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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 10 (1): 160-162, 2007
ISSN 1028-8880

Effect of Minta Effluent on the Phenology, Growth and Yield of *Vigna unguiculata* (L) Walp Var. Ife Brown

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Abstract: The composition of minta effluent and its effect on the phenology, growth and yield of seeds of *Vigna unguiculata* (L.) Walp var. Ife brown, were investigated. The effluent was highly acidic (pH 3.74) and the concentrations of Ca, Mg and SO_4 were appreciable (107.07, 351.47 and 221.11 mg L^{-1}, respectively). Germination of seeds sown in effluent was delayed by a day, reduced by 2% and not synchronous. Phenological investigations showed that plants grown in soil watered with effluent had 4-5 days delay in staking, bud formation, flower initiation, fruiting, pod ripening and plant senescence. These plants showed significant reductions in plant height, leaf area, shoot biomass and pod biomass ($p<0.05$). Furthermore, seed yield and 100 corn weight of treated plants were low. Minta effluent has low agropotential.

Key words: Minta effluent, chemical composition, phenology, growth, *Vigna*

INTRODUCTION

Industrial effluents contain a wide variety of mineral elements including heavy metals such as Hg, Cu, As, Fe, Cr, Pb, Zn and Cd (Varma *et al*., 1976; Clark, 1995). Some of these elements are essential for plant growth and metabolism but a few of such elements, such as Fe, Zn, Cu and Al depress growth at high concentrations (Wong and Bradshaw, 1982; Berti and Jacobs, 1996).

Agropotentiality of sewage effluent has long been identified though continuous loading of soil with this effluent may increase the concentration of trace elements in the plants grown in these lands, potentially affecting the growth of plants (Berti and Jacobs, 1996). Sugar factory effluent has been shown to have stimulating effects on physiological and biochemical contents of *Gossypium hirsutum* L. while sago factory effluent had inhibitory effects (Muthusamy and Jayabalan, 2001). Diluted effluent from pulp and paper mill has also been shown to enhance growth and grain yield in wheat (Anoop *et al*., 2002).

The agropotentiality of Minta effluent is assessed by studying its effect on the phenology, growth and yield of *Vigna unquiculata* (L.) Walp variety Ife brown.

MATERIALS AND METHODS

Collection of materials: Seeds of *Vigna unquiculata* (L.) Walp variety Ife brown (cowpea) were collected from the Institute of Agricultural Research and Training (IAR and T), Ibadan. The effluent was collected from the minta factory in Lagos.

Effluent analysis: The pH was measured using a pH meter (Jenway model). To 100 mL effluent, 20 mL 80% nitric acid was added and this was heated. Digestion was continued till content was half its volume. This was cooled and made up to 100 mL with distilled water (Jones, 1984). Mg, K, Zn, Cu,Mn and Fe contents were determined using atomic absorption spectrophotometry. Concentrations of sulphate, phosphate and nitrate were determined using methods outlined by WHO (1988).

Germination test: Seeds of cowpea were surface sterilized with 0.1% $HgCl_2$ solution and 20 seeds were sown on moistened filter paper in a Petri dish in three replicates. These were allowed to germinate at a room temperature of 21.6-31.3°C. Germination counts were made at daily intervals.

Planting procedure: Four seeds of cowpea were planted 3 cm apart and 2 cm deep in each of 40 planting pots containing loamy soil. Twenty pots were watered daily with minta effluent while the remaining served as the control.

Phenological investigations: The time of germination, production of first set of trifoliate leaves, staking, bud formation, flower initiation, production of first fruit, pod ripening and senescence was recorded.

Growth analysis: Three seedlings each were randomly selected from the control and the treated plants on the 45th Day After Planting (DAP). Plant part (shoot and root) biomass was taken after the plants were dried in an oven

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at 80°C for 3 days. The leaf area of freshly harvested plants were determined by the method of Eze (1965). The Net Assimilation Rate (NAR), Leaf Area Ratio (LAR) and Relative Growth Rate (RGR) were determined according to methods outlined by Noggle and Fritz (1976). The final harvest was done when two-third of the control pods were ripe (Aykroyd and Doughty, 1964). Growth parameters which include shoot, leaf, root, pod, 100 seeds biomass, average numbers of pods/plant and seeds/pod, were taken.

Statistical analysis: All analysis were carried out in three replicates and tests of significance were conducted using the t-test at $p<0.01$ and $p<0.05$.

RESULTS AND DISCUSSION

Minta effluent was found to be very acidic (pH 3.74) and had high concentrations of Ca, Mg and SO_4 (Table 1). Germination of seeds of *Vigna unquiculata* var Ife brown (cowpea) sown in minta effluent was delayed by a day and reduced by 2% when compared with untreated (control) seeds. Germination of treated seeds was not synchronous but lasted 7 days instead of 3 days (Fig. 1). Phenological studies showed that staking, bud formation, flower initiation, fruiting, pod ripening and plant senescence were delayed by 4-5 days in treated plants (Fig. 2). The effluent had a pH value that was far more acidic than the range for the cultivation of cowpeas (pH 5.5-6.5) (Davis *et al.*, 1991) and this affected growth and yield adversely.

Generally, plants grown in effluent had thin, feeble sprawling stems, leaf chlorosis and some necrotic spots at about 23 DAP. Furthermore, seeds produced by these plants were wrinkled, fewer, smaller in size and had tougher seed coats than the control. All parameters of growth studied were lower in treated plants than the control (Table 2) and the difference was significant in plant height, leaf area, shoot biomass and pod biomass (at $p<0.05$). Stunted growth and low yield in plants could result from loss or low moisture content under conditions of higher osmotic concentration of soils with increased loading of minerals (Sutcliffe and Baker, 1974).

