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WATER HYACINTH BASED ORGANIC FARMING AS A SUSTAINABLE METHOD FOR CULTIVATION OF ANDROGRAPHIS PANICULATA: A MEDICINAL PLANT OF GREAT PROMINENCE

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Abstract: Andrographis paniculata is a worldwide known medicinal plant grown mainly in India and China. It is being directly consumed as medicine. Therefore, it is necessary to adopt an organic method of cultivation to maintain human health safety. In this study, water hyacinth (Eichhornia crassipes) was collected from sweet water and water hyacinth (WH) based organic manure was used for the cultivation of Andrographis paniculata using pot assay. Water hyacinth imposes a threat to ecosystem balance and water quality. In the present study, eight treatments were implemented, from which the treatment with 25% water hyacinth and 75% chicken manure application at the rate of 10 tonnes /hectare(ha) provided promising results for growth improvement and yield than others. The maximum dry matter yield was found to be 1180 kg/ha with the application of WH and chicken manure(1:3), followed by 1134 kg/ha with the application of WH and chicken manure(1:1) when compared to other treatments. Also, the water hyacinth based organic manures have been tested for EC, pH, Total Organic Carbon, heavy metals, nitrogen, phosphorus, and potassium to assure their quality before commencing experiments. In the view of the above

observations, it is recommended to make use of the water hyacinth based organic manures for medicinal plants especially to ensure good yield and fertility of the soil.

Keywords: *Andrographis paniculata*, organic farming, sustainable agriculture, water-hyacinth, yield

1. Introduction:

Kalmegh (*Andrographis paniculata*) is a member of family Acanthaceae and is one of the nineteen types of the class Magnoliopsida. It is indigenous to India and has been a part of Indian frameworks of medication since days of past. *Andrographis paniculata* has been used to treat gastro-intestinal tract, upper respiratory infections, fever, herpes, sore throat, and other chronic and infectious diseases in Asian countries from ancient times (Radhika, 2012). Manageable horticulture targets utilizing the soil and environment assets for nourishment creation without imperiling the limit of people in the future to do likewise. It infers a foundational approach of nourishment creation, considering the government assistance of the total environment, including human and other organisms. Healthy soil is a pivotal segment of economical farming. Saving it requires a decrease in the utilization of engineered composts and reallocation towards the work of common assets for improving yield profitability (Reganold and Wachter, 2011). Several organic revisions are being utilized, such as, fertilizer, manure, biogas slurry, and crop deposits that upgrade natural carbon, water holding limit, and a total strength of the soil. Along these lines, natural cultivating vows to keep up the physicochemical what's more, natural parameter of soil, which expands its efficiency (Garcia-Orenes *et al*. 2010, Prosdocimi *et al*. 2016).

Soil application of natural fertilizer delivered from differing sources, like cows excrement, pig fertilizer, nourishment, and agricultural waste, woods litter, weed biomass and so forth., improves crop foundation, development, and yield of harvests (Atiyeh *et al*. 2000), reestablish the soil organic matter (SOM) and off-set disturbance of supplement cycling brought about by concentrated farming practices (Lal 2004). Natural fertilizer impacts soil efficiency through

the impact on soil physico-synthetic also, natural properties (Das et al. 2004, 2017). Cheaper organic manure can be generated by using water hyacinth, an aquatic weed having the capacity of huge proliferation. Water hyacinth(WH), *Eichhornia crassipes*, is progressively being used as a supplement provider as treated the soil material (Malik,2007) and like other natural manures, it increments physical and organic supplement stockpiling limit, water-holding limit, cation trade limit, smaller-scale total in soils and can diminish the impact of over-treatment by moderate arrival of supplements(Khan and Sarvvar, 2002). Utilization of water hyacinth manure in leafy foods crops creation is answered to build yield(Lata and Veenapani,2011). Water hyacinths have a high potential to supply nitrogen as it can put away to 3.2% in its dry mass and it has a carbon to nitrogen proportion (C/N) of around 8 to 15 (Sarvar 2002; Gunnarsson,2007).

