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Full Length Research Paper

Screening six cultivars of cowpea (*Vignia unguiculata* L.) walp for adaptation to soil contaminated with spent engine oil

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Field experiments were carried out in 2007 and 2008 growing seasons at the Delta State University, Asaba Campus Teaching and Research Farm to screen six cultivars of cowpea (IT80D- 699, IT82 (e-18), IT84S- 2246- 4, TVx3236, IT90K–277-2 and IT870- 941- 1) for adaptation to soil contaminated with spent engine oil. 0 (control), 25, 50, 75 and 100 ml of the oil served as the treatments. The experiment was arranged in a randomized complete block design with four replications. The results showed that cowpea cultivars grown in 25 ml of spent engine oil gave consistently significant higher ($P \leq 0.05$) values than the control and the other treatments (50, 75 and 100 ml) of the spent oil in terms of plant height, leaf area, number of leaves, stem diameter, days to 50% flowering, number of nodes on main stem, number of branches, and number and length of peduncles. The results also showed that as from the 50 ml of oil application to soil, all the traits examined showed significant reductions ($P \geq 0.05$) when compared to their controls, however, TVx3226 and IT84S – 2246-4 were higher in performance whereas, IT890.699 and IT870- 941-, showed the lowest inhibitory effect. The study also showed a build up of heavy metals in oil-impacted soil. The current study has demonstrated that spent engine oil has a highly significant effect of reducing the growth characteristics of the six cultivars of cowpea examined with the TVx3236 and the IT84S- 2246- 4 showing some levels of tolerance hence, they can be recommended to farmers in oil impacted areas.

Key words: Screening, cowpea cultivars, adaptation, spent engine oil.

INTRODUCTION

Cowpea (*Vignia unguiculata* L.) is a popular leguminous food in Nigeria (Adelaja, 2000; Adaji et al., 2007). Cowpea belongs to the family Fabaceae and sub-family Faboideae. It is cultivated and used fresh in derived savannah and rainforest belts thus, it is available throughout the year either as vegetable or as a pulse (Singh and Rachie, 1985; Asumugha, 2002; Olapade et al., 2002). Asumugha (2002) stated that cowpea is consumed in various ways especially in the form of "Akara and moin-moin", which are very popular breakfast and snack foods. Philip (1999) and Olaleke et al. (2006) reported that cowpea contains moisture (4.0%), ash (37.1%), crude fat (31.3%), crude fibre (24.0%), crude protein (75.3%), carbohydrate by difference (82.8%), fatty acids (25%) and energy $mjkg^{-1}$ (6.5193), a lot of minerals $(g/ kgDM)^2$ including Na, K, Mg, Ca, P, Ca, Co, Fe, Pb, Cu, Mn, Cd, Zn and Cr.

Cowpea is of major importance to the livelihoods of Millions of relatively poor people in less developed countries of the tropics (Anoliefo et al., 2006; Ogbo, 2009). In fresh form, the young leaves, immature pods and peas are used as vegetable while several snacks and main dishes are prepared from the grain (Turk, 1980; Terge, 1984). Islam et al. (2006) noted that cowpea is more tolerant to drought, water logging, infertile soils and acid stress than common beans. Islam et al. (2006) further maintained that west and central Africa is the leading cowpea producing regions in the world.

Nigeria still depends largely on crude oil and its refined products for her income earnings. Spent lubricating oil has been reported to be a major and most common soil contaminant from engines and other machinery in Nigeria (Aneliefo and Edegbai, 2000; Vwioko and Fashemi, 2005; Achuba 2006; Sharifi et al., 2007). The indiscriminate disposal of spent oil into open vacant plots and farms, gutters and water drains is an environmental risk both to

ground water, plants and other organisms. The effects of oil in soil include depression and inhibition of plant growth, by interfering with the soil-water-plant interrelationships (Agbogidi and Ejemete, 2005; Agbogidi and Dolor, 2007). Although, researches have been carried out on the effects of spent engine oil on the growth of crop plants (Anoliefo and Vwioko, 1995; Wang et al., 2000; Odjegba and Sadiq, 2002; Nwadinigwe and Uzodimina, 2005; Vwioko and Fashemi, 2005; Agbogidi and Nweke, 2006; Sharifi et al., 2007; Smith et al., 2007). Information on the effects of spent oil on the growth of cowpea is, however, scarce. This study has been designed to screen six cultivars of cowpea for adaptation to soil contaminated with spent engine oil with a view to selecting and recommending the tolerant cultivars to farmers especially in the oil producing areas of Nigeria. The study also has the advantage of affording plant breeders the opportunity of searching for ways of improving cowpea production in oil-producing areas. This is because successive cultivation of cowpea beyond the present limits in Nigeria requires the discovery and selection of cultivars that are tolerant to oil effects.

