

List of Tables, Figures, Sequences and Photos

List of Tables

Table No.	Particulars	Page No.
1.1	Potential toxic effects of exposure to explosive chemicals and their components	6
1.2	Important properties of Trinitrotoluene (TNT)	24
2.1	Estimation of trinitrotoluene (TNT- Assay)	51
2.2	pH, EC, Total Nitrogen (N) %, Organic Carbon (OC) % and C/N ratio of compost fillers.	55
2.3	Total N %, Total P ₂ O ₅ % and Total K ₂ O % (N P K) in compost fillers.	55
2.4	Microbial count per gram of compost fillers.	56
2.5	Micronutrients in compost fillers.	57
2.6	Microbial count per gram of compost mixtures after 15 days of incubation with NC (10,000 ppm), NG (1500 ppm), TBP (1500 ppm) and TNT (10,000 ppm).	57
2.7	Enzyme activities in compost mixtures at '0' hrs of incubation with explosives.	60
2.8	Enzyme activities in compost mixtures after 15 days of incubation with explosives.	60
2.9	Residual Nitrocellulose (NC) in compost matrix.	62
2.10	Residual Trinitrotoluene (TNT) in compost matrix.	65
2.11	Wavelength ranges and group assignments in infrared spectra.	66
2.12	Retention time of TNT metabolites in compost obtained in GC analysis	77
2.13	Identification of TNT metabolites in compost	78
2.14	% Seed germination and root shoot growth in matured compost incubated with NC, NG, TBP and TNT	84
2.15	Biomass, chlorophyll, carbohydrate and protein content in wheat plant grown on matured compost incubated with NC, NG, TBP and TNT	85
3.1	Scheme of alkaline hydrolysis of NC, TBP and TNT	99
3.2	Nitrate and Nitrite ion concentration in hydrolysates of NC (HNC), TBP (HTBP) and TNT (HTNT)	102
3.3 (a)	Data on seed germination with respect to various doses of NC hydrolysate prepared using varying feedstock and base concentration	108
3.3 (b)	Data on root growth with respect to various doses of NC hydrolysate prepared using varying feed stock and base concentration	109
3.4	Metabolic products of wheat plant grown on NC hydrolysate	110
3.5	Data on seed germination with respect to various doses of TBP hydrolysate prepared using varying feed stock and base concentration	112
3.6 (a)	Data on root growth with respect to various doses of TBP	113

	hydrolysate prepared using varying feed stock and base concentration	
3.6 (b)	Data on shoot growth with respect to various doses of TBP hydrolysate prepared using varying feed stock and base concentration	114
3.7	Metabolic products of wheat plant grown on TBP hydrolysate	115
3.8	Data on seed germination with respect to various doses of TNT hydrolysate prepared using varying feed stock and base concentration	117
3.9 (a)	Data on root growth with respect to various doses of T hydrolysate prepared using varying feed stock and base concentration	118
3.9 (b)	Data on shoot growth with respect to various doses of TNT hydrolysate prepared using varying feed stock and base concentration	119
3.10	Metabolic products of wheat plant grown on TNT hydrolysate	120
3.11	data on seed germination, root shoot growth and metabolic products of wheat plant grown on composted hydrolysates of NC	123
3.12	data on seed germination, root shoot growth and metabolic products of wheat plant grown on composted hydrolysates of TBP	123
3.13	data on seed germination, root shoot growth and metabolic products of wheat plant grown on composted hydrolysates of TNT	124
4.1	CFU count of bacterial colonies in compost matrices.	141
4.2	CFU count of dominant bacterial colonies in compost matrices.	141
4.3	CFU count of fungal colonies in compost matrices.	141
4.4	CFU count of dominant fungal colonies in compost matrices.	141
4.5	Morphological characteristics of isolated bacterial strains.	142
4.6	Morphotaxonomical identification of isolated fungal strains.	142
4.7	Physiological characteristics of isolated bacterial strains.	142
4.8	Biochemical characteristics of isolated bacterial strains.	143
4.9	Percentage similarity of strain VRI-1 with other similar strains reported in NCBI library (Hit List).	144
4.10	Percentage similarity of strain VRI-2 with other similar strains reported in NCBI library (Hit List).	144
4.11	Percentage similarity of strain VRI-3 with other similar strains reported in NCBI library (Hit List).	145
4.12	Percentage similarity of strain VRI-4 with other similar strains reported in NCBI library (Hit List).	145
4.13	Brief description of closest genetic neighbor as it appears in NCBI genebank Database for strain VRI-1.	154
4.14	Brief description of closest genetic neighbor as it appears in NCBI genebank Database for strain VRI-2.	155
4.15	Brief description of closest genetic neighbor as it appears in NCBI genebank Database for strain VRI-3.	156
4.16	Brief description of closest genetic neighbor as it appears in NCBI genebank Database for strain VRI-4.	157
4.17	Distance Matrix for strain VRI-1, VRI-2, VRI-3 and VRI-4.	158
5.1	Hoagland solution (Plant nutrition solution).	172
5.2	Taxonomical classification of plants under the study.	177