2. Materials and methods:

2.1 Collection of materials

Water hyacinth plants were collected from a nearby lake in Dabhoi, Vadodara. They were washed thoroughly with tap water. The plants were then chopped into small pieces (2-3 cm) and allowed to dry partially before composting. Cow dung used in the study was collected from a nearby cattle shed, chicken manure was collected from Chanwada village, near Tilakwada, Vadodara, and goat fecal pellets were collected from a Timbi, Vadodara a nearby village. The treatments employed in this study are: Treatment 1 (T1): Control (No manure added), Treatment 2 (T2): Decomposed Water hyacinth (mulched), Treatment 3 (T3): Water hyacinth and Chicken litter (1:1), Treatment 4 (T4): Water hyacinth and Chicken litter (1:3), Treatment 5 (T5): Water hyacinth and Goat manure (1:1), Treatment 6 (T6): Water hyacinth and Goat manure (1:3), Treatment 7 (T7): Water hyacinth and Cow dung (1:1) and Treatment 8 (T8): Water hyacinth and Cow dung (1:3)

2.2 Compost preparation

The compost pits of 1m x 1m x 2m (lxbxh) were prepared in Dabhoi, Vadodara. A quantity of 50 kg plant material and 50 kg of animal litter in case of treatment 3, 5, and 7 were added to the pits and quantity of 25 kg of plant material and 75 kg of animal litter was added in case of treatment 4, 6 and 8. For treatment number 2, the water hyacinth material was allowed to decompose by adding a small amount of cow dung slurry and excel microbial consortium(amount as given on pack) to provide the necessary inoculum and to speed up the decomposition process. The materials were allowed to decompose for 90 days and water was sprinkled on it as and when required to ensure proper moisture content in the pits. Mixing of the contents in the pit was carried out every 20 days (*Tejada et al*, 2008). The dark-colored final product obtained at the end was collected, sieved, and stored in the clean and dry room for further use (Dhal *et al.*, 2011).

2.3 Seed characterization and vigor tests

Seeds of *Andrographis paniculata* (Kalmegh) were obtained from Anand Agricultural University, Anand, Gujarat. The characterization of the seeds and vigor tests were performed as per Abdul-Baki and Anderson, 1973.

2.4 Manure analysis

The manures prepared were analyzed for physical and chemical properties as per the Fertilizer Control Order (FCO) regulation of organic fertilizers.

2.5 Culture assay of *Andrographis paniculata*

The soil-sand (3:1) mixture was weighed about 10 kg and prepared manures were added at the rate of 10 tonnes/ha. The mixture was mixed thoroughly and filled in pots and allowed to rest for about a week before sowing the seeds. Random Block Design of eight treatments was replicated 3 times. Various growth parameters like shoot length(cm), root length(cm), plant height(cm), stem girth(cm), leaf length(cm), distance between branches(cm), leaf number and leaf area(cm2) were measured at 30 days after sowing (DAS), 60 DAS, 90 DAS and 120 DAS. Fresh weight (g) and dry weight(g) of the plant were measured at 30, 60, 90, and 120 days by carefully uprooting the plant from the pots (Jagadeesh *et al*,2018).

2.6 Data analysis

Statistical analysis was done using SPSS 16.0 software. The data were subjected to one-way ANOVA with a confidence interval of 95% ($p \leq 0.05$). The means were separated using Duncan's Multiple Range Test (DMRT).

3. Result and Discussion

3.1 Seed characterization and vigor tests

The morphological characters were calculated for the seed lot of *Andrographis paniculata*. The average seed vigor index-I of four replicates is observed to be 1273.4 and the seed vigor index-II was 0.98.

Table 1: Morphological characters and vigor index of seeds of *Andrographis paniculata*

Name of the plant	Shape	Color	Length (cm)	Breadth (cm)	Thickness (cm)	Number of seeds per one gram	Hundred seed weight (g)	First count	SVI-I	SVI-II
Andrographis paniculata	Obovate	Brownish	0.20 ±0.003	0.21± 0.005	0.10±0.003	637±2.18	0.16±0.001	61±2.18	1273.4± 140.97	0.98±0.08

SVI- Seed vigor index, Values show mean of 4 replicates±Standard error

3.2 Manure analysis

Table-2 shows the physical properties of the prepared manures. From the result, it can be observed that moisture content ranged from 18.9 to 30.3% by weight for different composts whereas the bulk density ranged from 0.43 to 0.68 g/cm3. The lowest pH was found to be of the manure prepared by 1:1 ratio of water hyacinth and chicken manure while the highest pH was found to be of water hyacinth and goat manure(1:1) which was in the range from 0.98 to 3.30. The composts had brown to black color with no foul odor.