MATERIALS AND METHODS

The study was conducted during the 2007 and 2008 growing seasons at latitude 6°14^{1}N and longitude 6°49^{1}E (Asaba Meteorological Office, 2008) at the Delta State University Research farm, Asaba, Nigeria. The six cultivars of cowpea IT80D- 699, IT82 (e-18), IT84S- 2246- 4, TVx3236, IT90K–277-2 and IT870- 941- 1) were purchased as a single batch from International Institute for Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria. While the spent engine oil (SEO) was from 10 different motor mechanic workshops in Asaba, Delta State to allow for the generalization of the results. The site was ploughed by a tractor, harrowed after one week and the land was measured with tape and mapped out with pegs. Each plot measured 5 m in length and 3 m in width. The space between the plots was 1.5 m. A planting space of 60 x 30 cm was used following the procedure of Remison (1978). Two seeds from each cowpea cultivar were sown in each plot. Seedlings were thinned to one at two weeks after planting (WAP) when they were fully established. Regular weeding was ensured before plant maturity. Insect pests were controlled with Karate 2.5 EC at 2 weeks after seedling emergence and thereafter, at 10 days interval following the procedure of Awe (2008). 0 (control), 25, 50, 75 and 100 ml of oil per stand of the cowpea served as the treatments. Spent engine oil application (ring application) was done at 3 weeks after seedling emergence. No other application was done after this. The experiment was arranged in a randomized complete block design (RCBD) with four replications Subsequent examination followed. Growth indices measured were plant height, leaf area, number of leaves, stem diameter, number of branches, number of nodes on main stem, number of peduncles, length of peduncles and days to 50% flowering. Plant height was measured with a meter rule at the distance from soil level to terminal bud. Number of leaves was by visual counting of the leaves per cowpea plant. Leaf area (cm^2) was determined by tracing the margins of the leaf on a graph paper and the total area/ plant was obtained by counting the number of 1 cm square (Bamidele and Agbogidi, 2000). The stem diameter was measured at 2 cm above soil level with venire calipers. Data on number of branches/ plant, number of nodes/ plant, number and length of peduncles were collected at maturity before senescence by visual counting. Soil and Trace metal analysis of the SEO were also carried out at the Institute of Agricultural research and Training, Obafemi Awolowo University, Moor Plantation, Ibadan. Soil analysis for heavy metal concentration was by atomic absorption spectrophotometric procedure using Association of Official Analytical Chemists (AOAC), (1985). Data obtained on each trait were subjected to a single factor analysis of variance (ANOVA) while the significant means were separated with the Duncan's multiple range tests (DMRT) using SAS (1996).

RESULTS AND DISCUSSION

The results obtained for the growth characteristics and morphological characteristics of the six-cowpea cultivars are presented in Tables 1, 2 and 3 respectively. The results showed that cowpea seeds from TVx3236 cultivars and IT84S-2246-4 grown in 25 ml of spent engine oil gave consistently significant higher (≤) values than the control and the other treatments (50, 75 and 100 ml of SEO). Treatments 0 and 25 ml of the oil produced significantly higher ($P \leq 0.05$) plant height, leaf area, number of leaves, stem diameter, number of branches, number of nodes, number and length of peduncles than those of the higher treatments (Tables 1, 2 and 3). Plants grown in 25 ml of the SEO contaminated soil flowered earlier than those in the control and the higher treatments. Generally, the various responses of the cowpea cultivars to the contaminant was observed to be dose dependent, although an increase in the various traits was observed in the cultivars exposed to 25 ml of the SEO indicating growth stimulation at this level of oil treatment. Anoliefo and Vwioko (2005) and Sharifi et al. (2007) separately studied various plant species to soil contaminated with spent lubricating oil and reported growth enhancement (fertilizer effect) at 1% concentration when compared with the control. Agbogidi and Bamidele (2007) noted that small amount of hydrocarbon in substrates can enhance growth media and indirectly growth characteristics. The observed better performance of cowpea cultivars TVx 3236 and IT84S-2246-4 than the other cultivars indicates species dependent quality of oil effects. Anoliefo and Edegbai (2000) reported that *Solanum melongena* was more tolerant to spent lubricating oil than *S. incanum.* Similarly, Sharifi et al. (2007) noted that *Medicago truncatula* is the most tolerant plant species among the six species examined. Vwioko and Fashemi (2005) had earlier reported stimulation of growth in the germination and growth characteristics at 1% w/ w spent lubricating oil in soil for *Ricinus communis* seedling while growth in higher concentrations (2, 3, 4, 5 and 6%w/ w) exhibited depression. The results of soil and metal concentration analysis are shown in Tables 4 and 5, respectively. The result indicated that there was a build up of heavy metals in the soil with increasing oil doses in soil. This observation agrees with earlier reports of Vwioko et al. (2006), The study has showed that as from 50 ml of oil application to soil, all the traits examined showed significant reductions ($p \geq 0.05$). The current study has also

