Scientific Research and Essay Vol. 2 (4), pp. 127-131, April 2007
Available online at http://www.academicjournals.org/SRE
ISSN 1992-2248 © 2007 Academic Journals

Full Length Research Paper

Effect of different concentrations of crude oil (Bonny light) on major food reserves in guinea corn during germination and growth

Akaninwor, J. O., Ayeleso, A. O., and Monago, C. C.

Department of Biochemistry, University of Port Harcourt, Rivers State, Nigeria.

Accepted 30 March, 2007

Effect of different concentrations of crude oil on germination, growth and major food reserves (carbohydrate, lipid, protein) were investigated in guinea corn (*Sorghum bicolor*). The concentrations of the crude oil used were 0, 5, 10 and 20% (v/v). The result showed that the radicle and shoot lengths decreased significantly ($p<0.05$) with increasing concentrations of crude oil. In 84 h of growth, the lengths of radicle of guinea ranged from 43.33 ± 1.37 mm at 0% to 28.33 ± 2.13 mm at 10%. The lengths of shoot ranged from 40.33 ± 1.25 mm at 0% to 24.00 ± 0.82 mm at 10%. At 20%, both the radicle and shoot growth were significantly inhibited. The result of the proximate analysis showed that carbohydrate was highest in guinea corn (73.87%), which was followed by protein (9.35%). The result showed decrease in food reserves within 84 h of growth. Meanwhile, there was increase in carbohydrate content in guinea corn (74.59 ± 0.43, 75.50 ± 0.68, 75.43 ± 0.28) in 24 h at 0, 5 and 10% crude oil, respectively. At 20%, there was significant difference ($p<0.05$) in protein content during germination and growth. It can be concluded from the study that high concentration of crude oil can inhibit germination and growth of guinea corn, and hence guinea corn serves as bio-indicator of crude oil polluted areas.

Key words: Germination, crude oil, guinea corn.

INTRODUCTION

Crude oil is a complex mixture of thousands of hydrocarbons and non-hydrocarbon compounds including heavy metals. It is the largest and most important source of hydrocarbons (Hunt, 1996). Crude oil varies in appearance and composition from one oil kind to another (Craig, 2003). The varying compositions of one crude oil from the other have diverse effects on different organisms within the same environment (Overton et al., 1994). However, crude oil is not found naturally in every part of the world. It is transported from one place to other for refining. A seemingly inescapable consequence of these transport activities is the accidental spill of the oil into both land and water. Crude oil pollution has been reported to have deleterious effects on plant germination and seedling growth (Kyung-Hwa et al., 2004).

Bioassays such as measurements of seed germination and early seedling growth have been used to monitor treatment effects of oil-contaminated sites (Sverdrup et al., 2003). This has necessitated a similar investigation in Nigeria where a lot of pollution of farmlands occurs. The study will evaluate the toxicity response of guinea corn to different concentrations of crude oil using radicle and shoot growth and as well investigate the effect of crude oil on the concentrations of food reserves in guinea corn during germination and growth.

MATERIALS AND METHODS

Plant materials

Viable pest free seeds of guinea corn were purchased from Rumuomasi market of Port Harcourt, River State.

*Corresponding author. E-mail: akaninworj@yahoo.com.

Table 1. Proximate composition of guinea corn.

Parameters	Composition (%)
Moisture	8.69±0.30
Protein	9.35±0.61
Lipid	2.22±0.17
Ash	2.13±0.09
Fibre	2.15±0.06
Carbohydrate	73.87±0.60

