both the varieties. Variety L-1 (13.82%) had more of them. Further the frequency of mutation for high yield was in EMS treatment. The bold seeded mutants were found largely in L-1 variety (3.84%) than in RBL-50 (1.40%). The EMS treatment induced more of pod shattering resistant tupes. Similarly, several workers (Malik,1988; Sinha,1980; Sumanggono, 1987 and Tickoo,1987) obtained useful mutants as observed in the present study.

Although, other viable mutants (Table-3) such as abnormal, big leaves, white flower, big branching, white pod, coloured seed types were obtained in high frequencies in both varieties, they are not having immediate impact on farmer's field, but such mutants can be used in further improvement of rice bean crop especially in hybridization programme.

The compared data of frequency of chlorophyll and viable mutations revealed that in the variety L-1 the same doses (90KR gamma) or concentrations (EMS 0.5%, combination 30KR+0.2%) which brought out the highest chlorophyll mutations also gave highest viable mutations. Such relationships between two types of mutations may facilitate plant breeders in making early attention to increase the required treated populations so as to get number of viable mutants. Some of the mutants such as early types, determinate habit, synchronous pod maturity, bold seeded mutants are of practical value from the point of application in farmer's field immediately after confirming stability of mutants and also in hybridization programme.

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EFFECT OF DISTILLERY EFFLUENT AND ORGANIC AMENDMENT ON RICE YIELD AND SOIL FERTILITY STATUS

K.ANNADURAI, R.KAVIMANI and P.MASILAMANI

College of Agricultural Engineering
Kumulur, Tiruchirapalli- 621 712.

ABSTRACT

Field experiments were conducted during 1996-99 at College of Agriculatural Engineering, Kumulur to study the effect of distillery effluent and organic amendments on rice productivity. The distillery effluent with different dilutions was taken in the main plots (10,25,50,75,100 times and water). These treatments were superimposed with different organic amendments viz., FYM at 12.5t/ha, pressmud at 12.5t/ha, gypsum at 5t/ha, neem leaves at 5.25 t/ha and no manure as control. Results revealed that in the areas where water is available in adequate amount, applications of neem leaves at 6.25 t/ha was found to be suitable and in the areas where effluent is available, it should be diluted 50 times with water along with application of neem leaves at 6.25 t/ha to increase the rice yield without any detrimental effect on soil health. The treated distillery effluent irrigations resulted in significant increase in soil pH, E.C and organic carbon.

KEY WORDS: Rice, Effluent, Dilution, Organic amendments, Yield, Soil fertility status

Table 1. Effect of treatments on grain yield (t/ha)

Treatments	S1	S2	S3	S4	S5	Mean
I Crop (1996-97)						
M1	2.07	1.93	1.55	1.74	1.23	1.70
M2	2.88	2.66	2.32	2.59	2.20	2.53
M3	4.46	4.28	4.17	4.34	2.62	3.97
M4	3.86	3.76	3.67	3.86	2.75	3.58
M5	3.77	3.58	3.55	3.71	2.84	3.57
M6	4.32	4.46	4.16	4.39	2.70	4.00
Mean	3.56	3.49	3.23	3.43	2.39	
II Crop (1997-98)						
M1	1.30	1.20	1.01	1.10	1.01	1.12
M2	3.00	2.81	2.40	2.61	2.26	2.61
M3	4.81	4.61	4.30	4.80	2.54	4.21
M4	4.70	4.52	4.23	4.67	2.91	4.20
M5	4.83	4.63	4.30	4.72	3.17	4.33
M6	5.10	4.83	4.62	5.23	3.16	4.58
Mean	3.95	3.76	2.76	3.85	2.50	
III Crop (1998-99)						
M1	1.20	1.00	0.99	1.00	0.80	0.99
M2	2.80	2.60	2.20	2.40	2.00	2.40
M3	4.60	4.40	4.10	4.62	2.43	4.03
M4	4.50	4.31	4.00	4.80	2.49	4.02
M5	4.60	4.40	4.20	4.80	2.92	4.19
M6	4.90	4.61	4.40	5.02	2.96	4.37
Mean	3.76	3.55	3.31	3.78	2.26	
POOLED MEAN						
M1	1.52	1.38	1.18	1.28	1.01	1.28
M2	2.89	2.69	2.31	2.53	2.15	2.51
M3	4.62	4.43	4.19	4.59	2.53	4.07
M4	4.35	4.20	3.97	4.45	3.38	4.07
M5	4.40	4.29	4.02	4.43	3.01	4.03
M6	4.77	4.63	4.39	4.88	2.94	4.32
Mean	3.76	3.60	3.34	3.69	2.51	

