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Effect of Paint Effluent on Growth Components of Two Varieties of Cowpea *(Vigna unguiculata)*

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ABSTRACT
Effluent from paint production sites contain pollutants that affect the normal growth of plants. In this study two varieties of *Vigna unguiculata* improved variety (IT99K573-1-) and local variety (Wake Dan Arba'in) seeds were planted and allowed to grow for 10 weeks using different concentrations of dilution of the effluents from paint production site as means of irrigation namely; 100 % (stock), 75 %, 50 % and 25 % concentrations to ascertain the difference in morphology of the varieties of the cowpea. Analysis of variance (ANOVA) showed significant difference ($p<0.05$) across the varieties in the morphological parameters such that the treatments from the effluents decrease growth parameters as the concentration increases. The study has shown that paint effluent has contrary effects on the morphology of both the varieties of the cowpea treated. It was revealed that low concentrations; 25 % of paint effluent could be well utilized for agricultural crops so as to reduce the lethality of the pollutants. It may be further concluded that the higher concentration of released paint effluent causes various types of inhibitory effects on the plant growth. It is recommended that elemental and nutrient analysis of Paint effluents in Nigeria should be studied to fully understand its applicability in agriculture.

Keywords: morphology, cowpea, effluent, pollutants

INTRODUCTION
There is a common practice to discharge untreated or partially treated industrial effluent directly into the river and land surface. Discharge of industrial effluent directly into the river and agricultural land makes the water and soil polluted, which is not good for agricultural purpose (IUCN, 1991). However, due to the absence of better alternatives, many farmers in urban areas are compelled to irrigate their cropland by polluted river, water or even industrial effluent (Ghimire, 1994). The relationship between plant growth and application of industrial effluents has been a perplexing one for people as the industrial effluents had been found to be one of the potential sources of water in the soil and they had also been reported as a source of soil pollution due to the presence of heavy metals and other compound (Kumar and Chopra, 2012). The heavy metals and some other toxic compounds affect plant and soil in number of ways (Dhevagi and Oblisami, 2002). The hazard posed by the intentional disposal of liquid or semi-solid water on land surfaces and the collection of effluents for irrigation purpose by farmers has recently receive global attention (Kowsalya *et al.*, 2010; Chopra *et al.*, 2011; Kumar and Chopra, 2012).

The deliberate use of industrial effluents to farms can be attributed to cultural beliefs, reports on improvement of plants vegetative growth and enhanced yield (Hati *et al*., 2007; Umebese and Onasanya, 2007; Umebese *et al*., 2009; Udayasoorian and Ponmani, 2009). The nutrient composition of effluents used for farming could lead occasional improvement of plant growth and yield depending on the species, availability of water, nutrients in the soil etc. On the other hand, it could also inhibit growth and development.

Cowpea (*Vigna unguiculata*); Family Fabaceae, is one of the most popular grains in Africa. Cowpea is often called "black-eyed pea" due to its black or brown-ringed helium. It is an annual herbaceous nutritive legume rich in protein, vitamins, and minerals. Due to its tolerance for sandy soil and low rainfall it grows in tropical, subtropical and temperate regions of Africa. The plant's root nodules are able to fix atmospheric nitrogen, making it valuable for intercropping with other crops (Singh *et al.,* 1997). Among several food crops in Nigeria, cowpea is widely consumed among different tribes in the country and in preparation of many foodstuffs. Cowpea is of major significance to the livelihoods of millions of reasonably rural people in Nigeria because the grain is widely traded out of the major production areas. It provides a cheap and nutritious food for relatively poor urban communities. Seeds of *V. unguiculata* are eaten fresh as a green vegetable, dried, fried, roasted, boiled and also in the form of snack. Its flour could also be used in soup. Beans serve as a raw material in production of Animal feed and increase soil fertility via Nitrogen fixation (Locatelli *et al*., 2014). In traditional medicine leaves and seeds of beans are applied as a poultice to treat swellings and infections. Leaves are chewed to treat tooth ailments. Powdered and carbonized seeds are applied on insect stings (Brink and Belay, 2006). The seed is diuretic and used to strengthen the stomach. When boiled and eaten as a food to destroyed worms in the stomach (Brink and Belay, 2006). Therefore this research is aimed at determinining the effect of paint effluent on the growth components of two varieties of cowpea *(V. unguiculata).*

