EFFECT OF WATER HYACINTH COMPOST ON THE VEGETATIVE GROWTH AND YIELD OF *VIGNA RADIATA* L. (PE-DI-SEIN)

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Abstract

The experiment was conducted in Pyay University Campus, Pyay Township, Bago Region. Water hyacinth, *Eichhornia crassipes* (Mart.) Solms. is a free floating weed and become a valuable soil improver as composting for crop improvement. In this experiment, the compost was made cow dung, water hyacinth, rice straw mixing at 6: 3: 1. The effectiveness of compost were studied by growing of *Vigna radiata* L., Pe-di-sein. There were four treatments and each treatment had five replications with Completely Block Design (CRD). Before experiment, the compositions of soil, cow dung, rice straw, water hyacinth and the water hyacinth compost were analyzed. The germination rate of Pe-di-sein was carried out in the mixture of soil and sand medium. The results of vegetative growth of *Vigna radiata* L. such as the maximum plant height, petiole length, number of leaves per plant, leaf width, leaf length and leaf area were observed from T_4 (10 g plant^{-1}). Moreover, T_4 (10 g plant^{-1}) gave the biggest reproductive growth like the earliest first flowering days, seeds weight per plant, seed yield, pods weight per plant and pod yield. From above the results of this experiment, water hyacinth compost would be suitable organic soil amendment for soil restoration and crop production and also for yield improvement of legume crop to apply of 10 g plant^{-1}. The utilization of water hyacinth compost resulted in several benefits to cultivars and soil fertility.

Keyword: water hyacinth compost, Completely Block Design (CRD), vegetative growth, reproductive growth

Introduction

Legumes, or pulses, are flowering plants in the leguminosae family. This family is also known as Fabaceae and has 690 genera and 18,000 species. Leguminosae family is classified into three sub-families: Papilionoideae,

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Caesalpinioideae, and Mimosoidae. *Vigna radiata* L. is originated from India. Green gram (*Vigna radiata* L.) is an erect, fast-growing, annual, herbaceous legume stems, with fulvous or brown, long, spreading or bristly pubescence. The leaves are trifoliate with ovate leaflets 5-16 long and 3-12 cm wide. The inflorescence is axillary, about 10 cm long, few to numerous flowered. Fruit is spirally dehiscent, straight, turgid with dark brown and seeds oblong-rounded, cylindrical, greenish, brown or blackish (Qi-ming, 2008).

Green gram consists of among major ten crops of Myanmar. Green gram was cultivated 1.12 million hectare at 2011-2012 and 1.14 million hectare at 2015-2016 in Myanmar. Green gram is mainly grown in Magway, Sagaing and Bago Regions. It was produced 1.32 million metric ton and was exported to India, Malaysia and Singapore (JICA, 2013).

Vigna radiata L. is a plant flavoring warm weather but requires a well distributed rainfall of 25 to 35 inches (635-889 mm). This plant is well suited to grow on deep, well drained, loamy soil, as well as on red and black soil. The land is thoroughly ploughed and manured before the seeds are sown broad cost or drilled in rows spaced 9 to 12 inches (22.86-30.48 cm) apart. The crop requires occasional weeding but no irrigation, as it is grown during the monsoon season (Pandey, 2007).

Green gram small oval seeds are highly nutritious, and the green pods are also eaten. It makes a good source of protein. The plants are used as cattle feed and also used for hay. The green gram seed is sweet, oily, laxative, tonic, diuretic and galactactagogue (Kartika and Basu, 1935).

The water hyacinth, *Eichhornia crassipes*, (Liliales, Pontederiaceae), is an invasive plant that is native of the Amazon basin and whose capacity for growth and propagation causes major conservation problems with considerable socioeconomic repercussions. It is a species of great ornamental value used in gardening because of the beauty of its foliage and flowers. Most of the problems associated with *Eichhornia crassipes* are due to its rapid growth rate, its ability to compete with other aquatic plants, and its ease of propagation. These characteristics give rise to enormous amounts of biomass