Table 1. Plant height (cm) and leaf area (cm2) of the six cultivars of cowpea as affected by SEO.

Cowpea cultivar	Plant height/ oil level					
	0	25	50	75	100	Means
1WAOA						
IT81D-699	20.1	21.7	10.6	18.7	18.4	19.7e
IT82 (e-18)	22.4	22.6	21.4	21.0	20.6	21.6a
IT84S-2246-4	24.6	25.6	24.2	23.0	22.1	23.9b
TV x 3236	25.7	25.8	24.6	24.4	24.0	24.9a
IT90K -277-2	21.2	21.6	21.0	20.6	20.3	20.9d
IT870-941-1	20.3	20.6	20.0	19.4	18.6	19.8e
Means	22.4b	23.0a	21.8c	21.2d	20.7e	
2WAOA						
IT81D-699	40.3	41.0	40.1	39.6	38.4	39.9
IT82 (e-18)	46.7	46.9	46.3	43.7	40.1	44.7
IT84S-2246-4	56.7	56.9	56.4	56.2	55.6	56.4
TV x 3236	58.4	58.8	58.9	57.7	56.2	58.0
IT90K- 277-2	46.7	46.9	46.2	45.2	45.0	46.0
IT870-941	45.6	45.8	45.1	44.7	43.1	44.9
Means	49.1b	49.4a	48.8c	47.9d	46.4e	
3WAOA						
IT81D-699	56.4	56.5	56.2	56.0	53.1	55.6d
IT82 (e-18)	56.9	57.4	57.1	56.8	55.1	56.7d
IT84S-2246-4	70.3	70.7	70.5	70.2	70.0	70.3b
TV x 3236	74.8	74.4	74.4	74.4	73.2	74.3a
IT90K-277-25	7.6	57.7	57.3	56.8	56.3	57.1c
IT870-941-1	57.2	57.3	57.0	56.3	56.1	56.8d
Means	62.2b	62.4a	62.1b	61.8c	60.6d	
Cowpea cultivar	**Leaf area/ oil level**					
	0	**25**	**50**	**75**	**100**	**Means**
1WAOA						
IT81D-699	40.2	41.6	40.1	40.0	39.1	40.2e
IT82 (e-18)	42.2	43.6	42.0	41.7	41.6	42.2c
IT84S-2246-4	48.6	49.7	48.0	47.8	46.9	48.6b
TV x 3236	49.725.7	50.8	49.3	49.2	49.0	49.6a
IT90K -277-2	41.6	41.9	41.3	41.0	40.7	41.5d
IT870-941-1	41.6	42.5	41.0	41.2	41.4	41.5d
Means	43.9b	45.0a	43.6c	43.8d	43.3d	
2WAOA						
IT81D-699	56.1	56.7	56.0	55.0	55.0	55.8d
IT82 (e-18)	57.7	57.9	57.1	57.0	56.1	57.2c
IT84S-2246-4	62.0	63.1	59.4	58.7	57.6	58.2b
TV x 3236	64.4	65.2	63.7	63.3	63.0	63.9a
IT90K- 277-2	54.4	55.1	54.6	54.2	53.8	54.4d
IT870-941	53.7	54.3	53.0	53.1	53.0	53.4e
Means	58.1b	58.7a	57.3c	56.9d	56.4e	
3WAOA						
IT81D-699	57.4	58.3	57.2	57.0	56.1	56.6

Table 1. Contd.

IT82 (e-18)	59.9	60.3	59.0	57.6	55.4	58.3
IT84S-2246-4	64.6	65.9	63.4	63.2	62.1	63.8
TV x 3236	65.9	66.3	65.2	64.6	62.9	65.8
IT90K-277-25	56.1	56.7	55.0	53.7	51.6	54.6
IT870-941-1	54.9	55.4	53.2	52.7	51.6	54.6
Means	59.7b	60.5a	58.8c	58.1d	56.8e	

Means in the same column with different letters and with the same MAP are significantly different at $P \leq 0.05$ using DMRT. WAOA = Week after oil application.