METHODOLOGY

Sample Collection and Preparation

The method of effluent collection was according to Oladele *et al.,* (2011) with some modifications. Effluent was collected from the Paint Company in Katsina town, the effluent was collected directly from the draining source (considered 100 % concentrated), and then stored in well cleaned containers. The sample (effluent) was later diluted with borehole water at different concentrations namely; 25 %, 50 %, 75 %, and 100 % while borehole water was used as the control. Both the paint effluent and the borehole water were tested for some physico-chemical properties and some heavy metals. Two varieties of cowpea seeds (*V. unguiculata)* were used for this study; an improved variety (IT99K573-1) from International Institution of Tropical Agriculture (I.I.T.A.) Kano (11.9812°N, 8.5582° E) and a local variety (Wake dan arba'in) was obtained from Katsina Afforestation Project Unit (KTAPU) Katsina State (12.9717° N, 7.6015° E). Soil sample collected at a depth of 0-15 cm using soil auchor (Chopra *et al.,* 2011). The soil sample was mixed with cow manure and sand at a ratio of 2:1:1 according to Fazal *et al.,* (2007).

Planting Method

The study was carried out using randomized block design by the following set up adopted from Fazal *et al.,* (2007), AbdulRahman *et al.,* (2017) and Sajid and Masood (2018) with some modifications. Fifty (50) pots of 7 liters capacity filled with the soil were divided into two groups (A and B). An improved cowpea seed was planted in group A while Wake Danarba'in (local variety) in group B. the soil was irrigated with different concentrations of effluent control, 25 %, 50 %, 75 %, and 100 (T_c, T_{25}, T_{50}, T_{75}, T_{100}) while borehole water served as a control treatment. Briefly nine (9) seeds were sown in each pot (three seeds in three different spots) with an interval distance of 10 cm. After germination the seedling were thinned to four plants per pot. Each set was replicated five times as twenty plants were grown for each treatment group including the control group.

The sets of treatments were made by dissolving calculated amount of effluents in borehole water and by maintaining the ratio of effluent to borehole water; 0:100, 25:75, 50:50, 75:25, 100:0 as T_c, T_{25}, T_{50}, T_{75}, T_{100} respectively, the control group was made and irrigated with borehole water only.

Table 1: Physico-chemical properties of paint effluent and borehole water before Planting activities.

Sample ID	Borehole water	Paint effluent	FEPA	WHO	NIS
Color	Clear	White	--	--	
Odor	NO	Mild	--	--	
pH	6.6	4.5	6-9	6.5-8.5	6.5-8.5
EC (s/m)	2.07	46.010		<400	
TDS (Mg/l)	--	2103.31	2000	1000	
TSS (Mg/l)	--	35.37	30		

NO: Non offensive, EC: Electrical Conductivity, TDS: Total Dissolved Solid, TSS: Total suspended Solid, FEPA: Federal Environmental Protection Agency, WHO: World Health Organization, NIS: Nigerian Industrial Standard.

Table 2: Heavy metals analysis of paint effluent and borehole water before planting activities.

Sample ID	Borehole water	Paint effluent	FEPA	WHO	NIS
Cadmium (ppm)	0.001	0.333	<1	0.003	0.003
Chromium (ppm)	0.0125	3.750	<1	0.05	0.05
Calcium (ppm)	0.038	0.269	0.2	75	--
Lead (ppm)	0.01	0.217	<1	0.01	0.01
Iron (ppm)	0.002	2.595		0.3	0.3
Zinc (ppm)	0.194	0.555	<1	3.0	3.0

FEPA: Federal Environmental Protection Agency, WHO: World Health Organization, NIS: Nigerian Industrial Standard.