that cover the water surface of a great variety of habitats often interfering with the use and management of water resources (Tellez *et al.,* 2008). Water hyacinth as a very promising plant with tremendous application in wastewater treatment is already proved. It is used to treat waste water from dairies, tanneries, sugar factories, pulp and paper industries, palm oil mills, distilleries, etc. The water hyacinth have been found to have potential for use as phytoremediation, paper, organic fertilizer, biogas production, human food, fiber, animal fodder (Jha and Singh, 2015). Like seaweed, river grasses, water cresses, etc., the water-hyacinth has very high water content, ranging from 93 to 95 percent. Its composition varies considerably with the media in which it grows. When there is a scarcity of fertilizer elements the plant becomes diminutive, but with plenty of food the growth becomes luxurious, with a deep greenish-blue color. Fresh plant contains 95.5% moisture, 0.04% N, 0.06% P_2O_5, 0.20% K_2O, 3.5% organic matter. On a zero-moisture basis, it is 75.8% organic matter and 1.5% N (Tham, 2012). Composting water hyacinth is a good and feasible way of using harvested plants, especially in developing countries. Composting is a well-known low budget option for improving crop yields and can be carried out by mixing dried water hyacinths with soil, ash and organic municipal waste. Most important nutrients (N, P and K) are retained during the process and tolerable compost can be reached during the relatively short time period of 30 days. Decomposition of water hyacinths resulted in an increased mineralization of nutrients in the soil and as a result enhanced grain yield (Persson *et al*., 2014).

The aims and objectives of this research were to examine the role of water hyacinth compost as an organic fertilizer, to evaluate the growth and yield of *Vigna radiata* L. upon using water hyacinth compost and to distribute the knowledge of water hyacinth compost to the farmers.

Materials and Methods

Experimental Site

The experiment was conducted at the campus of Pyay University, Pyay Township, Bago Region. Soil sample was collected from the growing area of Pyay University campus before the soil preparation.

Analysis of soil sample, water hyacinth, cow dung, rice straw and water hyacinth compost

The collected soil samples, cow dung, water hyacinth, rice straw and the water hyacinth compost were analyzed in the soil laboratory, Land Use Division, Department of Agriculture, Yangon Region.

Soil Preparation

The soil from the growing area was mixed with ash in the ratio of 5:1 and the soil mix was watered and left for a week. Then the soil mixture was put into the bag.

Germination Test

Full check and almost the same size seeds are germinated in the prepared soil mixture (2:1 soil and sand) medium. The medium was put into the tray and this was divided into four plots. After that, the seeds of four plots were germinated in soil and sand (2:1) medium. One plot contained three rows and each row had ten seeds. Therefore, 120 seeds were used in the germination test. The numbers of germinating seeds were recorded. The germination rate was calculated using the method of Soupe (2009).

$$\text{Germination rate (\%)} = \frac{\text{Total No. of Germinated Seedlings}}{\text{Total No. of Cultivated Seeds}} \text{ x } 100$$

Raw materials of compost

Water hyacinth was collected from the lakes located near Pyay University campus and there were chopped into small pieces of about 2-3 cm and air-dried until the remaining of half weight. Cow dung and rice straw

were obtained from fields near by Pyay University campus. The rice straw was also chopped into 2-3 cm small pieces. Water hyacinth, cow dung and rice straw were mixed at 6:3:1 according to Dhal *et al.* (2011).

Composting process

According to Dhal *et al.* (2012), 10 kilograms of the mixture of the water hyacinth, cow dung and rice straw (6:3:1) were placed into the wood bin (length 53 cm, width 38 cm and height 31 cm). Temperature was monitored throughout the composting period. Manual turning up of compost was done in every three days throughout the composting period (Fig. 1).

Planting of *Vigna radiata* L. and Experimental layout

Five seeds of *Vigna radiata* L. were germinated in a bag. One week after sowing seeds, different rates of water hyacinth compost treatment: T_1 - control (without compost), T_2 - 8 g plant^{-1}, T_3 - 9 g plant^{-1} and T_4 - 10 g plant^{-1} were treated to the assigned plantlet. Each treatment had five replicates were laid out in a completely randomized design (CRD) (Fig. 2). The spacing between bags was 30 cm and between rows was 30 cm. Hence the total experimental area was 240 cm x 300 cm. Watering was done every day. Spraying of the organic pesticide such as Tamar pesticide, the extract of *Capsicum annum* and *Alium fruitescens* were carried out when the infestation of plants. Weeding was also carried out whenever it was necessary.