	I Crop (96-97)		II Crop (97-98)		III Crop (98-99)		Pooled Mean	
	SEd	CD	SEd	CD	SEd	CD	SEd	CD
Main	0.10	0.23	0.05	0.11	0.05	0.12	0.26	0.57
Sub	0.07	0.15	0.08	0.16	0.11	0.21	0.08	0.17
M at S	0.18	0.39	0.20	NS	0.24	NS	0.32	0.68
S at M	0.19	0.36	0.18	NS	0.26	NS	0.21	0.41

Continuous use of inorganic fertilisers, pesticides and fungicides (without organic manure) causes environmental pollution (soil and ground water pollution) thereby affecting the soil fertility on long term basis. For maintaining optimum productivity of the land and building up of soil fertility, the use of organic manure to crop needs no emphasis. It is a well known fact that the availability of organic manure is very much limited in the present day agriculture due to population explosion, reduction in livestock population etc. Devarajan *et al* (1994) reported that the distillery effluent can be considered as a liquid manure and controlled application of the treated effluent can increase the productivity of crops. There are a number of distillery units in Tamil Nadu. For the production of every one litre of alcohol, nearly 12 to 14 litres of effluent is discharged. Every distillery unit is generating 5- 10 lakh litres of raw effluent everyday. Some units have installed bio-methanization plants for producing bio-gas from the raw effluent and discharging the treated effluent with 90 per cent reduction in BOD (4500 ppm) and 63 per cent reduction in COD (35,000 ppm). These values are found to exceed the limit prescribed by Pollution Control Board (Devarajan and Oblisami, 1995). Hence an attempt was made to study the effect of distillery effluent and organic amendment on rice yield and soil fertility status.

MATERIALS AND METHODS

Field experiments were conducted during 1996-99 at College of Agricultural Engineering, Kumulur to study the effect of diluted distillery effluent and organic amendments on rice yield and soil

Table 2. Effect of treatments on straw yield (t/ha)

Treatments	S1	S2	S3	S4	S5	Mean
			ICrop (1996-97)			
M1	3.10	3.04	2.53	2.72	1.97	2.66
M2	4.31	4.15	3.68	4.00	3.41	3.91
M3	7.04	6.71	6.55	6.83	4.12	6.25
M4	6.08	5.91	5.76	5.92	4.15	5.56
M5	5.93	6.08	5.60	5.64	4.25	5.50
M6	7.36	6.85	6.70	7.03	4.30	
Mean						
			II Crop (1997-98)			
M1	1.94	1.82	1.61	1.65	1.58	1.72
M2	4.51	4.26	3.77	4.05	3.19	3.95
M3	7.19	7.38	6.74	7.29	3.78	6.47
M4	7.05	6.09	6.29	7.06	4.28	6.15
M5	7.31	7.10	6.45	7.20	4.71	6.55
M6	7.72	7.54	7.10	7.92	4.80	7.01
Mean	5.95	5.69	5.32	5.86	4.22	
			III Crop (1998-99)			
M1	1.92	1.79	1.62	1.64	1.45	1.68
M2	4.50	4.24	3.74	4.03	3.16	3.93
M3	7.64	7.32	6.70	6.62	3.66	6.38
M4	7.00	6.70	6.25	7.04	3.62	6.12
M5	7.26	7.06	6.40	7.29	4.32	6.46
M6	7.39	6.98	6.25	7.66	4.55	6.56
Mean	5.95	5.68	5.16	5.71	3.46	
			POOLED MEAN			
M1	2.32	2.22	1.92	2.00	1.69	2.03
M2	4.44	4.22	3.73	4.03	3.25	3.93
M3	7.46	7.14	6.66	6.77	3.85	6.38
M4	6.71	6.23	6.10	6.67	4.02	5.95
M5	6.83	7.75	6.15	6.38	4.43	6.11
M6	7.49	7.12	6.68	7.54	4.55	6.68
Mean	5.88	5.61	5.21	5.57	3.63	