Table 2. Number of leaves and stem diameter (cm) of the six cultivars of cowpea as affected by spent engine oil.

Cowpea cultivar	Leaf area/ oil level					
	0	25	50	75	100	Means
1WAOA						
IT81D-699	6.6	6.8	6.6	6.3	6.1	6.5c
IT82 (e-18)	6.5	6.7	6.4	6.2	5.7	6.3d
IT84S-2246-4	7.4	7.7	7.3	7.0	7.0	7.3b
TV x 3236	7.5	7.9	7.5	7.2	7.1	7.4a
IT90K-277-25	6.3	6.5	6.2	6.0	5.8	6.2e
IT870-941-1	6.4	6.5	6.1	5.9	5.6	6.1e
Means	6.8b	7.0a	6.7b	6.4c	6.2d	
2WAOA						
IT81D-699	7.4	7.6	7.3	7.0	6.4	7.1c
IT82 (e-18)	7.3	7.7	7.2	7.0	6.5	7.1c
IT84S-2246-4	9.4	9.8	9.2	9.0	8.3	9.1b
TV x 3236	9.6	10.4	9.6	9.2	9.0	9.5a
IT90K-277-25	7.3	7.5	7.2	7.1	6.5	7.1c
IT870-941-1	7.3	7.6	7.1	6.7	6.4	7.0c
Means	8.1b	8.4a	7.9c	7.7d	7.2e	
3WAOA						
IT81D-699	7.5	7.6	7.0	6.8	6.2	7.0c
IT82 (e-18)	7.5	7.6	7.0	6.7	6.1	7.0c
IT84S-2246-4	9.4	9.6	9.2	9.0	8.5	9.1b
TV x 3236	9.6	9.9	9.3	9.1	8.6	9.3a
IT90K-277-25	7.4	7.5	7.0	6.6	6.4	7.0c
IT870-941-1	7.3	7.4	7.0	6.5	6.3	6.9c
Means	8.1b	8.3a	7.8c	7.5d	7.0e	
Cowpea cultivar	**Stem diameter/ oil level**					
1WAOA						
IT81D-699	1.3	1.5	1.2	1.0	0.9	1.2c
IT82 (e-18)	1.4	1.6	1.3	1.0	0.9	1.2c
IT84S-2246-4	1.6	1.8	1.5	1.4	1.2	1.5b
TV x 3236	1.7	1.9	1.6	1.5	1.3	1.6a
IT90K-277-25	1.2	1.3	1.1	1.0	0.9	1.1d
IT870-941-1	1.1	1.2	1.0	0.8	0.7	1.0d
Means	1.4b	1.6a	1.3b	1.1c	1.0c	

Table 2. Contd.

2WAOA						
IT81D-699	1.4	1.6	1.5	1.3	1.0	1.4c
IT82 (e-18)	1.6	1.7	1.5	1.2	1.0	1.4c
IT84S-2246-4	1.9	2.0	1.9	1.4	1.1	1.7b
TV x 3236	2.0	2.1	2.0	1.0	1.3	1.8a
IT90K-277-25	1.4	1.3	1.2	1.0	0.8	1.1d
IT870-941-1	1.3	1.4	1.2	0.9	0.7	1.1d
Means	1.6b	1.7a	1.6b	1.2c	1.0d	
3WAOA						
IT81D-699	1.5	1.7	1.4	1.2	1.1	1.4d
IT82 (e-18)	1.7	1.8	1.6	1.4	1.1	1.5c
IT84S-2246-4	2.1	2.2	1.9	1.5	1.2	1.8b
TV x 3236	2.2	2.4	2.0	1.6	1.4	1.9a
IT90K-277-25	1.7	1.8	1.6	1.2	1.0	1.5c
IT870-941-1	1.6	1.7	1.4	1.1	0.8	1.3d
Means	1.8b	1.9a	1.7c	1.3d	1.1e	

Table 3. Morphological characteristics of the six cultivars of cowpea subject to SEO.