Table 2: Physical properties of water hyacinth based organic manures

Sr. No.	Manures	Moisture (percent by weight)	Bulk Density (g/cm3)	pH	EC(dsm^{-1})	Color	Odour	Days for composting
1	WH+chicken manure(1:1)	20.87±0.28	0.59±0.01	7.03±0.01	3.30±0.01	Dark Brown	No foul odor	70
2	WH+chicken manure(1:3)	26.4±0.49	0.51±0.01	7.10±0.05	2.75±0.01	Dark Brown	No foul odor	70
3	WH+goat manure(1:1)	20.2±1.56	0.49±0.01	7.55±0.02	1.13±0.02	Black	No foul odor	90
4	WH+goat manure(1:3)	18.9±0.10	0.43±0.02	7.12±0.03	1.90±0.03	Black	No foul odor	90
5	WH+cow dung(1:1)	27.2±0.33	0.63±0.01	7.54±0.01	0.98±0.01	Brown	No foul odor	85
6	WH+cow dung(1:3)	30.3±0.61	0.68±0.01	7.44±0.01	1.27±0.01	Brown	No foul odor	85

WH- Water Hyacinth, *Ideal values reference for manures: FCO-2009; Values show mean of 3 replicates±SEM

The chemical properties of the composts can be seen as per in Table 3. The values of total nitrogen ranged from 2.08 to 4.32 percent by weight. The highest values of phosphorus were found to be 2.87 percent by weight while the lowest value was 1.24 percent by weight. The potassium content of the composts was found in range with 1.69 percent by weight being the lowest and 3.12 percent by weight being the highest. Total organic matter(TOM) ranges

from 24.48 to 49.8%. Total organic carbon(TOC) ranges from 14.19 to 28.88 which falls in perfect range according to FCO. C/N ratio found highest in water hyacinth and chicken manure(1:1) was 9.25 and the lowest value 5.07 was found in water hyacinth and goat manure(1:1).

Table 3: Chemical properties of water hyacinth based organic manures

Treatment/Manures	Nitrogen(% by wt.)	Phosphorus(% by wt.)	Potassium(% by wt.)	Total Organic Matter(%)	Total Organic Carbon(%)	C:N
	(minimum 0.8)	(minimum 0.4)	(Minimum 0.4)	-	(Minimum 12.0)	(<20)
WH:Chicken manure(1:1)	3.12	2.34	2.65	49.8	28.88	9.25
WH:Chicken manure(1:3)	2.35	2.87	2.11	25.4	14.73	6.26
WH:Goat manure(1:1)	3.69	1.24	2.39	32.26	18.71	5.07
WH:Goat manure(1:3)	2.08	2.36	1.69	24.48	14.19	6.82
WH:Cow dung(1:1)	3.26	2.59	1.95	39.6	22.97	7.04
WH: Cow dung(1:3)	4.32	2.36	3.12	38.92	22.57	5.22

WH- Water hyacinth; *Minimum limit reference: FCO-2009

The study showed that the total microbial flora of the composts falls in the category of a good number of micro-organisms required in organic manures. The CFU/ml was 7.19x108, highest in water hyacinth and goat manure(1:1). The other manures showed at least a million microflora which was an indicator of good quality compost.

Pathogenicity test results revealed that no pathogens were found in any of the composts which are important for organic manures.

Table 4: Evaluation of water hyacinth based manure for microbial density and pathogens

Manures	CFU/ml	Pathogens
WH:Chicken manure(1:1)	$3.46x10^5$	Nil
WH:Chicken manure(1:3)	$1.96x10^5$	Nil
WH:Goat manure(1:1)	$7.19x10^8$	Nil
WH:Goat manure(1:3)	$2.87x10^8$	Nil
WH:Cow dung(1:1)	$1.15x10^6$	Nil
WH: Cow dung(1:3)	$5.73x10^6$	Nil

WH- Water hyacinth; CFU-colony forming units

3.3 Growth results

After 30 days of germination, it could be observed that the shoot length of treatments T1 and T7 were at proximity. The same was the case with root length and plant height. However, at later stages, that is after 60, 90, and 120 days there was a noticeable difference in the treatments in comparison with control. T2 with decomposed water hyacinth did not give encouraging results when used alone but when it was combined with animal litter, the results were promising, especially where WH was mixed with chicken manure and composted. Regarding leaf number, since the initial stages, good results were obtained for WH and chicken manure. However, treatments T5 and T6 also showed

decent results. Leaf area for T3 was higher initially but at later stages, T4 showed higher leaf area value than all the other treatments.

Andrographis paniculata is a medicinal plant, whose leaves are dried and consumed hence the wet and dry yield of the herb is of great importance. The wet and dry weight of the plant at 120 days was significantly higher in the case of T3(14.67g and 4.33g) and T4(14.00g and 4.67g), maximum being in T4 which was followed by T5(10.33g and 2.53g) respectively. T2(1.33g) showed higher dry weight than T1(1.30g) but the difference was not very significant.