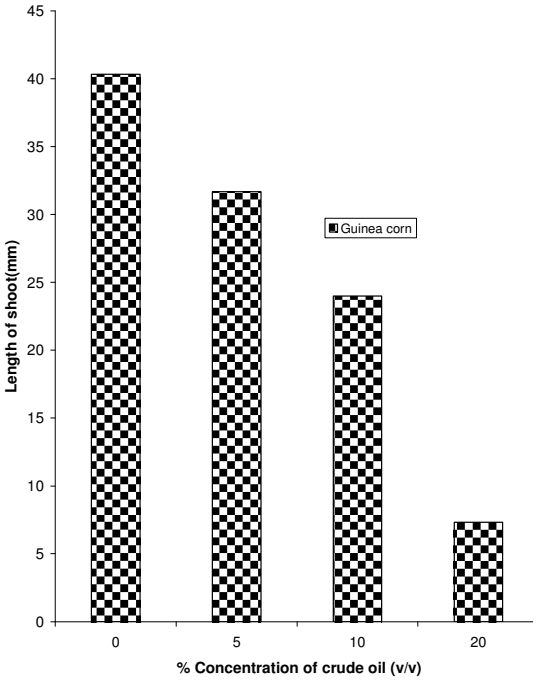

Figure 1. Growth of shoot of guinea corn within 84 h at different concentrations of crude oil.

Method of germination

The method of Aisien and Ghosh (1978) was used. Grains were hand selected for approximately equal size. The seeds were surface sterilized with 1% sodium hypochlorite solution for 10 min at room temperature and steeped in sterile distilled water for 9 h. The hydrated grains (120 seeds) were subsequently transferred to each sterile Petri dishes lined with 9 cm sterile filter paper wetted with different concentrations (0, 5, 10 and 20v/v) of crude oil. Germination was monitored for (0, 12, 24, 36, 46, 60, 72 and 84) h. Protrusion of the radicle was taken to signify the initiation of germination process. Germinated grains were kilned at 60^{o}C for 24 h and then ground for further analyses.

Analytical methods

Moisture, ash, total protein, sugar, starch, total lipids contents were determined using AOAC (1990) method. The total carbohydrate content was determined using Dubois et al. (1956) method. Crude fibre was estimated using Entwistle and Hunter (1994) method.

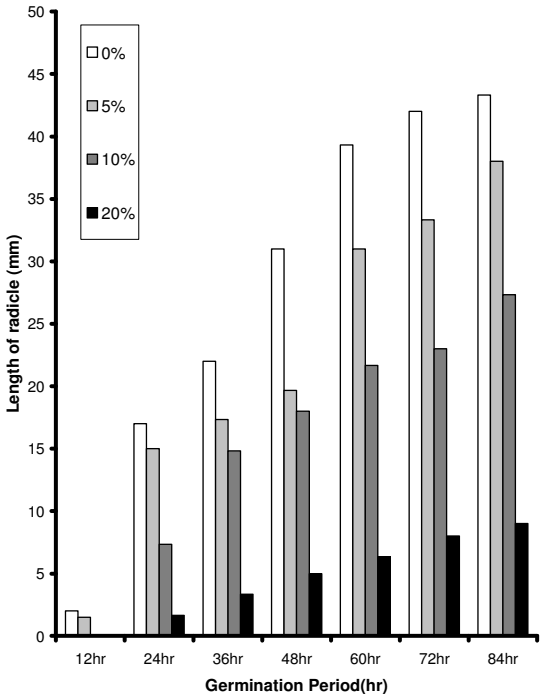

Figure 2. Growth rate of radicle of guinea corn at different concentrations of crude oil.

Statistical analysis

All the results were analyzed statistically through one-way Analysis of Variance (ANOVA) to determine the effect of treatments and Tukey's tests was used to determine the Least Significant Differences (LSD) between means of treatment.

RESULTS

Proximation composition of guinea corn

Proximate analysis revealed that guinea corn predominantly contained carbohydrate (73.87%), which was followed by protein (9.35%) and moisture (8.69%) (Table 1). Other nutrients present were ash (2.13%), lipid (3.83%) and fibre (2.15%).

Germination and growth

Figure 1 showed that millet germinated in 12 h at 0 and 5% crude oil while there was delay at 10 and 20% crude oil. There was significant decrease in growth at increasing concentrations of crude oil. The values of lengths of radicle of millets in 84 h of growth at 0, 5, 10 and 20% were 43.33 ± 1.37, 35.00 ± 0.82, 28.33 ± 2.13 and 9.00 ± 0.77 mm, respectively. The lengths of shoot in millets in 84 h were 40.33 ± 1.25, 31.67 ± 1.25, 24.00 ± 0.82 and 7.33 ± 0.97 mm at 0, 5, 10 and 20%, respectively, as shown in Figure 2.