Character	Cowpea cultivars	Oil level					
		0	25	50	75	100	Means
Days to 50% flowering	IT81D-699	39.8	37.6	40.2	44.6	45.0	41.48d
	IT82 (e-18)	40.6	38.2	40.9	43.5	45.2	41.68c
	IT84S-2246-4	38.2	37.0	43.3	44.7	44.9	41.62b
	TV x 3236	38.0	37.0	42.7	43.9	44.1	14.14a
	IT90K- 277-2	39.8	38.7	42.9	45.8	46.3	42.7e
	IT870-941	40.8	39.4	43.6	47.3	47.9	43.8f
	Means	39.5b	38.9a	42.3c	45.8d	45.6d	
Number of nodes on main stem	IT81D-699	9.7	10.6	9.1	8.7	8.0	9.22c
	IT82 (e-18)	9.6	10.5	9.0	8.7	7.6	9.08d
	IT845-2246-4	10.0	10.9	9.6	9.2	9.0	9.74b
	TV x 3236	10.9	11.7	10.5	9.6	9.4	10.42a
	IT90k- 277-2	9.5	10.4	9.2	8.5	7.3	8.98e
	IT870-941	9.3	9.9	8.7	8.3	7.5	8.74f
	Means	9.83b	10.67a	9.35c	8.83d	8.13e	
No of branches	IT81D-699	4.6	4.8	4.3	4.0	3.6	4.3c
	IT82 (e-18)	3.8	4.0	3.6	3.5	3.0	3.6e
	IT84S-2246-4	5.6	5.8	5.2	4.6	3.9	5.0b
	TV x 3236	7.8	8.0	7.7	5.8	6.3	7.3a
	IT90K- 277-2	4.2	4.6	4.0	3.2	2.8	3.8d
	IT870-941	4.1	4.5	3.8	3.1	2.6	3.6e
	Means	5.0b	5.3a	4.8c	4.1d	3.1e	
Number of peduncles	IT81D-699	7.1	7.4	7.0	6.3	6.2	6.8c
	IT82 (e-18)	7.2	7.5	6.2	6.4	5.2	6.4d
	IT84S-2246-4	8.6	8.8	7.4	7.2	7.0	7.8a
	TV x 3236	8.7	8.9	7.9	7.7	7.4	7.8a
	IT90K- 277-2	7.3	7.5	7.0	6.4	6.3	6.9b

Table 3. Contd.

	IT870-941	7.4	7.6	7.0	6.4	6.3	6.9b
	Means	7.7b	8.0a	7.1c	6.7d	6.4e	
	IT81D-699	9.4	9.6	9.3	9.0	9.3	9.3d
	IT82 (e-18)	9.7	9.7	9.3	9.2	9.1	9.3d
	IT84S-2246-4	12.7	12.7	10.9	10.4	10.3	11.2b
Length of peduncles	TV x 3236	12.9	12.9	11.4	10.9	10.6	11.5a
	IT90K- 277-2	9.9	9.9	9.4	8.7	8.5	9.2d
	IT870-941	9.9	9.9	9.5	9.4	9.2	9.5c
	Means	10.3b	10.8a	10.0c	9.6d	9.5d	

Means in the same column and within the same parameter with different letter are significantly different at P≤ 0.05 using DMRT

Table 4. Physico-chemical properties Asaba soil before planting.

Parameter	Value
Silk %	94.5
Silt %	2.1
Clay %	3.4
Soil Ph	5.60
Organic carbon (%)	0.91
Total N (%)	0.06
Available P (mg/kg)	30.00
Ca2+ (cmol/kg)	1.31
Mg2+ (cmol/kg)	0.16
Na+ (cmol/kg)	0.25
K+ (cmol/kg)	0.17
H+ (cmol/kg)	0.45
Al3+ (cmol/kg)	0.08
ECEC (cmol/kg)	2.42
Based saturation	78.10
Trace elements	0.02

Source: Agbogidi (2006).

Table 5. Heavy metal concentration ($mgkg^{-1}$) of soils under various treatments.

Crude oil level in soil (%w/w)	Heavy metal content							
	Fe	Zn	Cd	Cu	Mn	Pb	Cr	Ni
0.00	0.62_d	0.98_d	0.50_d	0.03_d	0.05_e	0.50_d	0.62_e	2.20_e
1.50	0.98_d	1.21_c	0.87_c	0.11_c	1.12_d	1.30_c	1.08_d	4.01_d
3.00	1.49_c	1.45_c	1.12_c	0.26_c	2.43_c	1.41_c	1.51_c	6.00_c
4.50	2.45_b	1.84_b	1.58_b	0.48_b	2.94_b	1.56_b	2.10_b	8.46_b
6.00	3.26_a	2.01_a	1.97_a	0.86_a	4.52_a	1.86_a	2.37_a	11.20_a

Means with different letters are significantly different at P≤0.05 using Duncan's multiple range tests.

also demonstrated that spent engine oil has a highly significant effect of reducing the growth characteristics of the six cultivars of cowpea examined with the TVx3236 and the IT84S-2246- 4 showing some levels of tolerance, hence, they can be recommended to farmers in oil impacted areas.

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