	I Crop (96-97)		II Crop (97-98)		III Crop (98-99)		Pooled Mean	
	SEd	CD	SEd	CD	SEd	CD	SEd	CD
Main	0.021	0.046	0.08	0.17	0.14	0.30	0.31	0.69
Sub	0.018	0.036	0.18	0.35	0.21	0.42	0.09	0.19
MatS	0.044	0.091	0.43	NS	0.48	NS	0.37	0.81
SatM	0.044	0.088	0.39	NS	0.51	NS	0.23	0.47

fertility status. The trial was laid out in split plot design, replicated thrice. The distillery effluent with different dilution was taken in the main plots. These main plot treatments were superimposed with the different organic amendments. Main plots were : M1 – Treated distillery effluent (TDE) with 10 times dilution; M2- TDE with 25 time dilution; M3-TDE with 50 times dilution M4-TDE with 75 times dilution; M5-TDE with 100 times dilution; M6- Normal irrigation water.

Sublots: S1-application of 12.5 t FYM/ ha+Recommended N&P. S2- application of 12.5t press mud/ha+ recommended N&P. S3- application of 5t gypsum/ha+recommended N&P S4-application 6.25 t of *Azadiracta indica* leaves+recommended N&P, S5-control (no organic amendments).

The variety ADT-39 was used for the study. The soil of the experimental field was sandy clay loam. The organic amendments were applied(as per the treatment schedule) basally at the time of last ploughing except neem leaves which was applied at 6.25 t/ha seven days prior to transplanting. A fertiliser dose of 150:50:50 kg N,P_2O_5 and K_2O was followed. Fifteen effluent irrigation were given to rice crop as per the treatment schedule. Yield was reocrded and post harvest soil samples were analysed for estimation of pH, E.C and organic carbon.

RESULTS AND DISCUSSION

Grain and straw yield

The grain and straw yields were recorded at harvest and the results are presented in Tables 1 and 2. The results on grain yield revealed that the

Table 3: Effect of treatments on post harvest soil PH

Treatments	S1	S2	S3	S4	S5	Mean
			I Crop (1996-97)			
M1	8.74	8.75	8.81	8.77	8.81	8.78
M2	8.68	8.50	8.54	8.51	8.57	8.56
M3	8.18	8.19	8.28	8.20	8.27	8.21
M4	8.16	8.17	8.19	8.18	8.20	8.18
M5	7.93	7.95	7.99	7.96	8.06	7.98
M6	7.83	7.84	7.88	7.87	7.89	7.86
Mean	8.25	8.23	8.27	8.25	8.30	
			II Crop (1997-98)			
M1	8.67	8.64	8.67	8.62	8.76	8.67
M2	8.51	8.32	8.36	8.35	8.42	8.39
M3	7.47	7.50	7.70	7.90	8.06	7.72
M4	8.12	8.12	8.33	8.13	8.25	8.19
M5	8.02	8.05	8.09	8.06	8.24	8.09
M6	7.40	7.31	7.60	7.40	7.80	7.50
Mean	8.03	7.99	8.13	8.08	8.26	
			III Crop (1998-99)			
M1	8.45	8.63	8.60	8.63	8.72	8.61
M2	8.48	8.30	8.34	8.33	8.41	8.37
M3	7.40	7.30	7.50	7.37	7.70	7.45
M4	7.90	7.98	7.98	7.95	7.29	7.82
M5	7.13	7.15	7.19	7.20	7.32	7.20
M6	6.60	6.70	6.81	6.60	6.90	6.72
Mean	7.66	7.68	7.74	7.68	7.72	
			POOLED MEAN			
M1	8.62	867	8.69	8.67	8.76	8.69
M2	8.56	8.37	8.41	8.39	8.47	8.44
M3	7.68	7.66	7.80	8.22	7.70	7.80
M4	8.06	8.09	8.17	8.09	7.91	8.06
M5	7.96	7.72	7.75	7.74	7.87	7.76
M6	7.28	7.28	7.43	7.20	7.53	7.36
Mean	7.98	7.97	8.04	8.00	8.09	