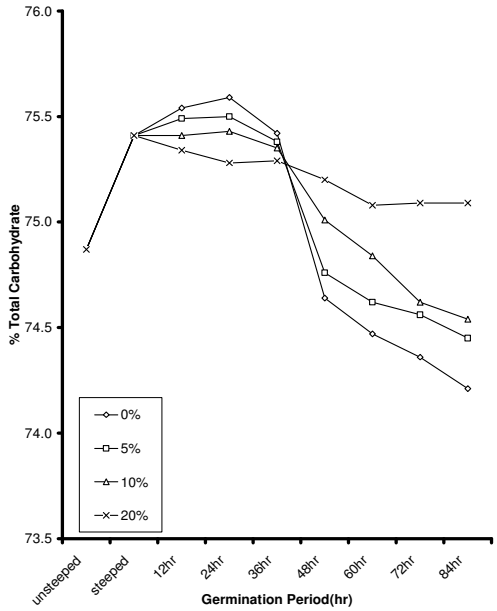

Figure 3. Changes in the concentrations of carbohydrate in guinea corn during growth at different concentrations of crude oil.

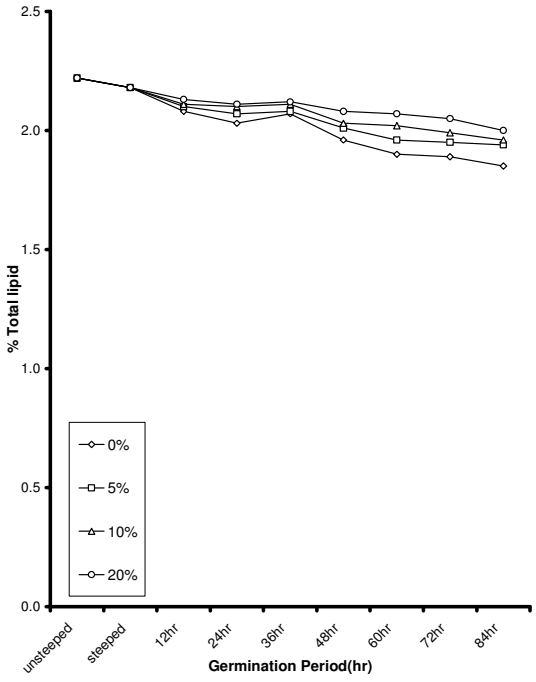

Figure 4. Changes in the concentrations of the lipid in guinea corn during growth at different concentrations of crude oil.

Carbohydrate content

The results in Figure 3 showed increase in carbohydrate content (74.59 ± 0.43, 75.50 ± 0.68, 75.43 ± 0.28 and 75.28 ± 0.56%) of guinea corn in 24 h at 0, 5 and 10% crude oil, respectively, and thereafter decreased rapidly while; there was no increase at 20%. The values of carbohydrate content in 84 h were 74.21 ± 0.73, 74.45 ± 0.34, 74.54 ± 0.91 and 75.09 ± 0.88%, respectively at all the concentrations of crude oil used.

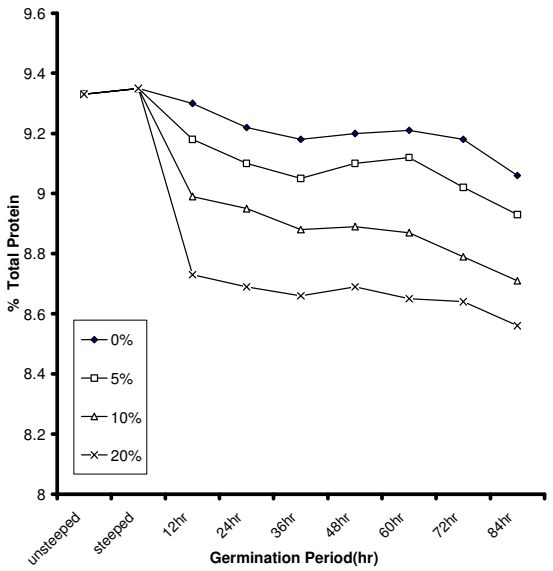

Figure 5. Changes in the concentrations of protein in guinea corn during growth at different concentrations of crude oil

