{c}	69.92 ± 6.23^{c}
TS + W	4.33 ± 0.188^{c}	1.85 ± 0.114^{d}	22.00 ± 1.591^{c}	67.78 ± 5.989^{c}	71.10 ± 5.539^{c}

Means bearing the same letters do not differ significantly using DMRT

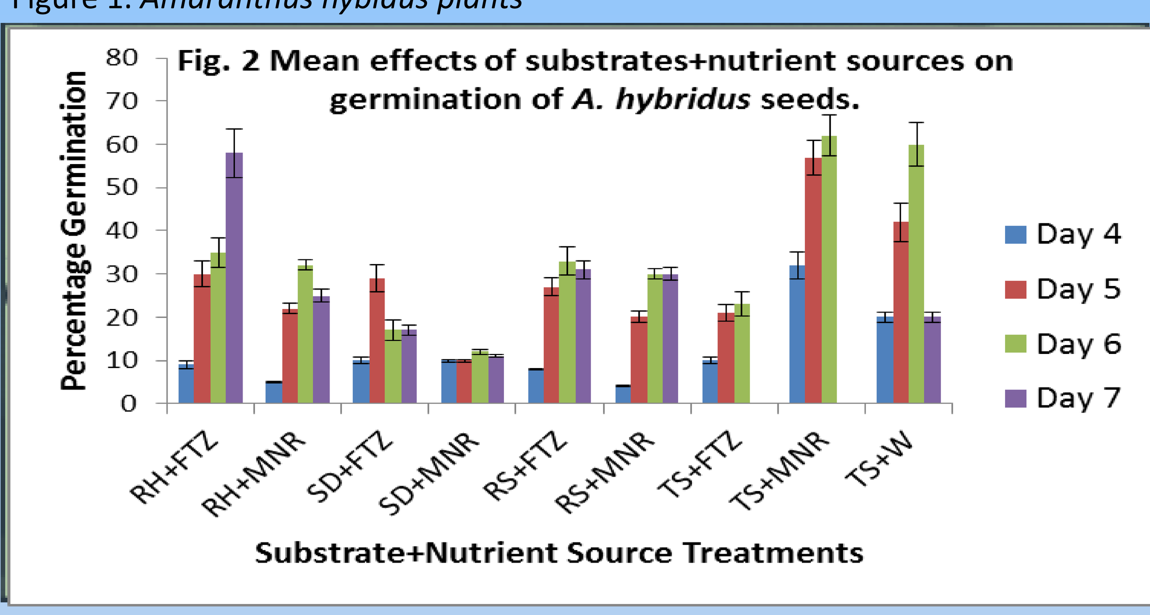

Fig. 2- Effect of Substrates + Nutrients on the germination of *A. hybridus* seeds

Table 4. Effect of treatments on the fresh weight of *A. hybridus* plants

Treatment	FWS	FWR	FWI
RS+ FTZ	1.9833 ± 0.197^{a}	1.5667 ± 0.128^{a}	1.0167 ± 0.0167^{b}
TS+ FTZ	2.5700 ± 0.405^{a}	1.7286 ±0.204^{a}	0.0000 ± 0.000^{a}
RH+ FTZ	2.2750 ± 0.342^{a}	1.6625 ± 0.125^{a}	0.9625 ± 0.024^{b}
SD+ FTZ	2.0438 ± 0.143^{a}	1.4375 ± 0.105^{a}	0.15000 ± 0.150^{a}
RH + MNR	21.5455 ± 4.663^{b}	6.6500 ± 0.815^{bc}	1.1136 ± 0.139^{b}
SD + MNR	2.9875 ± 0.263^{a}	2.7417 ± 0.234^{ab}	0.0000 ± 0.000^{a}
RS+ MNR	16.6142 ± 2.731^{b}	5.1958 ± 0.762^{b}	2.1250 ± 0.214^{c}
TS +MNR	44.7083 ± 5.242^{c}	9.0083 ± 1.380^{d}	1.6167 ± 0.336^{bc}
TS + W	41.3750 ± 4.964^{c}	7.5750 ± 0.894^{cd}	1.6167 ± 0.338^{bc}

Means bearing the same letters do not differ significantly using DMRT

Table 1: Mean length of Plumule and Radicle grown in different treatments

Treatment	Length of Plumule	Length of Radicle
RS+ FTZ	1.3167 ± 0.132^{a}	0.7667 ± 0.061^{a}
TS+ FTZ	1.2000 ± 0.093^{a}	0.7250 ± 0.071^{a}
RH+ FTZ	1.1250 ± 0.0446^{a}	0.8833 ± 0.068^{ab}
SD+ FTZ	1.1250 ± 0.0446^{a}	0.8833 ± 0.068^{ab}
RH + MNR	2.0667 ± 0.109^{c}	1.3333 ± 0.156^{c}
SD + MNR	1.8583 ± 0.100^{bc}	1.3583 ± 0.157^{c}
RS+ MNR	1.7750 ± 0.109^{bc}	1.2667 ± 0.098^{c}
TS +MNR	1.8750 ± 0.117^{bc}	1.3583 ± 0.109^{c}
TS + W	1.6667 ± 0.096^{b}	1.1583 ± 0.095^{bc}
LSD	0.60	0.58