Determination of single Leaf Area

For measuring leaf area, length-width method was used in this experiment (Puttasamy *et al.,* 1976). The leaf sample was collected and measured the length and the maximum width and the area was computed as follow:

$$A = K\ L\ W$$

A = single leaf area, K = adjustment factor (0.6306)

L = leaf length, W = broadest width

Data Collection

Out of three plants in a bag, only two plants were selected for data collection. Germination rates, vegetative growth such as plant height, petiole length, number of leaves per plant, leaf width, leaf length and single leaf area, reproductive growth like first flowering days, pod length, pod width, single pod weight, pods weight per plant, and pod yield were recorded.

Results

Analysis of soil, cow dung, water hyacinth, rice straw and water hyacinth compost

Physico-chemical analysis of the soil revealed that soil was neutral with pH of 7.22. The total nitrogen was 0.46%. It had an exchangeable cation K^+ content of 1.79 meq 100 g^{-1}, an available nutrients P, 66.94 ppm (Olsen), K_2O, 84.19 mg 100 g^{-1}, moisture content of 3.83%, organic carbon, 5.64% and humus content of 10.11% (Table 1). The cow dung had the nitrogen content of 2.41%, phosphorous content of 0.36%, potassium content of 1.14%, organic carbon content of 36.85%, moisture content of 13.65% and C:N of 15.29:1 respectively. Physico-chemical analysis of the water hyacinth revealed that the total nitrogen was 2.019%, total P_2O_5 0.8122%, Total K_2O 5.20%, organic carbon 14.152%, moisture content of 46.701% and C:N of 13.42:1. Physico-chemical analysis of the rice straw stated that the total nitrogen was 0.606%, total P_2O_5 0.116 %, total K_2O 0.369%, organic carbon 9.788%, moisture content of 35.709% and C: N of 34.17:1. Physico-chemical analysis of the water hyacinth compost showed that the total nitrogen was 1.47%, total P_2O_5 1.184%, total K_2O 0.765%, organic carbon 33.527%, moisture content of 39.605%, C: N of 15.63:1 and pH 7.82 (Table 2).

Temperature and reduced weight during water hyacinth composting period

Temperature

The temperature of compost piles were recorded 3 days after composting. The initial temperature was 39°C and which drop up to 28°C

during 30 days period of composting. The mean temperature of compost pile during composting period was 32.8°C (Table 3).

Reduced weight

The reduced weight of water hyacinth compost in 5 replications expressed that out of 10 kg initial weight, the final weight became 6.8 kg in this decomposting period. Therefore, the reduced weight was 32% during 30 days period of decomposting plant materials (Table 4).

Germination test

Among 30 seeds in each plot, plot 1 had 30 germinated plants (100% of germination), plot 2 had numbers of germinated plants 27 (% of germination), plot 3, 28 germinated plants (% of germination) and plot 4, 25 germinated plants (% of germination), respectively. Therefore total germination rate is 91.67 % (Table 5).

Vegetative Growth

Plant height

According to weekly collected data, the results of plant height response to water hyacinth compost treatments showed that the longest height was 17.51 cm T_4 (10 g plant^{-1}) and it was followed by 17.11cm, T_3 (9 g plant^{-1}), then 16.79 cm, T_2 (8 g plant^{-1}) and 13.71 cm, T_1 (control) respectively (Table 6).

Petiole length

The results of petiole length response to water hyacinth compost treatments revealed that T_4 (10 g plant^{-1}) had the longest length 3.93 cm followed by T_2 (8 g plant^{-1}) 3.90 cm, then T_1 (control) 3.69 cm and T_3 (9 g plant^{-1}) had 3.25 cm respectively (Table 7).

Number of leaves per plant

The results of number of leaves per plant response to water hyacinth compost treatments showed that T_4 (10 g plant^{-1}) had much leaves 3.17. The

second highest leaf number was observed 3.12 in T_1 (Control) and 3.07, T_2 (8 g plant^{-1}) and the least number was 2.98, T_3 (9 g plant^{-1}) (Table 8).

Leaf width

The mean value of leaf width among the water hyacinth compost treatments gave that T_4 (10 g plant^{-1}) was highest leaf width 54.77 cm. It was followed by T_2 (8 g plant^{-1}) 50.94 cm, T_1 (control) 48.88 cm and T_3 (9 g plant^{-1}) had least leaf width of 45.75 cm respectively. (Table 9).

Leaf length

The result of the leaf length among the water hyacinth compost treatments showed that T_4 (10 g plant^{-1}) had highest leaf length 40.21 cm. It was followed by T_1 (control) 38.28 cm, T_2 (8 g plant^{-1}) 38.23 cm and T_3 (9 g plant^{-1}) had least leaf length of 38.07 cm respectively (Table 10).