Lipid content

Figure 4 showed decline in lipid content of guinea corn (2.06 ± 0.16, 2.07 ± 0.15, 2.10 ± 0.17 and 2.11 ± 0.13%) in 24 h at 0, 5, 10 and 20% crude oil, respectively. Thereafter, was an increase in 36 h (2.07 ± 0.14, 2.08 ± 0.12, 2.11 ± 0.11 and 2.12 ± 0.10, respectively) that later decreased as the growth of guinea corn proceeded to 84 h (1.85 ± 0.14, 1.94 ± 0.21, 1.96 ± 0.16 and 2.00 ± 0.18) at all the concentrations of crude oil used, respectively.

Protein content

Figure 5 showed decrease in protein content of guinea corn in 84 h of growth. The values of protein in 84 h were 8.99 ± 0.33, 8.93 ± 0.26, 8.71 ± 0.41 and 8.56 ± 0.28% at 0, 5 10 and 20% crude oil, respectively.

DISCUSSION

The proximate analysis showed that guinea corn had carbohydrate as the major food reserve. Like other cereals, guinea corns are starchy (FA0, 1990). The degrees of inhibition of germination and seedling growth were dep-

endent on the concentrations of the crude oil used. The fact that guinea corn was able to survive well at 5% indicates that guinea corns can thrive well in an environment that is slightly polluted with crude oil. While at 20%, the crude oil was not only able to inhibit germination of guinea corn but also was considerably effective against seedling growth. The seeds of guinea corn surviving at 20% crude oil were weak and distorted. Earlier works on the effect of pollutants on germination and growth of plants have reported similar results (Dejong, 1980; Sharma et al., 1980; Fernandes and Henrigues, 1991; Peralta et al., 2000; kyung-Hwa et al., 2004). Suppression of germination and subsequent growth of plants by crude oil could be as a result of impairment of the biochemical processes such enzyme development or synthesis taking places during germination

The increase in carbohydrate in the first few hours of germination in guinea corn could be from amino acids derived from the breakdown of protein at the same time. Stewart and Beevers (1967) demonstrated that increase in carbohydrate in germinating castor beans endosperm could be as result in gluconeogenesis from amino acids. The fact that, the concentrations of carbohydrate were not significantly different at 5 and 10% in millet indicated that the degradation of carbohydrate was not impaired. The slow degradation of carbohydrate at 20% indicated that the enzyme such as amylase whose activity is essential for providing energy for the embryo during growth might have been inhibited by crude oil. These suggest that the carbon skeletons for the growing embryo through the respiratory breakdown of utilizable substrate are inhibited by crude oil. Several chemicals have been demonstrated to inhibit degradation of carbohydrate (Penner, 1966).

The breakdown of lipids in millet in the first few hours of growth indicated that lipid materials were properly mobilezed for the growing seedlings. High concentration of crude oil (20%) tends to inhibit the degradation of lipid materials in millet but not significantly. The catabolism of lipids coincided with the accumulation of sugar. It may be inferred that there is a possible conversion of lipid materials to carbohydrates during germination and growth. Similar reports have also been reported by Kornberg and Beevers (1957), Calvin and Beevers (1961).

The decrease in the concentrations of proteins in guinea corn showed that protein was broken down into simpler substances for the use of the seedlings during germination and growth. Similar reports have been reported by Taneyama et al. (1996) in Vigna mungo et al. (1990) in *Vicia sativa.* The significant difference ($p<0.05$) in the concentrations of protein at 10 and 20% in millet could be as a result of interference of crude oil with protein synthesis.