Figure 1: Effect of water hyacinth based manures on yield of *Andrographis paniculata* at 120 days

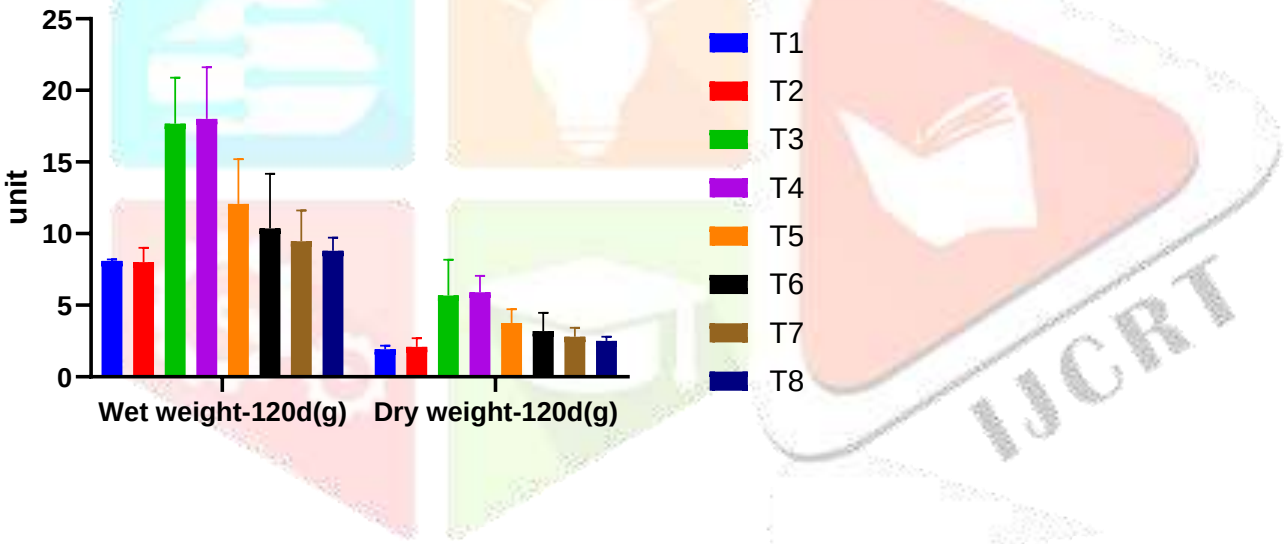
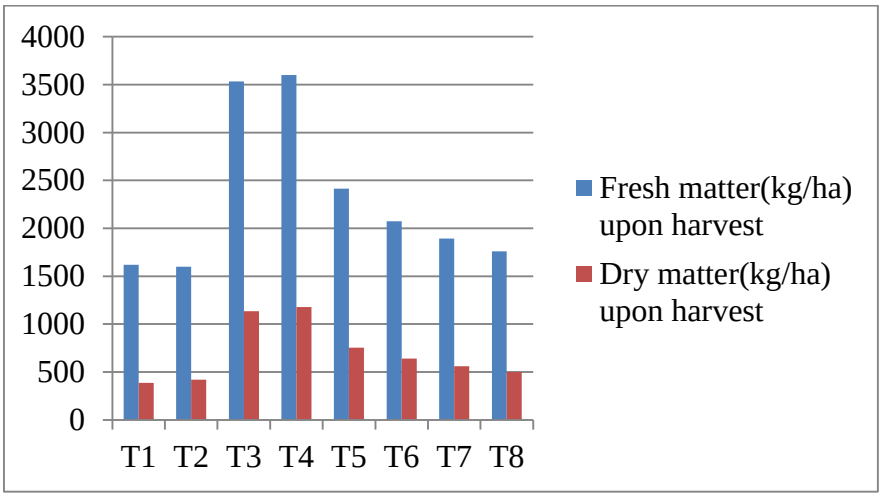


Figure 2: Fresh matter yield(kg/ha) and dry matter yield(kg/ha) of Andrographis paniculata at harvest



4. Conclusion:

Integrated application of water hyacinth and animal litter improves the growth and yield of medicinal plant Andrographis paniculata. The yield was comparable for treatments T3 and T4. A high yield can be attributed to the highest total organic carbon. Hence, based on the above results it is concluded that water hyacinth mixed with chicken manure significantly increases the growth and yield attributes than others. So, it is highly recommended for the organic cultivation of medicinal plants.

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