Single leaf area

The biggest single leaf area were 56.89 cm^2 in T_4 (10 g plant^{-1}), followed by T_2 (8 g plant^{-1}) had 52.72 cm^2 and then T_1 (control) had 48.96 cm^2, T_3 (9 g plant^{-1}) had 46.33 cm^2 (Table 11).

All data collection of vegetative growth was not significant. The summarized results of vegetative growth stated the effect of water hyacinth compost on *Vigna radiata* L. that the highest plant height was 17.51 cm, the biggest petiole length 3.93 cm, the maximum number of leaves per plant 3.17, the largest leaf width 54.77 cm, the greatest leaf length 40.21 cm and the broadest single leaf area 56.89 cm^2 in T_4 (10 g plant^{-1}), respectively (Table 12 and Figure 3).

Reproductive Growth

First flowering days

The mean number of the earliest first flowering days is 49 days in T_3 (9 g plant^{-1}) and T_4 (10 g plant^{-1}), followed by 50 days in T_1 (control) and T_2 (8 g plant^{-1}), respectively (Table 13).

Single pod weight

The single pod weight showed that *Vigna radiata* L. was obtained the highest pod weight 0.65 g (T_4, 10 g plant^{-1}), followed by 0.58 g (T_3, 9 g plant^{-1}) and 0.50 g (T_2, 8 g plant^{-1}), 0.36 g (T_1, control) respectively. According to the statistical analysis revealed that all data were highly significant (Table 14).

Pods Weight per plant

The pods weight per plant of green gram had the highest 7.35 g (T_4,10 g plant^{-1}) followed by 4.50 g (T_3, 9 g plant^{-1}), 3.64 g (T_2, 8 g plant^{-1}) and 1.38 g (T_1, control) respectively. According to the statistical analysis showed that all data were highly significant (Table 15).

Pod yield

T_4 (10 g plant^{-1}) had highest pod yield 1422.96 kg ha^{-1} and T3 (9 g plant^{-1}) had second highest yield 871.20 kg ha^{-1}. T_2 (60 g plant^{-1}) produced 704.70 kg ha^{-1} and it had the third yield. Followed by T_1 (control) had 267.17 kg ha^{-1}. According to the statistical analysis showed that all data were highly significant (Table 16).

Seeds weight per Plant

The seeds weight per plant of green gram had the best weight by 2.97 g (T_4, 10 g plant^{-1}) , followed by 1.68 g (T_3, 9 g plant^{-1}), 1.26 g (T_2, 8 g plant^{-1}) and 0.4 g (T_1, control) respectively. According to the statistical analysis showed that all data were highly significant (Table 17).

Seed yield

The seed yield of green gram had the best weight 574.99 kg ha^{-1} (T4,10 g plant^{-1}) , followed by 325.25 kg ha^{-1} (T3, 9 g plant^{-1}), 243.94 kg ha^{-1} (T2, 8 g plant^{-1}) and 196.70 kg ha^{-1} (T1, control), respectively. According to the statistical analysis showed that all data were highly significant (Table 18).

All data collection of reproductive growth was highly significant. The summarized results of reproductive growth stated the effect of water hyacinth compost on *Vigna radiata* L. the maximum single pod weight 0.65 g, pods

weight per plant 7.35 g, pod yield, 1422.96 kg ha^{-1}, seed weight per plant 2.97 g and seed yield 574.99 kg ha^{-1} respectively were observed in T_4, 10 g $plant^{-1}$ (Table 19).