5.3	Chlorophyll and carotenoids content of the control and NG (80 mg/L) exposed plants	178
5.4	Total Proteins, Free amino acids, Total carbohydrates and free reducing sugars in control and NG exposed plants.	178
5.5	Activity of catalase and peroxidase enzymes in control and NG exposed plants.	178

List of Figures

Fig. No.	Particulars	Page No.
1.1	Classification of explosives based on performance.	3
1.2	Molecular Structure of Nitrocellulose.	21
1.3	Molecular structure of Nitroglycerine.	23
1.4	Molecular structure of Trinitrotoluene.	24
2.1	Calibration curve of Nitrocellulose	62
2.2	Concentration of NC observed on degradation by compost bioremediation.	63
2.3	Maximum absorbance of TNT Meissenheimer complex	64
2.4	Calibration curve for maximum absorbance of TNT Meissenheimer complex at 500 nm.	64
2.5	Concentration of TNT observed on compost bioremediation	65
2.6 (a)	IR spectra of compost incubated with NC (5000 ppm) for '0' hrs and 336 hrs	67
2.6 (b)	IR spectra of compost incubated with NG (1500 ppm) for 0, 72, 144, 216, 288 and 336 hrs	68
2.6 (c)	IR spectra of compost incubated with TBP (1500ppm) for '0' hrs and 336 hrs	68
2.6 (d)	IR spectra of compost incubated with TNT (5000ppm) for 0, 216 and 336 hrs	69
2.7 (a)	IR spectrum of TNT degradation products at '0' hrs in compost matrix (2,4,6-trinitrotoluene)	69
2.7 (b)	IR spectrum of TNT degraded products at '120' hrs in compost matrix (2,6 -dinitrotoluene)	70
2.7 (c)	IR spectrum of TNT degraded products at '120' hrs in compost matrix (2,4 -dinitrotoluene)	70
2.7 (d)	IR spectrum of TNT degraded products at '216' hrs in compost matrix (2,6 -diaminotoluene)	70
2.7 (e)	IR spectrum of TNT degraded products at '216' hrs in compost matrix (2,4 -diaminotoluene)	71
2.7 (f)	IR spectrum of TNT degradation products at '336' hrs in compost matrix (complete mineralization)	71
2.8	Biotransformation scheme of TNT degradation products in compost.	72
2.9 (a)	HPLC spectra of TNT (5000 ppm) at '0' hrs of incubation in compost	72
2.9 (b)	HPLC spectra of TNT degradation products in compost at 24 and 120 hrs	74 - 76
2.10	UV spectra of NG for λ max.	78
2.11 (a)	HPLC spectra of NG(1500 ppm) at 0 and 120 hrs of incubation in compost	79