	I Crop (96-97)		II Crop (97-98)		III Crop (98-99)		Pooled Mean	
	SEd	CD	SEd	CD	SEd	CD	SEd	CD
Main	0.004	0.009	0.06	0.14	0.05	0.10	0.19	0.42
Sub	0.005	0.011	0.07	0.15	0.06	NS	0.03	0.07
M at S	0.013	0.025	0.17	NS	0.15	NS	0.09	0.17
S at M	0.012	0.025	0.17	NS	0.15	NS	0.09	0.17

highest grain yield of 4.32 t/ha was recorded with M6(water used for irrigation). The grain yield of 4.07 t/ha was recorded withM3(50 times) and M4(75 times) which was on par with M5(100 times dilution) as reported by Chinnusamy *et al.*, (1998). Devarajan and Oblisami (1995) reported that 50 times diluted effluent was found to be suitable for rice and the undiluted effluent was not suitable for rice crop. The lowest grain yield of 1.28 t/ha was recorded with 10 times diluted treatments. Among the organic amendments, application of FYM at 12.5 t/ha.(S_1) recorded more grain yield (3.69 t/ha) which was on par with application of neem leaves at 6.25 t/ha. The interaction effect was well pronounced in influencing grain yield where the highest grain yield of 4.88 t/ha was recorded with M_5S_4 closely followed by M_6S_1 treatment. An yield of 4.62 t/ha was recorded with M_4S_1 followed by M_4S_4 (4.59 t/ha). The same trend was noticed in the case of straw yield. The highest straw yield of 7.54 t/ha was recorded with M_6S_4.

Soil Fertility Status

The post harvest soil samples were analysed and the results are presented in Tables 3-5. The results on soil pH revealed that as the dilution level increased, there was reduction in soil pH. The lowest soil pH of 7.36 was recorded with water used for irrigation where as the TDE 10 times diluted treatment recorded higher pH of 8.69. the significant increase in the soil pH could be attributed to the organic matter oxidation brought by microbial activity (Mattiazzo and Ada Gloria, 1985). Among the organic amendments, the control

Table 4. Effect of treatments of post harvest soil EC

Treatments	S1	S2	S3	S4	S5	Mean
I Crop (1996-97)						
M1	0.82	0.83	0.83	0.82	0.86	0.83
M2	0.71	0.76	0.72	0.72	0.72	0.73
M3	0.44	0.45	0.47	0.46	0.48	0.46
M4	0.32	0.33	0.35	0.33	0.36	0.34
M5	0.37	0.38	0.37	0.39	0.40	0.38
M6	0.27	0.28	0.28	0.29	0.30	0.28
Mean	0.49	0.50	0.50	0.50	0.52	
II Crop (1997-98)						
M1	0.83	0.82	0.84	0.80	0.85	0.83
M2	0.68	0.70	0.66	0.61	0.74	0.68
M3	0.42	0.43	0.43	0.41	0.49	0.44
M4	0.47	0.46	0.46	0.42	0.51	0.46
M5	0.43	0.45	0.43	0.42	0.51	0.45
M6	0.29	0.26	0.28	0.25	0.32	0.28
Mean	0.52	0.52	0.52	0.49	0.50	
III Crop (1998-99)						
M1	0.81	0.80	0.82	0.79	0.84	0.81
M2	0.66	0.68	0.68	0.64	0.72	0.67
M3	0.40	0.42	0.42	0.38	0.50	0.42
M4	0.47	0.45	0.44	0.40	0.49	0.45
M5	0.44	0.43	0.41	0.40	0.49	0.43
M6	0.27	0.26	0.26	0.23	0.31	0.27
Mean	0.51	0.51	0.50	0.47	0.56	
POOLED MEAN						
M1	0.82	0.82	0.83	0.80	0.85	0.82
M2	0.68	0.71	0.69	0.66	0.73	0.69
M3	0.42	0.43	0.44	0.42	0.46	0.43
M4	0.42	0.41	0.42	0.38	0.45	0.42
M5	0.41	0.42	0.40	0.40	0.47	0.42
M6	0.28	0.27	0.27	0.26	0.31	0.28
Mean	0.51	0.51	0.51	0.49	0.55	

