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WASTE WATER IRRIGATION AND N AND P FERTILISATION ON HCN AND NO_3 CONTENT OF FODDER

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ABSTRACT

A field experiment was conducted to study the effect of waste water irrigation and graded levels of N and P fertilisation on hydrogen cyanide (HCN) and nitrate NO_3 contents of fodder sorghum var. co.27. The HCN and NO_3 contents were high in waste water irrigated fodder and the highest value was registered with cattle shed wash. Application of N increased and that of P decreased these toxic components in fodder. As crop growth advanced, a decrease in HCN and NO_3 contents were observed. The trends observed suggest that a delayed harvest of the fodder would certainly prove more safe.

KEY WORDS : Hydrogen Cyanide (HCN), Nitrate (NO_3), Fodder, Sorghum, Waste Water

For many obvious reasons sorghum is considered as an ideal forage but under certain conditions it also contains substantial amount of HCN and /or NO_3 which are proven to be toxic to animals.

Hydrogen cyanide (HCN) content of sorghum fodder is affected by environmental and nutritional factors (Harms and Tucker, 1973). HCN Content decreases with advancing maturity (Wheeler *et al.*, (1984) and higher available phosphorus in soil; but increases with higher available nitrogen (wheeler *et al.*, 1980). Singh *et al.* (1983) also observed decrease in HCN content in the shoots with increasing levels of P. Lodhi and Grewal (1989) stated that there was a decrease in the content of dhurin glucoside with advancement in the growth of forage sorghum.

Forage containing NO_3- N more than 2000 mg/kg may be lethal to ruminant animals (Kingsbury,1964). Lyons *et al.* (1992) stated that grazing within 20 days after N application (125 kg urea/ha) would be dangerous as NO_3 - N levels in the grass are high. May *et al.* (1990) observed higher NO_3 concentration in regrowth. Subash Chandra Bose and Fazlullah Khan (1994) reported that the irrigation water and cutting intervals significantly altered NO_3 content of BN-Hybrid fodder. Hence the present study was carried out to determine the effect of waste water irrigation and N and P fertilisation on HCN and NO_3 content of sorghum fodder.

MATERIALS AND METHODS

A field experiment was conducted in factorial randomized block design with two replications at Tamil Nadu Agricultural University, Forage Production Unit during 1994-95. The treatments included four irrigation sources (borewell) water (B), cattleshed wash (C), domestic wash (D) and sewage (S), four levels of nitrogen [O (N_0), 50 (N_1), 100 (N_2) and 150 (N_3)] per cent of recommended dose of 60 kg N/ha and two levels of phosphorus [50 (p_1) and 100 (P_2) per cent of recommended dose of 40 kg P_2O_5/ha)]. The recommended dose of 20 kg K_2O/ha was also included in the fertiliser schedule. The test crop, sorghum var. CO.27, was sown on 08.07.94, and was harvested on 14.09.94.

The soil of the experimental site classified as Typic haplustalf was clay loam in texture,alkaline in reaction (pH 8.48), harmless in EC rating (EC 0.328 dS/m), with a CEC of 24.8 C mol/Kg and organic Carbon 0.72 per cent. The available N, P_2O_5 and K_2O (241.7, 18.14 and 291.5 kg/ha) rated low, medium and high respectively. The analytic data of the irrigation sources (Table 1) revealed the presence of appreciable amounts of organic materials and microbial load, certain plant nutrient elements and heavy metals and showed considerable variation among the different sources of waste water.

Hydrogen cyanide and No_3 contents of the fodder were estimated periodically once in 10 days

Table 1. Characteristics of waste water (all values except pH and EC and microbial population EC in mg l^{-1})

Parameters	Borewell water (control)	Cattleshed wash	Domestic wash	Sewage
Physical (organic)				
Total solids	150	2100	2250	1800
Suspended solids	30	300	250	400
Dissolved solids	120	1800	2000	1400
Physico-chemical				
pH	7.60	8.10	8.40	8.50
EC dSm^{-1}	2.20	2.55	2.49	1.75
Biological				
Dissolved oxygen	4.82	3.46	3.42	3.25
Biological oxygen demand	3.51	2.86	2.53	4.20
Chemical oxygen demand	4.20	3.45	3.24	6.52
Bacterial population x 10^6 ml^{-1}	1.92	8.76	28.67	41.33
Fungal population x 10^4 ml^{-1}	4.20	7.34	34.00	25.37
Actinomycetes population x 10^5 ml^{-1}	3.30	3.46	7.33	12.34
Chemical				
Ammonical nitrogen	ND	237	ND	42
Nitrate nitrogen	ND	14	ND	ND
Phosphorus	ND	ND	ND	ND
Potassium	20	83	36	66
Sodium	186	193	190	187
Calcium	64	66	74	44
Magnesium	61.2	45.6	64.6	30.0
Carbonate	120	150	180	120
Bicorbonate	61.0	122.0	152.5	122.0
Chloride	319.5	326.6	355.0	255.6
Sulphate	138.7	5.8	4.8	61.4
Iron	0.10	0.10	ND	0.10
Copper	0.37	0.39	0.38	0.38
Lead	ND	0.13	0.13	0.27
Nickel	0.28	0.31	0.41	0.48
Water quality parameters				
SAR	3.97 (S_1)	4.46 (S_1)	3.89 (S_1)	5.82 (S_1)
RSC	-3.3	-0.1	-0.6	+1.3
	(good)	(good)	(good)	suitable)
SSP	47.93	47.78	45.36	56.06
	(good)	(good)	(good)	(good)
PS	10.45	8.89	10.05	7.84