An excess of certain metal cations such as Mg, Cu, Zn or Ni may induce symptoms similar to those of iron deficiency which is extensive chlorosis of the leaves (Hewitt, 1963). Continuous wetting of plants with Mg rich minta effluent could have increased the Mg load of the soil to toxic levels inducing the chlorotic condition observed in the leaves of treated plants. High concentration of Ca in this effluent may have caused a reduction in the uptake of Mn leading to symptoms that comprise a wide variety of chlorotic and nectrotic patterns (Sutcliffe and Baker, 1974).

Table 1: pH and Chemical properties of minta effluent

Parameter	Levels detected (mg L^{-1})
pH	3.74±0.01
Fe	0.99±0.15
K	2.04 ±0.52
Ca	107.07±7.67
N	ND
Mg	351.47±13.23
Cu	ND
Mn	ND
NO_3	8.31±0.89
PO_4	4.58±0.46
SO_4	221.11±24.01

ND-Not Detected

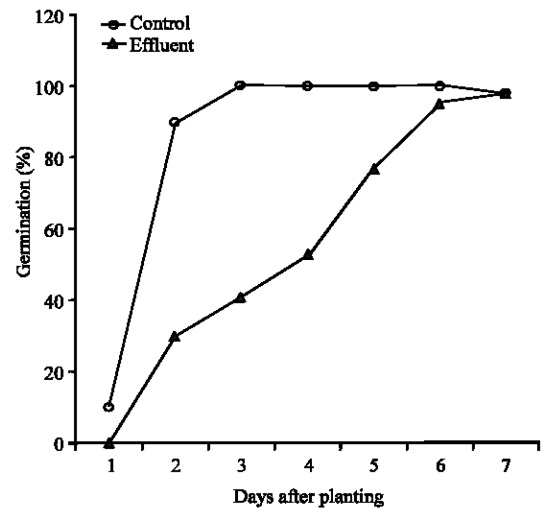

Fig. 1: Percentage germination of cowpea seeds sown in minta effluent

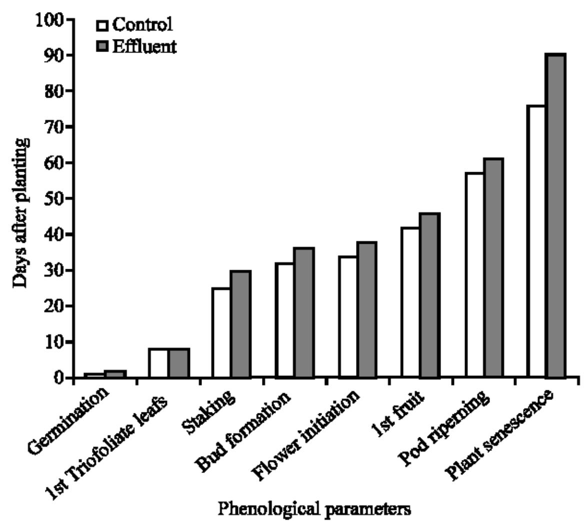

Fig. 2: Phenological parameters of cowpea plants grown in soil treated with minta effluent

The drastic reduction in leaf area, plant height, shoot and pod biomass shown by treated plants (Table 2) may be due to Zn deficiency. Zn deficient plants have a low

Table 2: Growth parameters of cowpea plants grown in soil treated with minta effluent

Growth parameter	Treated plants	Control
45 DAP		
Plant height (cm)	43.00±2.01	128.00±39.82**
Stem girth (cm)	1.80±0.18	1.93±0.19NS
Leaf area (cm^2)	413.33±59.40	593.33±21.34**
Shoot biomass (g)	1.90±0.57	3.27±0.47*
Root biomass (g)	0.13±0.05	0.23±0.05NS
NAR (g cm^2 day^{-1})	$1.82\pm1.01\times10^{-2}$	$3.25\pm0.94\times10^{-2}$NS
LAR (cm^2 g^{-1})	231.05±21.59	235.51±9.39NS
RGR (g g^{-1} day^{-1})	$4.14\pm2.30\times10^{-2}$	$7.70\pm2.42\times10^{-2}$NS
80 DAP		
Shoot biomass (g)	2.30±0.42	2.20±0.49NS
Leaf biomass (g)	2.70±0.76	2.33±1.02NS
Root biomass (g)	0.28±0.05	0.20±0.03NS
Pod biomass/ plant (g)	1.77±0.28	2.87±0.33*
Average number of pods/plant	2	4
Average number of seeds/pod	6	8
100 seed biomass (g)	13.60	15.50

NS = Not significantly different p = 0.05, *Significantly different at p = 0.05, **Significantly different at p = 0.01

level of auxin, an essential growth hormone. Zn activates enzymes in protein synthesis and is involved in regulation and consumption of sugars and the formation of chlorophyll. It is necessary for starch formation and proper root development and it influences the rate of seed and stalk maturation (Anderson, 2004). Flowering and fruiting of treated plants were delayed and reduced, probably due to boron deficiency (Hewitt, 1963). The high concentration of some of the metals in the effluent (Ca and Mg) may have hindered the absorption of Zn and B. Furthermore, the acidity of the effluent (pH 3.74) may have increased the mobility and availability of these metals compounding their toxic effects on growth (Willet *et al*., 1994).

The change in the morphology of treated plants (thin, feeble, sprawling stems) can influence photosynthesis and carbon transport resulting in reductions in yield (Izquierdo and Hosfield, 1983). Seeds of treated plants were fewer and smaller in size than the control (Table 2).

The acidity of minta effluent and the high Ca and Mg contents give it a low agropotential. However, diluting this effluent may improve its agropotential as reported by Anoop *et al*. (2002) growing wheat with diluted pulp and paper mill effluent.

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