	I Crop (96-97)		II Crop (97-98)		III Crop (98-99)		Pooled Mean	
	SEd	CD	SEd	CD	SEd	CD	SEd	CD
Main	0.006	0.013	0.007	0.015	0.003	0.007	0.03	0.07
Sub	0.006	0.012	0.007	0.015	0.005	0.010	0.07	0.01
M at S	0.015	NS	0.018	NS	0.011	0.022	0.03	NS
S at M	0.014	NS	0.018	NS	0.012	0.023	0.02	NS

plot recorded higher pH of 8.09 and the lowest pH of 7.97 was recorded with application of FYM and pressmud treatments. The interaction effect was significant. The lowest soil pH of 7.20 was recorded with M_6S_4 and the highest soil pH of 8.76 was recorded with M_1S_5 (Table 3). With regard to soil EC, there was reduction in EC with good quality water irrigation as compared to dilution treatments. Soil EC was very high with TDE 10 times diluted treatments (0.82 dS/m). Among the organic amendments, there was not much variation in soil EC except control. The interaction effect was not significant in influencing soil EC (Table 4). There was much improvement in soil organic carbon with lesser dilution levels. M1 recorded higher OC of 1.13 per cent whereas M6 recorded 0.56 percent. Among the organic amendments, application of FYM (S1), pressmud (S2) and neem leaves improved the soil O.C as compared to control. (Table 5). The interaction effect was not significant.

From this study, it could be concluded that in the areas where water is available in adequate quantity for irrigation, application of neem leaves at 6.25 t/ha was found to be good in influencing yield and improving soil health. In the areas where effluent is available, it should be diluted 50 or more than 50 times with irrigation water along with application of organic amendments (neem leaves at 6.25 t/ha or FYM at 12.5 t/ha), to increase the rice yield without any detrimental effect to soil health.

Table 5. Effect of treatments on post harvest soil organic carbon

Treatments	S1	S2	S3	S4	S5	Mean
			ICrop (1996-97)			
M1	1.12	1.12	1.11	1.10	1.12	1.11
M2	0.94	0.94	0.95	0.97	0.94	0.94
M3	0.72	0.70	0.72	0.71	0.67	0.71
M4	0.65	0.64	0.63	0.63	0.62	0.63
M5	0.61	0.61	0.62	0.64	0.57	0.61
M6	0.61	0.61	0.62	0.64	0.57	0.61
Mean	0.78	0.77	0.78	0.78		
			II Crop (1997-98)			
M1	0.18	1.16	1.14	1.12	1.31	1.18
M2	0.85	0.82	0.76	0.81	0.61	0.77
M3	0.63	0.61	0.55	0.68	0.43	0.58
M4	0.71	0.72	0.71	0.70	0.59	0.69
M5	0.69	0.68	0.62	0.69	0.52	0.64
M6	0.58	0.61	0.52	0.63	0.41	0.55
Mean	0.77	0.77	0.72	0.77	0.64	
			III Crop (1998-99)			
M1	1.16	1.14	1.12	1.10	0.96	1.10
M2	0.83	0.86	0.74	0.79	0.96	0.76
M3	0.60	0.63	0.53	0.65	0.41	0.56
M4	0.69	0.68	0.69	0.68	0.54	0.66
M5	0.67	0.66	0.64	0.67	0.50	0.63
M6	0.56	0.59	0.50	0.60	0.3[illegible]	
Mean						

	POOLED MEAN					
M1	1.15	1.14	1.12	1.11	1.13	1.13
M2	0.87	0.87	0.82	0.83	0.71	0.82
M3	0.65	0.65	0.60	0.68	0.60	0.62
M4	0.68	0.68	0.68	0.67	0.59	0.66
M5	0.67	0.65	0.63	0.67	0.54	0.63
M6	0.58	0.60	0.55	0.62	0.46	0.56
Mean	0.77	0.77	0.73	0.76	0.66	

	I Crop (96-97)		II Crop (97-98)		III Crop (98-99)		Pooled Mean	
	SEd	CD	SEd	CD	SEd	CD	SEd	CD
Main	0.008	0.019	0.04	0.10	0.003	0.007	0.05	0.10
Sub	0.008	0.016	0.04	0.080	0.0101	0.101	0.02	0.03
MatS	0.019	NS	0.09	NS	0.013	0.026	0.06	NS
SatM	0.020	NS	0.09	NS	0.012	0.025	0.04	NS

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