Data Collection

Data on plant shoot height, leaf length, leaf width, number of leaves and number of branches were recorded weekly according to Fazal *et al*. (2007).

Statistical Analysis

The statistical analysis of the recorded data in the study was subjected to 2 way Analysis of Variance (2 way ANOVA) using SPSS 20.0 with a probability level of $p>0.05$.

RESULTS

Plant Shoot Height

The result of the morphological analysis of cowpea (both improved and local variety) treated with paint effluent at different concentrations is presented in Table 1. The result showed that the maximum plant height (10.56 cm) improved variety was recorded in at 50 % concentration while 100 % concentration treatment showed the minimum height value at (8.04 cm) week 10. Similarly, maximum and maximum heights were recorded in the Wake-Danarba'in at 75 % and 25 % concentration. The result indicated a significant difference in the shoot height across the varieties ($p<0.05$) but there is no significant interaction ($P>0.05$) between the treatments and varieties.

Table 3: Plant height (cm) of improved and local varieties of V. *unguiculata* at different weeks and concentration of the paint effluent.

WAP	Cowpea Varieties	Treatments				
		100%	**75%**	**50%**	**25%**	**Control**
1	IV	4.22±0.396 [a]	4.08±0.192 [a]	4.10±0.751 [a]	4.58±0.756 [a]	4.26±0.433 [a]
	WD	3.66±1.278 [a]	3.46±0.456 [a]	3.86±0.770 [a]	3.48±1.055 [a]	3.02±0.845 [a]
2	IV	5.32±1.171 [a]	5.24±0.618 [a]	4.42±0.549 [a]	4.86±0.7197 [a]	5.34±0.260 [a]
	WD	4.76±1.060 [a]	5.20±0.578 [a]	4.64±1.141 [a]	4.12±1.182 [a]	3.64±0.606 [a]
3	IV	5.60±0.961 [a]	5.38±0.526 [a]	4.82±0.258 [a]	5.16±0.669 [a]	5.52±0.238 [a]
	WD	5.00±1.065 [a]	5.26±0.958 [a]	5.14±0.695 [a]	4.24±1.106 [a]	4.74±0.909 [a]
4	IV	5.72±1.264 [a]	5.42±0.766 [a]	5.54±0.589 [a]	6.96±0.8385 [a]	6.70±0.591 [a]
	WD	5.36±1.053 [a]	5.72±0.420 [b]	5.66±0.698 [b]	4.38±1.178 [c]	5.80±0.836 [d]
5	IV	7.02±1.992 [a]	7.32±0.732 [a]	7.94±1.926 [a]	7.26±2.122 [a]	7.56±2.182 [a]
	WD	5.42±0.697 [a]	6.30±0.685 [a]	5.80±0.689 [a]	4.64±0.676 [a]	6.04±0.820 [a]
6	IV	7.30±2.049 [a]	8.02±1.238 [a]	8.20±1.956 [a]	7.90±2.702 [a]	8.20±2.280 [a]
	WD	5.54±0.589 [a]	6.56±0.931 [a]	6.00±0.707 [a]	4.84±0.770 [a]	6.20±0.905 [a]
7	IV	7.78±1.775 [a]	8.32±2.181 [a]	9.36±1.038 [a]	8.18±1.72 [a]	8.48±1.178 [a]
	WD	5.86±0.296 [a]	6.78±0.944 [a]	6.64±0.873 [a]	5.24±0.7197 [a]	6.36±0.740 [a]
8	IV	8.92±1.006 [a]	9.08±1.424 [a]	10.18±1.254 [a]	9.18±2.431 [a]	9.38±0.912 [a]
	WD	7.90±1.105 [a]	8.60±1.068 [a]	8.00±1.871 [a]	6.34±1.339 [a]	6.52±0.712 [a]
9	IV	9.52±0.914 [a]	9.46±1.352 [a]	10.28±1.289 [a]	9.68±2.339 [a]	9.84±0.8706 [a]
	WD	7.96±1.026 [a]	8.84±1.019 [a]	8.24±1.898 [a]	6.34±1.339 [a]	7.36±0.786 [a]
10	IV	8.96±1.031 [a]	9.86±1.555 [a]	10.56±1.248 [a]	9.2±2.355 [a]	9.44±0.820 [a]
	WD	8.04±0.983 [a]	8.80±1.082 [a]	8.12±1.849 [a]	6.34±1.339 [a]	6.70±0.724 [a]