Discussion and Conclusion

In this experiment, the mixture of water hyacinth, cow dung and rice straw in aerobic condition for 30 days was used as compost. The growing of *Vigna radiata* L. using this compost carry out 7 days from germination to harvesting. The reduced weight of decomposed was 32% (Table 4). The initial temperature was 39°C and which drop up to 28°C during 30 days period of composting. The mean temperature of compost pile during composting period was 32.8°C (Table 3). Beesigamukama *et al*. (2018) studied that the highest temperatures were determined in the first week. In all compost treatments, temperature rapidly increased from the initial values of 26°C to peaks ranging between 30 and 43°C before beginning to slope to about 25°C throughout the third week. Thereafter, temperature changes were minimal up to the end. The temperature changes increased from an initial value of 28 to a peak value of 43°C on the second day and decreasing sharply on the eighth day. Sarika *et al.* (2014) reported that he rise in temperature was caused mainly by the metabolic heat generated during degradation of organic matter. The highest peak of temperature (59.7°C) was observed with waste composition of water hyacinth, cattle manure and sawdust (6:3:1) due to optimum proportion of raw materials. Compost accomplished ambient temperature at the end of 20^{th} day indicating the maturity of compost. It also indicated that the microbial activity has reduced due to decrease in the amount of degradable organic matter. Similar results have been obtained by Dhal *et al.* (2012) where maximum temperature was recorded as 57.3°C. Singh and Kalamdhad (2012) reported the maximum temperature of 56°C during water hyacinth composting. Bui *et al.*, (2015) stated that water hyacinth is an excellent organic fertilizer, as it contains 49% moisture, 0.56% total nitrogen, 25.5% phosphorus, 15: 1 C: N and 14.3 organic matters. The chemical properties of water hyacinth were different according to the growing area of water hyacinth which possessed

different climatic conditions. Makind and Ayoola (2012) showed that composition of cow dung was C 36%, N 1.48%, P 0.29%, K 0.75% and C:N 24:1. Cow dung is generated in large quantities from cattle farms. They also contain nitrogen, phosphorus, potassium and essential nutrients. Jusoh *et al.* (2013) revealed that rice straw as an organic waste can be converted to fertilizer throughout the process of composting and contained moisture 55%, N_2 0.49%, Phosphorus 38.2 (mg/kg), C:N 15: 1 and organic matter 12.7%. The physico-chemical analysis of water hyacinth, cow dung and rice straw expressed that the nitrogen content was high in cow dung 2.41% followed by water hyacinth 2.02% and rice straw 0.61%. Among these materials and water hyacinth compost, C: N were the best in water hyacinth, 13.41: 1 followed by cow dung, 15.29: 1, water hyacinth compost, 15.63: 1 and rice straw, 34.17: 1 (Table 2). Sanni and Adesina (2012) showed that water hyacinth compost contains N_2 2.56%, phosphorous 1.9%, potassium 1.35% and organic carbon 33%. There are two methods of decomposition: aerobic and anaerobic decomposition. In this experiment, aerobic decomposition was used by turning up in every three days intervals. Moreover, composting of plant materials such as water hyacinth and rice straw was mixed by 6:1 where three times of cow dung was added as an amendment. Therefore the compost used in this experiment became 6: 3: 1 which was in accordance with the ratio of compost used by Dhal *et al*., (2011). The applied cow dung included *E. coli*, Salmonella, coliform bacteria and fecal coliform (Gong, 2007). These bacteria helped in decomposing of plant materials quickly and efficiently**.** Batham *et al*. (2014) showed that the C:N ratio of a substrate material reflects the organic waste mineralization and stabilization during the process of composting. C:N ratio is considered as a parameter to establish the degree of maturity of compost and its agronomic quality. Decline of C:N ratio to less than 20 indicates an advanced degree of organic matter stabilization and reflects a satisfactory degree of maturity of organic wastes. Organic farming in agriculture preserves the ecosystem. It does not involve the use of harmful chemicals and fertilizers. Rather, symbiotic life-forms are cultured, ensuring weed and pest control and optimal soil biological activity, which maintain

fertility. The maximum plant height, the longest petiole length, the largest number of leaves, the best leaf width, the biggest leaf length and maximum single leaf area in T_4 (10 g plant^{-1}) were recorded from this experiment. Padmaja and Paulose (2010) revealed the biggest increase in plant height, the maximum increase in the number of leaves and a significant increase in root volume of green gram using water hyacinth compost, 210 mg plant^{-1}. Sanni and Adesina (2012) stated the biggest number of leaves and the largest plant height applying water hyacinth compost (60 g plant^{-1}) in the growing of spinach. The yield components data experiment showed that the earliest first flowering days, the largest single pod weight, pods weight per plant and pod yield, seed weight per plant and seed yield ^{1} in T_4 (10 g plant^{-1}) were obtained although Padmaja and Paulose (2010) reported maximum yield parameters such as number of flowers per plant, number of pods per plant, single pod weight, number of seeds per pod and hundred seeds weight of green gram were observed by 210 mg plant^{-1} water hyacinth compost. These results can be different according to plant varieties, soil texture, different organic fertilizer, environmental and weather condition. From above results of this experiment, vegetative growth and reproductive growth observed in the water hyacinth compost (10 g plant^{-1}). Ozalkan *et al*. (2010) investigated that the correlation between grain yield was significantly positive correlated with the growth parameters. In this research paper, water hyacinth compost (10 g plant^{-1}) would be suitable organic soil amendment for soil restoration and crop production and also for yield improvement of crop. There is a short point in this experiment was not using the higher value of water hyacinth compost 10 g plant^{-1}. Therefore, it is suggested that level of hyacinth compost higher than (10 g plant^{-1}) was needed to assess for any future experiment of growing green gram. The utilization of water hyacinth compost resulted in several benefits to farmer and enhanced soil fertility. However, there was a weak point in this experiment.