ND - Not detectable

() Water quality ratings for agricultural use

from the 20th day of sowing adopting colorimetric Anderson Picrate method (Anderson, 1960) and Bremner method (Jackson, 1973) respectively.

The crop was harvested on 60th day (at 50% flowering). The green and dry fodder yields and biometric observations viz., plant height, number of tillers and leaf-stem ratio were recorded. Fodder

Table 2. Effect of waste water irrigation on fodder yield and yield attributes

Irrigation treatments	Yield		Yield attributes			
	GFY t ha^{-1}	DFY t ha^{-1}	Plant height (m)	No.of tillers per plant	Leaf stem ratio	Soku plant (%)
Borewell water (control)	26.12	8.09	2.82	2.18	0.20	11.40
Cattleshed wash	31.15	10.01	2.75	1.70	0.17	11.05
Domestic wash	31.59	10.42	2.87	3.36	0.26	14.11
Sewage	30.32	9.92	2.92	2.26	0.18	8.18
CD (P=0.05)	1.66	0.68	0.08	0.34	0.053	1.62

Note : Soku plant = Sorghum plants that will not flower even after sufficient maturity.

samples were analysed for quality parameters such as crude protein, ether extractives, crude fibre and minerals.

RESULTS AND DISCUSSION

The yields data (Table 2) revealed that waste water irrigation increased green and dry fodder production of sorghum. The highest yield was recorded in domestic wash irrigated plots. Singh and Mishra (1987) ascribed the increased yield mainly in the presence of nutrients essential for crop growth in these waster waters. All the waste waters contained appreciable amounts of total and dissolved solids. Further the cattle shed wash contained substantial amounts of nitrogen and potassium was also high in cattle shed wash and sewage water. This was further confirmed by the promotion of yield parameters like plant height and number of tillers. Waster water irrigation also influenced leaf-stem ratio and soku plant per cent (Sorghum plants that will not flower even after sufficient maturity). These observations are in line with the findings of Singh and Singh (1983).

The HCN and NO_3 contents of the fodder were generally higher in waster water irrigation treatments (Table 3 and 4). Cattle shed wash irrigated treatment the highest value followed by sewage and domestic wash and this had relation to the increased availability of nitrogen. Similar results were observed by Subash Chandra Bose and Fazlullah Khan (1994) with BN hybrid grass. The major difference observed between HCN and NO_3 content of fodder in response to irrigation water was that HCN content distinctly varied among the irrigation waters used in the present study but NO_3 content was distinctly high only in cattle shed wash irrigated and other three were on par. This is attributable to the extremely high content nitrogen in this water and its direct influence on NO_3 content of fodder. Similar results were reported by Wheeler *et al.* (1980)and Wheeler *et al.* (1984). The results of simple linear correlation analysis shown below also revealed closer relationship of yield (GFY and DFY) with HCN and NO_3 content of fodder.

Characters	Correlation (R) with	
	GFY	DFY
HCN 20th day	0.550**	0.516**
HCN 30th day	0.534**	0.496**
HCN 40th day	0.491**	0.462**
HCN 50th day	0.497**	0.433**
HCN 60th day	0.572**	0.524**
NO_3 20th day	0.204 NS	0.211 NS
NO_3 30th day	0.404**	0.361**
NO_3 40th day	0.216 NS	0.176 NS
NO_3 50th day	0.350**	0.331**
NO_3 60th day	0.266*	0.216 NS

Table 3. Effect of waste irrigation and N and P fertilisation on periodic changes in hydrogen cyanide content of sorghum fodder (ppm)

		Period (days after sowing) (D)																			
Phosphorus (P)		20				30				40				50				60			
Nitrogen (N)		Irrigation sources (I)																			
		B	C	D	S	B	C	D	S	B	C	D	S	B	C	D	S	B	C	D	S
P_1	N_0	605	1002	765	837	600	1000	712	810	572	845	615	762	312	512	357	382	214	329	235	281
	N_1	620	1070	822	877	612	1026	792	857	547	857	603	822	342	547	380	407	221	329	255	293
	N_2	642	1095	847	882	630	1080	812	870	580	907	647	847	360	582	410	440	235	348	283	302
	N_3	657	1142	905	987	647	1117	845	885	605	972	657	872	367	600	447	457	248	364	306	313
P_2	N_0	602	877	702	830	600	865	700	802	510	795	600	705	300	477	350	355	209	203	230	260
	N_1	607	1020	725	845	605	1007	712	827	527	817	617	725	315	500	360	362	218	322	251	271
	N_2	640	1065	812	865	627	1047	805	857	610	890	637	805	347	522	400	380	228	341	271	285
	N_3	647	1107	867	887	640	1082	892	887	617	940	652	837	355	545	410	412	235	361	281	297
	Mean	627	1048	805	865	620	1032	779	849	565	878	632	797	337	535	389	399	226	337	264	287