Key: WAP= Weeks after planting, WD= Local variety of cowpea (Wake Dan arba'in), IV= Improved variety of cowpea. Values with the same superscripts have no significant difference across the rows

Leaf Length:
The investigation is presented in table 2 which revealed that in responses of *V. unguiculata* to treatment from paint effluent at different concentrations, there is a significant difference in the leaf length of the plant across the varieties, the treatments and varieties*treatments with values (0.000<p), (0.003<p) and (0.035<p) respectively. The result showed that the maximum mean of leaf length in the improved variety was recorded at 50% concentration and below while minimum leaf length was recorded at high effluent concentration (75 % and 100 %). Similarly, in local variety the maximum leaf length value was recorded at 75 % concentration whereas the minimum value was recoded at 100 % concentration.

Table 4: Plant leaf length (cm) of improved and local varieties of *V. unguiculata* at different concentration of the paint effluent.

WAP	Cowpea Varieties	Treatments				
		100%	**75%**	**50%**	**25%**	**Control**
1	IV	4.28±0.580 [a]	3.96±1.074 [a]	3.84±0.723 [a]	4.04±0.585 [a]	3.3±0.458 [a]
	WD	3.22±0.819 [a]	4.1±1.042 [a]	2.78±0.687 [a]	3.18±0.649 [a]	3.54±0.838 [a]
2	IV	4.60±0.948 [a]	4.32±1.504 [a]	5.00±0.628 [a]	4.14±0.296 [a]	3.5±0.839 [a]
	WD	3.82±0.327 [a]	4.52±0.408 [a]	4.14±0.976 [a]	4.24±0.669 [a]	4.78±1.158 [a]
3	IV	4.78±1.018 [a]	4.52±1.413 [a]	5.72±0.327 [a]	4.42±0.426 [a]	5.28±0.597 [a]
	WD	4.14±0.786 [a]	5.14±0.181 [a]	4.60±0.738 [a]	4.54±0.527 [a]	5.00±0.291 [a]
4	IV	4.90±1.382 [a]	4.76±0.753 [a]	6.20±1.120 [a]	5.52±0.729 [a]	5.38±1.964 [a]
	WD	4.38±0.238 [a]	5.56±0.691 [a]	5.10±0.524 [a]	4.76±0.503 [a]	5.58±0.708 [a]
5	IV	6.42±1.911 [a]	5.70±1.042 [a]	6.52±1.128 [a]	5.94±0.230 [a]	6.62±0.389 [a]
	WD	4.86±1.385 [a]	5.88±0.571 [a]	5.84±1.106 [a]	5.12±0.580 [a]	5.66±0.873 [a]
6	IV	6.86±1.753 [a]	5.94±1.159 [a]	6.76±1.152 [a]	6.42±1.283 [a]	6.82±0.295 [a]
	WD	5.46±2.038 [a]	6.62±0.364 [a]	6.02±1.165 [a]	5.38±0.567 [a]	6.12±0.852 [a]
7	IV	7.56±1.457 [a]	7.72±1.27 [a]	8.76±1.965 [a]	6.66±0.654 [a]	7.64±1.184 [a]
	WD	5.74±2.008 [a]	5.54±0.527 [a]	6.40±1.065 [a]	5.48±0.795 [a]	6.38±0.846 [a]
8	IV	7.82±1.443 [a]	8.20±1.454 [a]	8.92±2.063 [a]	6.80±1.223 [a]	7.92±1.119 [a]
	WD	5.90±1.342 [a]	9.50±2.894 [b]	7.22±1.134 [b]	6.06±0.466 [c]	6.84±0.7436 [c]
9	IV	8.18±1.501 [a]	8.46±1.481 [a]	9.42±2.165 [a]	7.08±1.211 [a]	8.16±1.069 [a]
	WD	6.16±1.32 [a]	9.72±2.873 [b]	7.4±1.114 [b]	6.3±0.367 [c]	7.06±0.716 [c]
10	IV	8.60±1.296 [a]	9.04±1.381 [a]	9.38±2.047 [a]	7.52±1.262 [a]	8.78±1.112 [a]
	WD	6.66±1.148 [a]	8.38±1.543 [a]	7.96±0.288 [a]	6.52±0.739 [a]	7.08±0.852 [a]