Means bearing the same letters do not differ significantly using LSD ≤ 0.05

Table 5. Effect of treatment on the dry weight of *A. hybridus* plants

Treatment	(DWS)	(DWR)	(DWI)
RS+ FTZ	0.5333 ± 0.533^{a}	0.3000 ± 0.30^{a}	0.1333 ± 0.133^{a}
TS+ FTZ	05333 ±0.533^{a}	0.5000 ±0.252^{a}	0.0000 ± 0.000^{a}
RH+ FTZ	0.8000 ±0.404^{a}	0.5000 ± 0.264^{a}	0.1333 ± 0.133^{a}
SD+ FTZ	0.8000 ± 0.404^{a}	0.5000 ±0.252^{a}	0.0000 ± 0.000^{a}
RH + MNR	7.4333 ±2.545^{ab}	2.433 ±2.140^{a}	0.3000 ± 0.300^{a}
SD + MNR	1.8600± 0.769^{a}	0.1667 ±0.166^{a}	1.4333 ± 0.176^{b}
RS+ MNR	9.9333 ± 0.317^{b}	2.400 ±2.400^{a}	1.1000 ± 0.153^{b}
TS +MNR	27.0000 ± 4.725^{c}	1.300±1.300^{a}	1.0167 ± 0.280^{b}
TS + W	27.1667 ± 2.127^{c}	1.1667 ± 1.667^{a}	1.4333 ± 0.176^{b}

Means bearing the same letters do not differ significantly using DMRT

Table 2. Effect of treatments 2 weeks after application of nutrient solutions.

Treatment	Number of node	Area of 10th leaf	Area of 11th leaf
RS+ FTZ	0.0000 ± 0.000^{a}	10.4340 ± 1.491^{a}	10.6540 ± 2.206^{a}
TS+ FTZ	0.2500 ± 0.250 ^{a}	14.9325 ± 2.092^{a}	15.4875 ± 1.901^{a}
RH+ FTZ	0.0000 ± 0.000^{a}	12.8133 ± 1.245^{a}	12.5817 ± 1.525^{a}
SD+ FTZ	0.0000 ± 0.000^{a}	13.3960 ± 0.893^{a}	15.5360 ± 1.549^{a}
RH + MNR	2.7500 ± 0.729^{b}	64.1533 ± 7.322^{b}	64.8317 ± 8.266^{b}
SD + MNR	0.4167 ± 0.336^{ab}	17.7792 ± 1.402^{a}	19.5300 ±1.792^{a}
RS+ MNR	2.0000 ± 0.899^{ab}	54.8650 ± 6.560^{b}	58.2817 ± 5.731^{b}
TS +MNR	5.9167 ± 0.897^{c}	98.8625 ± 7.182^{c}	100.1125 ± 6.779^{a}
TS + W	4.7500 ± 0.897^{bc}	102.1258 ± 7.731^{c}	105.9075 ± 8.849^{a}

Means bearing the same letters do not differ significantly using DMRT

Table 6. Proximate analysis of *A. hybridus* leaves from different treatments

Treatment	Moisture (%)	Ash (%)	Fat (%)	Fiber (%)	CHO (%)	Protein (%)
RS+ FTZ	87.94	0.95	2.65	0.63	4.15	3.68
TS+ FTZ	85.93	0.98	2.39	0.75	4.30	5.70
RH+ FTZ	84.37	0.93	2.58	0.67	5.75	5.69
SD+ FTZ	75.89	0.99	2.54	0.70	16.29	3.61
RH + MNR	86.27	1.11	2.17	0.67	6.27	3.51
SD + MNR	85.25	0.97	2.22	0.71	7.60	2.98
RS+ MNR	88.52	0.93	2.57	0.68	3.13	4.03
TS + MNR	72.50	0.87	2.45	0.66	20.12	3.42
TS + W	87.52	0.97	2.18	0.69	3.81	4.83

Objectives

To determine whether significant differences exist in the germination and seedling growth of *A. hybridus* seeds planted in RH,RS and SD substrates with TS as the positive control, treated with MNR and FTZ as nutrient sources(Treatments). To also determine if significant differences exist in the vegetative and reproductive growth of *A. hybridus* grown in the treatments. To equally determine if significant differences exist in the proximate content of the leaves of *A. hybridus* grown in the treatments.