	SEd	CD (0.05)
I	32.13	63.46
N	32.13	63.46
P	22.72	NS
D	35.49	70.95

Interactions are not significant

Note. N_0, N_1, N_2, N_3 = Nitrogen levels
P_1, P_2 = Phosphorus levels
B = Borewell water, C = Cattleshed wash, D = Domestic wash, S = Sewage

Table 4. Effect of waste irrigation and N and P fertilisation on periodic changes in nitrogen content of sorghum fodder (ppm)

Phosphorus (P)	Nitrogen (N)	20 B	20 C	20 D	20 S	30 B	30 C	30 D	30 S	40 B	40 C	40 D	40 S	50 B	50 C	50 D	50 S	60 B	60 C	60 D	60 S
P_1	N_0	12256	13137	10785	11276	7700	9100	7917	7350	7004	9135	7000	6699	4582	7277	5660	5660	1602	1802	1602	1201
	N_1	12624	13504	10908	11643	7745	9468	8050	8645	7156	9744	7154	7159	4717	7412	6064	6334	1702	2102	2002	1302
	N_2	13237	18138	11275	13233	8050	10850	9013	8750	7308	10353	8223	7313	5121	5929	6468	6738	2002	1601	1702	1802
	N_3	13237	18252	12256	13353	8295	10973	8400	8995	7613	10506	8635	7613	5255	7142	6738	6873	1902	1702	2002	1902
P_2	N_0	6374	7844	7844	10736	6300	7700	7350	6300	7308	7722	7395	6090	4851	6468	5929	4582	1802	2002	1062	1001
	N_1	6615	8212	7967	11275	7350	8050	7945	7000	7722	8222	7459	6395	4986	6603	6334	4851	1702	1902	1852	1302
	N_2	12344	9315	6373	15888	6300	8750	8050	9100	8222	6395	6699	6090	6468	5929	5929	4312	1602	1602	2002	1401
	N_3	12711	8560	6833	14830	7850	9100	8295	8750	8831	7308	7459	6699	6229	6738	6334	4582	1502	2102	2002	1802
	Mean	11175	12246	9284	12762	7449	9249	8127	8111	7645	86773	7503	6757	5276	6687	6182	5491	1702	1852	1845	1454

Period (days after sowing) (D); Irrigation sources (I)

	SEd	CD (0.05)		SEd	CD (0.05)		SEd	CD (0.05)		SEd	CD (0.05)
I	267.9	353.7	I x N	535.9	NS	N x D	599.1	790.9	I x P x D	847.3	1118.5
N	267.9	353.7	I x P	378.9	500.2	P x D	423.6	559.2	N x P x D	847.3	NS
P	189.5	250.1	I x D	599.1	790.9	I x N x P	757.8	1000.4	I x N x P x D	1694.3	NS
D	299.6	395.4	N x P	378.9	NS	I x N x D	1198.2	NS			

Note : N_0, N_1, N_2, N_3 = Nitrogen levels
P_1, P_2 = Phosphorus levels
B = Borewell water, C = Cattleshed wash, D = Domestic wash, S = Sewage

Another striking feature in the present study is that there was very close association between HCN and NO_3 contents during different growth stages of the fodder (except the estimate on 60th day after sowing) as shown below :

Characters related	Correlation value (R)
HCN on 20th day Vs NO_3 20th day	0.313*
HCN on 30th day Vs NO_3 30th day	0.592*
HCN on 40th day Vs NO_3 40th day	0.285*
HCN on 50th day Vs NO_3 50th day	0.591*
HCN on 60th day Vs NO_3 60th day	NS

* Significant at 5% level

** Significant at 1% level

NS Non significant

This again confirms that HCN and NO_3 accumulation is closely related to growth rate of the crop, which subsidises after 50th day.

Increasing levels of N fertilisation also increased the HCN and NO_3 content of fodder (Table 3 and 4). It is interesting to note that the increase of P decreased these toxic principles. Singh *et al.* (1983) also observed decrease in HCN content with increasing levels of P fertilisation. The age of the crop also had significant bearing on the content of these toxic principles.

The HCN and NO_3 contents decreased with advancing maturity of the fodder. The HCN content of the fodder showed a gradual decline with growth and maturity whereas a steep decline was observed with NO_3 content of the fodder. Thus it could be inferred that delayed harvest (after 60th day) of the fodder would certainly prove more safe under such varied/changed environment.

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