Key: WAP= Weeks after planting, WD= Local Variety of cowpea (Wake Dan arba'in), IV= Improved variety of cowpea. Values with the same superscripts have no significant difference across the rows.

Leaf Width:
The result of leaf width of both the improved and local variety (Table 3) indicated a significant difference across the varieties, but there is no significant difference in leaf width across the treatments and varieties*treatments with values (0.220>p) and (0.256>p) respectively. The mean leaf width decreases with increase in effluent as compared to control in the improved variety cowpea. The local variety showed a rather significant increase in leaf width with increase in effluent at lower concentrations (50 % and 25 %).

Table 5: Plant leaf width (cm) of improved and local varieties of *V. unguiculata* at different concentration of the paint effluent.

WAP	Cowpea Varieties	Treatments				
		100%	**75%**	**50%**	**25%**	**Control**
1	IV	1.88±0.258^{a}	1.96±0.320^{a}	2.06±0.658^{a}	2.16±0.270^{a}	1.94±0.439^{a}
	WD	1.8±0.122^{a}	1.9±0.234^{a}	1.7±0.509^{a}	1.74±0.288^{a}	1.94±0.456^{a}
2	IV	2.22±0.192^{a}	2.2±0.578^{a}	2.52±0.571^{a}	2.88±0.719^{a}	2.16±0.555^{a}
	WD	2.06±0.151^{a}	2.22±0.334^{a}	1.9±0.6245^{a}	2±0.324^{a}	2.22±0.465^{a}
3	IV	2.34±0.421^{a}	2.58±0.630^{a}	2.68±0.363^{a}	3.06±0.403^{a}	2.74±0.357^{a}
	WD	2.54±0.260^{a}	2.24±0.1817^{a}	2.1±0.6245^{a}	2.22±0.216^{a}	2.28±0.408^{a}
4	IV	2.74±0.391^{a}	2.64±0.343^{a}	2.84±0.378^{a}	3.14±0.378^{a}	3.06±1.001^{a}
	WD	2.66±0.270^{a}	2.8±0.6892^{a}	2.48±0.130^{a}	2.92±0.816^{a}	2.58±0.311^{a}
5	IV	3.26±1.048^{a}	3.04±0.5505^{a}	3.16±0.427^{a}	3.20±0.223^{a}	3.12±0.277^{a}
	WD	2.70±0.353^{a}	3.12±0.657^{a}	2.72±0.148^{a}	3.16±0.747^{a}	2.84±0.421^{a}
6	IV	3.48±1.145^{a}	3.28±0.563^{a}	3.38±0.389^{a}	3.26±0.328^{a}	3.2±0.291^{a}
	WD	2.82±0.618^{a}	3.26±0.577^{a}	3.38±0.389^{a}	3.2±0.212^{a}	3.06±0.433^{a}
7	IV	3.50±0.367^{a}	3.48±0.535^{a}	3.88±0.687^{a}	3.44±0.634^{a}	3.22±0.311^{a}
	WD	2.84±0.364^{a}	3.28±0.327^{a}	3.42±0.356^{a}	3.32±0.258^{a}	3.24±0.230^{a}
8	IV	3.98±0.641^{a}	3.74±0.487^{a}	4.06±0.357^{a}	3.72±0.804^{a}	3.24±0.251^{a}
	WD	2.9±0.273^{a}	3.3±0.4472^{a}	3.46±0.415^{a}	3.38±0.376^{a}	3.26±0.391^{a}
9	IV	4.22±0.668^{a}	4.10±0.291^{a}	4.26±0.336^{a}	4.08±0.705^{a}	3.46±0.296^{a}
	WD	2.92±0.277^{a}	3.52±0.432^{a}	3.7±0.4848^{a}	3.38±0.342^{a}	3.48±0.228^{a}
10	IV	4.42±0.672^{a}	4.10±0.291^{a}	4.42±1.092^{a}	4.38±0.657^{a}	3.82±0.130^{a}
	WD	3.00±0.255^{a}	3.52±0.584^{a}	3.82±0.327^{a}	3.40±273^{a}	3.54±0.114^{a}