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Table 1. Nutrient contents of analyzed soil

Parameters	Composition
Total N (%)	0.46
Exchangeable cation, K^+ (meq 100 g^{-1})	1.79
Available nutrients, P, ppm (Olsen)	66.94
Available nutrients, K_2O (mg 100 g^{-1})	84.19
pH	7.22
Moisture (%)	3.83
Organic Carbon (%)	5.64
Humus (%)	10.11

Table 2. Nutrient contents of cow dung, water hyacinth, rice straw and water hyacinth compost

Parameters	Nutrient Contents			
	Cow dung	Water hyacinth	Rice straw	Water hyacinth compost
N (%)	2.410	2.019	0.606	1.470
P_2O_5 (%)	0.360	0.812	0.116	1.184
K_2O (%)	1.140	5.200	0.369	0.765
Organic carbon (%)	36.850	14.152	9.788	33.527
Moisture (%)	13.650	46.701	35.709	39.605
C:N	15.29:1	13.42:1	34.17:1	15.63:1
pH (1:2.5)	-	-	-	7.82

Table 3. Temperature of composting period

Days after composting	Temperature (°C)
3	39
6	39
9	38
12	35
15	32
18	31
21	30
24	28
27	28
30	28
Mean	32.8

Table 4. Reduced weight of water hyacinth compost

Compost	Bin I	Bin II	Bin III	Bin IV	Bin IV	Mean
Initial weight (kg)	10	10	10	10	10	10
Final weight (kg)	7	6	8	6	7	6.8
Reduced weight (kg)	3	4	2	4	3	3.2

Table 5. Germination rate of *Vigna radiata* L.

Plot	No. of sown seeds	Germinated plants	Germination %
1	30	30	100.00
2	30	27	90.00
3	30	28	93.33
4	30	25	83.33
Total	120	110	91.67

Table 6. Plant height of *Vigna radiata* L.treated by water hyacinth compost

Treatment	**Plant height (cm)**						
	3 WAS	4 WAS	5 WAS	6 WAS	7 WAS	8 WAS	Mean
T_1 (Control)	11.08	13.45	15.30	16.20	17.30	18.90	13.71
T_2 (8 g plant^{-1})	12.81	14.92	16.40	18.05	18.75	19.80	16.79
T_3 (9 g plant^{-1})	12.83	15.63	16.30	18.40	19.30	20.20	17.11
T_4 (10g plant^{-1})	13.20	15.45	16.90	19.20	19.70	20.60	17.51
F- test	ns	ns	ns	ns	ns	ns	
CV%	13.1	10.9	8.2	7.0	8.1	9.9	
5 % LSD	2.24	2.24	1.83	1.74	1.11	2.72	

WAS = Weeks after sowing CV% = coefficient variation (%),

LSD = least significant difference

Table 7. Petiole length of *Vigna radiata* L.treated by water hyacinth compost

Treatment	Petiole length (cm)						
	3 WAS	4 WAS	5 WAS	6 WAS	7 WAS	8 WAS	Mean
T_1 (Control)	2.28	3.00	3.65	4.14	4.35	4.70	3.69
T_2 (8 g plant^{-1})	2.24	2.91	4.00	4.39	4.55	5.30	3.90
T_3 (9 g plant^{-1})	1.95	2.49	3.20	3.60	3.95	4.30	3.25
T_4 (10 g plant^{-1})	2.28	3.24	4.02	4.38	4.65	5.02	3.93
F- test	ns	ns	ns	ns	ns	ns	
CV%	11.10	13.20	12.70	11.30	10.00	12.10	
5 % LSD	0.33	0.53	0.65	0.64	0.60	0.81	