2.11 (b)	HPLC spectra of TBP (1500 ppm) at 0 hrs and 120 hrs of incubation	79
2.12	GCMS spectrum of TNT (5000 ppm) from compost at 0, 72 and 120 hrs	80
2.13	GCMS spectrum of NG (1500 ppm) from compost at 0, 72 and 120 hrs	81
2.14	GCMS spectrum of NC (5000 ppm) from compost at 0, 72 and 120 hrs	82
2.15	GCMS spectrum of TBP (1500 ppm) in compost at 0 and 72 hrs	83
2.16 (a)	Root length of <i>Triticum aestivium</i> plant grown on NC, NG, TBP and TNT incubated compost	86
2.16 (b)	Soot length of <i>Triticum aestivium</i> plant grown on NC, NG, TBP and TNT incubated compost	86
2.17 (a)	Total biomass of <i>Triticum aestivium</i> plant grown on NC, NG, TBP and TNT incubated compost	87
2.17 (b)	Total chlorophyll content of <i>Triticum aestivium</i> plant grown on NC, NG, TBP and TNT incubated compost	87
2.17 (c)	Total carbohydrate content of <i>Triticum aestivium</i> plant grown on NC, NG, TBP and TNT incubated compost	88
2.17 (d)	Total protein content of <i>Triticum aestivium</i> plant grown on NC, NG, TBP and TNT incubated compost	88
3.1	Experimental setup for alkaline hydrolysis	99
3.2	Arrangements of petridishes in seed germinator chamber	100
3.3	Progressive colour changes in NC and TNT alkaline hydrolysis reaction mixture	101
3.4 (a)	Ion chromatograph for nitrate and nitrite ions in HNC (5% alkali, 5000 ppm)	102
3.4 (b)	Ion chromatograph for nitrate and nitrite ions in HTBP (5% alkali, 5000 ppm)	102
3.4 (c)	Ion chromatograph for nitrate and nitrite ions in HTNT (5% alkali, 5000 ppm)	103
3.5 (a)	Biomass weight and total chlorophyll content of wheat plant grown on NC hydrolysate (hydrolysate of NC prepared with 5 % alkali and 5000 ppm of NC feedstock concentration)	110
3.5 (b)	total carbohydrate and total protein content of wheat plant grown on NC hydrolysate (hydrolysate of NC prepared with 5 % alkali and 5000 ppm of NC feedstock concentration)	111
3.6 (a)	biomass and total total chlorophyll content of wheat plant grown on TBP hydrolysate (hydrolysate of TBP prepared with 5 % alkali and 5000 ppm of TBP feedstock concentration)	115
3.6 (b)	Total carbohydrate and total protein content of wheat plant grown on TBP hydrolysate (hydrolysate of TBP prepared with 5 % alkali and 5000 ppm of TBP feedstock concentration)	116
3.7 (a)	biomass and total total chlorophyll content of wheat plant grown on TNT hydrolysate (hydrolysate of TNT prepared with 5 % alkali and 5000 ppm of TNT feedstock concentration)	120
3.7 (b)	Total total carbohydrate and total protein content of wheat plant grown on TNT hydrolysate (hydrolysate of TNT prepared with 5 % alkali and 5000 ppm of TBP feedstock concentration)	121
3.8	Biomass and metabolic products of wheat plant grown on composted hydrolysates of NC, TBP and TNT	124
4.1	Phylogenetic Tree of strain VRI-1	146
4.2	Phylogenetic Tree of strain VRI-2	147
4.3	Phylogenetic Tree of strain VRI-3	148

4.4	Phylogenetic Tree of strain VRI-4	149
5.1	Various steps involved in phytoremediation.	169
5.2	Calibration curve of NG (0.1 to 1 ppm) for λ max.	182
5.3	HPLC chromatograph of Nitroglycerine (NG) at 0 hrs in <i>Typha</i> roots	182
5.4	IR spectra of NG at 0 hrs in <i>Typha</i> roots	183
5.5	Concentration of NG in live plant of <i>Typha</i> and three parallel controls in hydroponic culture.	183
5.6	Concentration of NG in live plant of <i>Phragmites</i> and three parallel controls in hydroponic culture.	184
5.7	Concentration of NG in live plant of <i>Eichhornia</i> and three parallel controls in hydroponic culture.	184
5.8	Concentration of NG in live plant of <i>Pistia</i> and three parallel controls in hydroponic culture.	185
5.9	Infrared spectra of Nitroglycerine (NG) and degraded compound present in NG exposed <i>Typha</i> roots in hydroponic study at 0 hrs, 24 hrs, 48 hrs, 96 hrs and 120 hrs.	185
5.10 (a)	HPLC Chromatograph of NG in <i>Typha</i> roots at 0 hrs	186
5.10 (b)	HPLC Chromatograph of NG in <i>Typha</i> roots at 24 hrs	186
5.10 (c)	HPLC Chromatograph of NG in <i>Typha</i> roots at 48 hrs	186
5.10 (d)	HPLC Chromatograph of NG in <i>Typha</i> roots at 72hrs	187
5.10 (e)	HPLC Chromatograph of NG in <i>Typha</i> roots at 96hrs	187
5.10 (f)	HPLC Chromatograph of NG in <i>Typha</i> roots at 120 hrs	187
5.11	MSMS chromatograph of <i>Typha</i> roots at 0 hrs and 96 hrs	188

List of Sequences

Sequence No.	Particulars	Page No.
Sequence 4.1	Nucleotide sequence of strain VRI-1, Accession no. HQ231888	150
Sequence 4.2	Nucleotide sequence of strain VRI-2, Accession no. HQ231889	151
Sequence 4.3	Nucleotide sequence of strain VRI-3, Accession no. HQ231890	152
Sequence 4.4	Nucleotide sequence of strain VRI-4, Accession no. HQ231891	153