Key: WAP=Weeks after planting, WD= Local Variety of cowpea (Wake Dan arba'in), IV= Improved variety of cowpea. Values with the same superscripts have no significant difference across the rows.

Number of Leaves:

Statistical analysis using analysis of variance (ANOVA) showed that the effect of effluent have significant difference in the number of leaves (0.00>p) across the varieties, but there was no significant difference in the number of leaves across the treatment and varieties*treatments with values (0.623>p) and (0.368>p) respectively. The result is presented in table 4.

Number of Branches:

Statistical analysis using analysis of variance (ANOVA) indicated a significant difference in the number of branches across the varieties (0.02<p), but there is no significant difference in the number of branches across the treatments and varieties*treatments with values of (0.806>p) and (0.251>p) respectively. The result is presented in Table 5.

Table 6: Number of leaves in the plant of improved and local varieties of *V. unguiculata* **at different concentration of the paint effluent.**

WAP	Cowpea Varieties	Treatments				
		100%	**75%**	**50%**	**25%**	**Control**
1	IV	2.00±0.000[a]	2.00±0.000[a]	2.00±0.000[a]	2.00±0.000[a]	2.00±0.000[a]
	WD	2.00±0.000[a]	2.00±0.000[a]	2.00±0.000[a]	2.00±0.000[a]	2.00±0.000[a]
2	IV	4.00±1.000[a]	4.00±0.707[a]	4.60±0.547[a]	4.00±0.707[a]	4.60±0.547[a]
	WD	3.80±0.836[a]	3.80±0.836[a]	4.20±0.836[a]	3.80±0.836[a]	4.20±0.836[a]
3	IV	6.40±1.140[a]	6.20±0.836[a]	6.60±0.894[a]	6.20±0.836[a]	6.80±0.836[a]
	WD	6.00±0.707[a]	6.00±1.000[a]	6.00±0.707[a]	6.00±1.000[a]	6.00±1.000[a]
4	IV	7.20±1.924[a]	8.20±1.924[a]	9.60±1.517[a]	8.00±0.707[a]	8.40±1.817[a]
	WD	7.40±1.140[a]	7.40±0.894[a]	7.40±0.547[a]	7.00±1.000[a]	7.80±0.836[a]
5	IV	14.6±2.302[a]	15.8±2.775[a]	16.8±1.924[a]	16.2±4.324[a]	17.0±6.124[a]
	WD	8.8±3.033 [a]	9±1.414 [a]	9.2±1.304 [a]	9.2±0.836[a]	8.6±1.14 [a]
6	IV	18.6±2.408[a]	19.6±4.561[a]	21.2±1.643[a]	20.4±6.914[a]	23.4±5.225[a]
	WD	14±5.568 [a]	11.6±2.702[a]	12.4±3.647[a]	12.8±2.683[a]	9.4±1.14 [a]
7	IV	19.8±1.643[a]	21.6±3.715[a]	21.8±1.643[a]	21.8±6.419[a]	24.8±4.868[a]
	WD	14.8±2.864[a]	13.8±2.588[a]	12.4±2.302[a]	14.8±2.683[a]	11.6±1.673[a]
8	IV	20.6±5.814[a]	22±4.583 [a]	22.4±8.355[a]	24±4.848 [a]	25.4±6.107[a]
	WD	17.4±4.98 [a]	21.2±5.167[a]	20±7.176 [a]	22.8±3.271[a]	12.8±3.114[a]
9	IV	23.8±7.328[a]	25.8±4.087[a]	26.0±7.810[a]	27.0±4.690[a]	26.0±4.743[a]
	WD	19.8±3.701[a]	22.4±3.286[a]	20.4±4.615[a]	24.6±3.578[a]	14.0±1.581[a]
10	IV	25.0±6.325[a]	26.0±4.583[a]	27.0±9.028[a]	28.0±4.848[a]	26.0±3.391[a]
	WD	19.6±4.722[a]	23.4±5.225[a]	22.2±7.259[a]	25.0±3.674[a]	14.6±3.647[a]