Materials & Methods

Germination studies

For germination studies (5kg, 6kg, 7kg, of saw dust, rice hull and river sand) substrates were respectively soaked in water for 24h. Precisely 100g of fertilizer (NPK [20:15:15] mixed with Urea in the ratio of 2:1) as well as, organic manure (poultry droppings) were individually dissolved in 20litres of water to formulate the nutrient solutions. The 9 treatments were: Rice hull + fertilizer=RH+FTZ, Rice hull + fertilizer=RH+FTZ, Saw dust + fertilizer =SD+FTZ, Rice hull + manure=RH+MNR, River sand + manure=RS+MNR, Saw dust + manure=SD+MNR, Top soil + fertilizer=TS+FTZ- (+ve control), Top soil + manure=TS+MNR- (+ve control), Top soil + water only=TS+W- (+ve control). Thirty seeds were planted in each of the 10litre sized black polythene bags perforated at the bottom. There were 3 replications per treatment. To each of the bags were added 400ml of nutrient solution. The bags were kept inside a screen house. Data were collected on the following parameters: percentage germination, length of plumule and radicle.

Growth, yield studies and Proximate analysis.

The substrates and treatments were similar to that for germination. There were 12 replications. The 4 weeks old seedlings were transplanted into each of the 108 polythene bags at a depth of 5cm. Thereafter 100ml of each of the stock nutrient solutions was diluted with 5 litres of water following the method of Savvas (2003). This was applied 5 times per week to the bags. Watering was weekly. Data were collected on node number, number of leaves, circumference of stem, plant height, area of leaves, fresh and dry weights of shoot, root and inflorescence. All data were subjected to ANOVA and means separated using DMRT. Proximate analysis was carried out on the leaves following standard protocols. The following data were collected-ash, fat, fiber, carbohydrate and protein contents.

Results and Discussion

For the germination studies SD+MNR treatment was the poorest while the other treatments showed appreciable germination with RH+FTZ out performing the others and comparing favourably with TS+MNR and TS+W controls(Fig. 2). Obviously the nutrient content of RH coupled with its water retention ability and the fast nutrient releasing FTZ facilitated this performance. For the growth of the seedling as shown in Table 1, the MNR treatments outperformed the other treatments with RH+MNR outperforming even the controls. Again the rich nutrient content of RH coupled with that of MNR, usually released slowly could be responsible. For the growth of the plants, Table 2 shows that the same trend where the MNR treatments outperformed the others after 2 weeks of application of the nutrient sources. The performance of the RH+MNR treatment for number of node, area of 10th and 11th leaves, was about 50% of the controls that were not hydroponic treatments. For the overall effect of the treatments on plant growth(Table 3), the same trend was observed with all the MNR treatments outperforming the FTZ treatments in number of leaves(NOL), circumference of stem(COS), plant height(PLH), area of leaf 7(AOL7 and AOL8). This shows that the substrates RH , which are abundant is ideal for hydroponics and meets Munoz(2010) standards for good hydroponic substrates and also confirms the findings of Pani (2010). For fresh and dry weights of the plants, similar trends were observed, though SD+MNR treatment showed poor performance akin to those of the FTZ treatments(Tables 4 and 5). For fresh weight RH+MNR gave appreciable results which was close to 50% of the controls. The performance of TS+MNR was however lower than this though still encouraging. The slow release of nutrients by MNR is believed to be responsible for this performance. The poor performance of the FTZ treatments is believed to be connected with the leaching of the inorganic fertilizer after successive watering. For dry weight RS+MNR treatment gave a better result than RH+MNR treatment for the dry weight of shoot(DWS), dry weight of root(DWR) and dry weight of inflorescence(DWI). The reason for this is not clear and merits further studies which might include chemical analysis of the river sand used. For the proximate analysis the treatment RH+FTZ gave the best result for protein content which was equaled by the control TS+FTZ. The Carbohydrate(CHO) content of SD+FTZ was the highest and compared favourably with that of TS+MNR control. The fiber and fat and ash contents of all the treatments were almost identical, with the exception of RH+MNR which had the highest ash content. It does appear that these qualities are not very much influenced by nutrient source. This merits further investigation. The moisture content of all the treatments were high enough equally suggesting that this quality may not be highly dependent on nutrient source, otherwise the controls ought to have shown higher values. The studies points to a bright future for hydroponic production of *A .hybridus* in the region.

Summary and Conclusion

The present study showed that the performance of plants grown in liquid organic manure applied to rice hull substrate is good for both germination, growth and production of *A. hybridus* in Eastern Nigeria and perhaps in other areas. River sand plus nutrients especially the MNR performed better than Saw dust. The performance hierarchy is given as follows: RH+Nutrient > RS+Nutrient > SD+Nutrient. RH + MNR is the choice combination for hydroponic production of *A. hybridus* in Eastern Nigeria.

Citations

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