Conclusion

It could be concluded that the deleterious effect of crude oil on seed germination and growth of guinea corn was relative to its concentrations and the higher the concentration, the greater the effects of the crude oil. The tendency of guinea corn to still thrive at 5% (v/v) crude oil indicates that they can survive in an environment that is slightly contaminated with crude oil while high contamination (20% crude oil) hinders plant germination and growth. The results obtained for the changes in the various concentrations of food reserves in guinea corn at 0% were in agreement with most research findings that carbohydrates, lipids, proteins are broken down at one stage or the other and the products were used by the growing embryo for energy production, enzymes synthesis, protoplasm and cell wall materials production. On the hand, the impairment of biochemical processes in the seeds during germination and growth must have been as a result of the inhibitory effect on the high concentration of the crude oil. These deleterious effects of crude oil pollution will adversely affect farmlands containing these crops, which is a major source of nutrients to the populace thus rendering them nutritionally disadvantaged.

REFERENCES

Aisen OA, Ghosh BP (1978). J. Sci. Food Agric. Am. Chem. Soc. 29: 865.

AOAC (1990). Official Methods of Analysis Association of Official Analytical Chemists, 15th ed. Washington. D.C., USA.

Canvin DT, Beevers H (1961). Sucrose synthesis from acetate in the germinating castor bean: kinetics and pathway. J. Biol. Chem. 236: 988-995.

Craig CF (2003). Occupational safety and health administration. Washington D.C. 20210.

Dubois M, Gilles KA, Hamilton, JK, Rebers PA, Smith F (1956). Colorimetric method for determination of sugars and related substances. Anal.Chem. 28: 350-356.

Entwistle PV, Hunter W L (1994). Report on crude fibre. JACAC 32 : 651 – 656.

FAO (1990). Structure et caractéristiques de 1'économie mondiale du mil. CCP: GR 90/4. Rome. p. 15.

Fernandes JC, Henriques (1991). Biochemical, physiological, and structural effects of excess copper in plants, The Bot. Rev. 57: 246-273.

HACH (1990). Systems for food, feed and beverages analysis procedures.

Hunt JM (1996). Petroleum Geochemistry and Geology; 2nd Edition.

Kornberg HI, Beevers H (1957). The glyoxylate cycle as a stage in the conversion of fat to carbohydrate in castor beans. Biochim. Biophys. Act. 26: 531-537.

Kyung-Hwa B, Hee-Sik K, Hee-Mock O, Byung-Dae Y, Jaisoo K, In-Sook L (2004). Effect of crude oil, oil components, and bioremediation on plant growth, J. Environ. Sci. health. (39)9: 2465-2472.

Misra NM, Kar RK (1990). Regulation of storage protein Physiol. XXXIII4: 333-339.

Overton EB, Sharp WD, Roberts P (1994). Toxicity of petroleum. In Basic Environ. Toxicol. CRC Press: Boca Raton, FL. pp. 133-156.

Penner D, Ashton FM (1966). Nature London 212: 935.

Peralta JR, Gaeden-Torresdey JL, Tiemann KJ Gomez E, Arteaga S, Rascon, Parsons JG (2000). Study of the effects of heavy metals on seed germination and plant growth on Alfalfa plant (*Medicago sativa*) grown in solid media. Proceeding of the 2000 Conference on hazardous waste pp. 135-140.

Stewart CR, Beevers H (1967). Gluconeogenesis from amino acids in germinating Castor bean endosperm and its role in transport to the embryo. Plant Physiol. 42: 1587-1595.

Sverdrup GD, CM, Krogh PH, Nielsen T, Kjaer C, Sternersen J (2003). Toxicity of eight polyclic aromatic compounds to red clover (*Trifolium pretense*), ryegrass (*Lolium perenne*), and mustard (Sinapsis alba). Chemosphere 53: 993-1003.

Taneyama M, Okamoto T, Yamauchi D, Minamikawa T (1996). Development of endopeptidase activity in cotyledons of *Vigna mungo* seedling: Effects of exogenously applied end products and plant hormones. Plant Cell Physiol. 37: 19-26.