Table 8. Number of leaves per plant of *Vigna radiata* L. treated by water hyacinth compost

Treatment	Number of leaves per plant						
	3 WAS	4 WAS	5 WAS	6 WAS	7 WAS	8 WAS	Mean
T_1 (Control)	1	2	3	3.9	4.3	4.5	3.12
T_2 (8 g plant^{-1})	1	2	3	3.9	4.1	4.4	3.07
T_3 (9 g plant^{-1})	1	2	2.9	3.8	3.9	4.3	2.98
T_4 (10 g plant^{-1})	1	2	3	3.8	4.4	4.8	3.17
F- test	ns	ns	ns	ns	ns	ns	
CV%	0.00	0.00	7.80	6.80	7.60	11.00	
5 % LSD	0.00	0.00	0.32	0.36	0.44	0.68	

Table 9. Leaf width of *Vigna radiata* L. treated by water hyacinth compost

Treatment	Leaf width (cm)						
	3 WAS	4 WAS	5 WAS	6 WAS	7 WAS	8 WAS	Mean
T_1 (Control)	2.18	7.95	8.80	9.50	9.95	10.50	48.88
T_2 (8g plant^{-1})	2.20	7.88	9.21	9.95	10.70	11.00	50.94
T_3 (9 g plant^{-1})	2.09	7.60	8.30	8.71	9.35	9.70	45.75
T_4 (10 g plant^{-1})	2.10	8.32	10.00	10.60	11.70	12.05	54.77
F-Test	ns	ns	ns	ns	ns	ns	
CV %	6.5	18.4	10.9	8.4	15.1	15.4	
5% LSD	0.19	2.01	1.36	1.13	2.18	2.30	

Table 10. Leaf length of *Vigna radiata* L. treated by water hyacinth compost

Treatment	Leaf length (cm)						
	3 WAS	4 WAS	5 WAS	6 WAS	7 WAS	8 WAS	Mean
T_1 (Control)	4.65	5.08	5.90	6.40	7.04	9.01	38.28
T_2 (8 g plant^{-1})	4.65	5.36	6.03	6.25	6.90	10.37	38.23
T_3 (9 g plant^{-1})	4.49	5.07	5.70	6.22	7.05	9.54	38.07
T_4 (10 g plant^{-1})	4.82	5.67	6.07	6.73	7.19	9.73	40.21
F- Test	ns	ns	ns	ns	ns	ns	
CV %	13.8	10.8	11.6	9.7	13.9	15.1	
5% LSD	0.89	0.79	0.95	0.85	1.35	2.01	

Table 11. Single leaf area of *Vigna radiata* L. treated by water hyacinth compost

Treatment	Single Leaf Area (cm^2)						
	2 WAS	3 WAS	4 WAS	5 WAS	6 WAS	7 WAS	Mean
T_1 (Control)	6.39	25.47	32.74	38.34	44.17	59.66	48.96
T_2 (8g plant^{-1})	6.45	26.63	35.02	39.22	46.56	71.93	52.72
T_3 (9 g plant^{-1})	5.92	24.30	29.83	34.16	41.57	58.35	46.33
T_4 (10 g plant^{-1})	6.38	29.75	38.28	44.99	53.05	73.94	56.89
F- Test	ns	ns	ns	ns	ns	ns	
CV %	16.20	23.60	19.10	14.90	25.80	22.00	
5% LSD	1.56	9.66	9.97	8.99	18.43	22.06	

Table 12. Summarized table of vegetative growth on the *Vigna radiata* L. treated by water hyacinth compost

Treatment	Plant height (cm)	Petiole length (cm)	No. of leaves per plant	Leaf width (cm)	Leaf length (cm)	Single leaf area (cm^2)
T_1 (Control)	13.71	3.69	3.12	48.88	38.28	48.96
T_2 (8 g $plant^{-1}$)	16.79	3.90	3.07	50.94	38.23	52.72
T_3 (9 g $plant^{-1}$)	17.11	3.25	2.98	45.75	38.07	46.33
T_4 (10 g $plant^{-1}$)	17.51	3.93	3.17	54.77	40.21	56.89

Table13. First flowering days of *Vigna radiata* L. treated by water hyacinth compost