Key: WAP=Weeks after planting, WD= Local Variety of cowpea (Wake Dan arba'in), IV= Improved variety of cowpea. Values with the same superscripts have no significant difference across the rows.

Table 7: Number of branches on the plant of improved and local varieties of ***V. unguiculata*** **at different concentration of the paint effluent.**

WAP	Cowpea Varieties	Treatments				
		100%	**75%**	**50%**	**25%**	**Control**
1	IV	0	0	0	0	0
	WD	0	0	0	0	0
2	IV	1.4±0.547 [a]	1.8±0.447 [a]	1.8±0.447 [a]	1.8±0.447 [a]	1.2±0.447 [a]
	WD	1.6±0.547 [a]	1.6±0.547 [a]	1.8±0.447 [a]	1.8±0.447 [a]	1.4±0.547 [a]
3	IV	2.6±0.547 [a]	2.8±0.447 [a]	2.4±0.547 [a]	2.6±0.547 [a]	2.4±0.547 [a]
	WD	2.2±0.447 [a]	2.6±0.547 [a]	2.4±0.547 [a]	2.6±0.547 [a]	2.2±0.447 [a]
4	IV	3.4±0.547 [a]	2.8±0.836 [a]	2.4±0.547 [a]	2.4±0.547 [a]	2.8±0.447 [a]
	WD	2.8±0.447 [a]	3±0.707 [a]	2.4±0.547 [a]	3±0.707 [a]	3.2±0.836 [a]
5	IV	4.00±0.707 [a]	4.4±1.140 [a]	4.8±0.836 [a]	4.2±0.836 [a]	4.2±1.304 [a]
	WD	3.4±1.342 [a]	3.2±0.447 [a]	3.6±0.894 [a]	4.0±1.225 [a]	4.4±1.673 [a]
6	IV	5.8±1.095 [a]	6.8±1.924 [a]	7.4±1.517 [a]	6.8±2.49 [a]	9.2±0.836 [a]
	WD	5.2±2.588 [a]	4±0.7071 [a]	4.6±1.949 [a]	5.2±0.447 [a]	5.2±1.924 [a]
7	IV	6.6±1.342 [a]	7.8±1.924 [a]	8.6±1517 [a]	7.8±2.490 [a]	9.8±1.304 [a]
	WD	6.8±2.683 [a]	5.4±1.140 [a]	6.4±1.817 [a]	5.8±0.836 [a]	5.0±1.414 [a]
8	IV	6.8±1.095 [a]	8±1.581 [a]	9.4±1.14 [a]	8.8±1.483 [a]	10±1.225 [a]
	WD	7.4±3.13 [a]	7.8±1.304 [a]	6.6±2.074 [a]	7.6±1.517 [a]	5±1.414 [a]
9	IV	7.6±0.894 [a]	8.8±1.304 [a]	9.6±1.140 [a]	9.6±1.140 [a]	10.4±1.817[a]
	WD	8.2±2.775 [a]	8.4±1.140 [a]	7.8±1.924 [a]	8.6±1.140 [a]	6.2±1.304 [a]
10	IV	8.2±1.304 [a]	9.2±1.304 [a]	9.6±1.817 [a]	10.0±1.581[a]	10.6±2.074 [a]
	WD	8.4±2.302 [a]	8.6±1.140 [a]	8.0±1.581 [a]	9.0±1.581 [a]	7.4±1.140 [a]

Key: WAP=Weeks after planting, WD= Local Variety of cowpea (Wake Dan arba'in), IV= Improved variety of cowpea. Values with the same superscripts have no significant difference across the rows.