Treatments	**First Flowering Days**
T_1 (control)	50
T_2 (8g $plant^{-1}$)	50
T_3 (9 g $plant^{-1}$)	49
T_4 (10 g $plant^{-1}$)	49

Table 14. Single pod weight per plant of *Vigna radiata* L. treated by water hyacinth compost

Treatments	Single pod weight per plant (g)
T_1 (control)	0.36
T_2 (8 g $plant^{-1}$)	0.50
T_3 (9 g $plant^{-1}$)	0.58
T_4 (10 g $plant^{-1}$)	0.65
F. test	**
CV %	38.7
5%LSD	5.28

Table 15. pods weight per plant of *Vigna radiata* L. treated by water hyacinth compost

Treatment	pods weight per plant (g)
T_1 (control)	1.38
T_2 (8 g plant^{-1})	3.64
T_3 (9 g plant^{-1})	4.50
T_4 (10 g plant^{-1})	7.35
F. test	**
CV %	38.7
5%LSD	5.28

Table 16. Pod yield (kg) of *Vigna radiata* L. treated by water hyacinth compost

Treatments	**Pod yield (kg ha^{-1})**
T_1 (control)	267.17
T_2 (8 g plant^{-1})	704.70
T_3 (9 g plant^{-1})	871.20
T_4 (10 g plant^{-1})	1422.96
F. test	**
CV %	37.33
5%LSD	5.05

Table 17. Seeds weight per plant of *Vigna Radiata* L. treated by water hyacinth compost

Treatments	Seeds weight plant^{-1} (g)
T_1 (control)	0.4
T_2 (8 g plant^{-1})	1.26
T_3 (9 g plant^{-1})	1.68
T_4 (10 g plant^{-1})	2.97
F. test	**
CV %	56.2
5%LSD	0.70

Table 18. Seed yield of. *Vigna radiata* L. treated by water hyacinth compost

Treatments	Seed yield (kg ha^{-1})
T1 (control)	196.70
T2 (8 g plant^{-1})	243.94
T3 (9 g plant^{-1})	325.25
T4 (10 g plant^{-1})	574.99
F. test	**
CV %	36.68
5%LSD	5.76

Table 19. Summarized table of reproductive growth on the *Vigna radiata* L. treated by water hyacinth compost

Treatment	First Flowering Days	Single pod weight per plant (g)	pods weight per plant (g)	Pod yield (kg ha^{-1})	Seed weight $plant^{-1}$ (g)	Seed yield (kg ha^{-1})
T_1 (Control)	50	0.36	1.38	267.17	0.4	196.70
T_2 (8 g $plant^{-1}$)	50	0.50	3.64	704.70	1.26	243.94
T_3 (9 g $plant^{-1}$)	49	0.58	4.50	871.20	1.68	325.25
T_4 (10 g $plant^{-1}$)	49	0.65	7.35	1422.96	2.97	574.99

Figure 1. Water hyacinth composting process

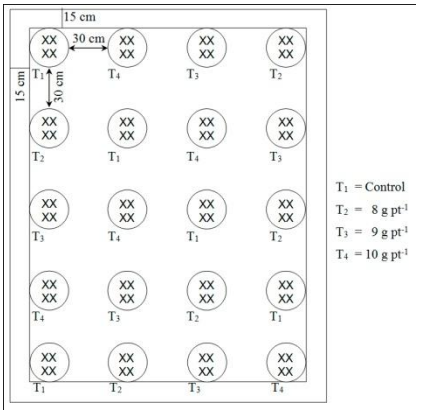

Figure 2. Experimental layout (CRD)

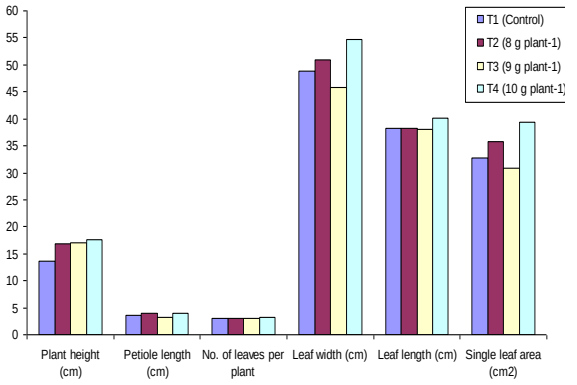

Figure 3. Summarized vegetative growth on the *Vigna radiata* L. treated by water hyacinth compost