DISCUSSION

The improved variety of cowpea is substantially taller than the local variety, even though there was no discernible difference between the treatments (Table 1). This is in contrast to Desir and Pinchiant's (1976) study which found no discernible differences in the shoot height of mixed cowpea types. However, according to Abdurrahman *et al*. (2017) *Sesanum indicum's* shoot height did not significantly change between plants treated with effluent. Oladele (2011) revealed that there was a considerable difference between paint effluent concentration and textile and flash battery effluents, although the difference in the stem height of cowpea was less prominent. The improved variety showed longer leaves than the local variety which may be attributed to genetic effect of individual varieties (Magani and Kuchinda, 2009).

This indicates that minimal dilution supported a considerable leaf length because the leaf length at higher concentrations showed sporadic decreases compared to the leaves of the treated at low concentrations. High levels of total dissolved solids and the potentially dangerous effects of an excess of critical metals in the effluent may be responsible for the decreased vegetative development of plants at high effluent concentrations (AbdulRahaman *et al*., 2017). This is comparable to a work by Folurunso *et al.* (2018) who found that brewery effluent drastically shortens plant leaves. Stevovic *et al*. (2010) also reported that leaf length taken from plant grown in effluents polluted areas were significantly reduced than leaves from the control area. Similarly, Rafia *et al*. (2009) reported that the reduction found in the leaf area of *Phaseolus mungo and Lens culinaris* may be considered as an adaptive advantage that enables leaves to develop and function in habitats marked by strong variations of heavy metals such as lead toxicity with solar radiation, air temperature and humidity. The presence of organic and inorganic compounds in irrigation water resists energy supply to plants and leads to retarded growth and development, alongside the toxicity of effluent which is known to impair the development of leaf in plants (Baskaran *et al.,* 2009). A study from Abiodun *et al.* (2019) also revealed that the application of untreated effluent tends to reduce leaf length of the cowpea while a slight increase in leaf area of cowpea was observed in the treated effluent-amended group due to reduce toxicity of the effluent.

Leaf width showed no significant difference in the treatment and varieties*treatment but showed difference in the varieties this is because the local variety plant leaf was smaller than that of the improved variety, which could be associated to genetic of individual variety (Magani and Kuchinda, 2009). This leaf size reduction because lead was found to be in the paint effluent that have a direct consequences on it (Oladele, 2011).

The number of leaves and branches from the result only showed significant difference across the varieties. The improved variety produced more leaves and branches than the local variety which is attributed to their difference in genetic makeup that helps the improve variety to absorb all the essential nutrient present in the paint effluent better than the local variety (Kumar, 2006). The increase in vegetative development in improved variety as observed has been linked to the study of Abiodun *et al.* (2019) who reported that treated paint effluent at high concentration has been reported to help increase development in cowpea varieties.

CONCLUSION AND RECOMMENDATION

The result indicated a significant difference across the varieties and across the treatments in leaf length. The other parameters showed a significant difference across the varieties only with improved variety consistently ahead of the local variety. It was revealed that low concentration of paint effluent could be well utilized for agricultural crops so as to reduce the lethality of the pollutants. It may be further concluded that the higher concentration of released paint effluent causes various types of inhibitory effects on the plant growth. Furthermore, these visible significant changes seen in all the *Vigna unguiculata* varieties grown in effluent concentration could be employed as an index of monitoring environmental pollution. The improvement found in this study about cowpea revealed a useful property of the paint effluents and with further study on the effluents, it usefulness for other crops could be established.

However, proper treatment and removal of toxic substances are necessary before further use of these industrial effluents for irrigation purpose on a large scale as a proof of reduced risk of elemental toxicity which needs to be established.

It is therefore recommended that further investigation on elemental concentration in different part of the plant should be carried out to investigate the bioaccumulation of toxic metals which could have contributed to the significant growth and reduction observed in different plant morphological characteristics.

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