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Irrigational impact of distillery spentwash on the production of quality additive graminacious forage crops on livestock digestibility

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Abstract
Graminacious forages namely; Anjan Grass (Cenchrus Ciliaris), Setaria Grass (Setaria Anceps), Para Grass (Brachiaria Mutica) and Rhodes Grass (Chloris Gayana) were cultivated and irrigated with distillery spentwash of different proportions. The distillery spentwash i.e., primary treated spentwash (PTSW), 1:1, 1:2 and 1:3 distillery spentwash were analysed for plant nutrients such as nitrogen, phosphorous, potassium (NPK) and other physical and chemical parameters. The plants were cultivated by irrigation with raw water (RW), 1:1, 1:2 and 1:3 distillery spentwash in the prepared pots. The impact of distillery spentwash on proximate principles for quality forage (Crude protein, Neutral detergent fibre, Acid detergent fibre and Total digestible nutrient) i.e., forage digestibility for livestock were analysed. It was observed that good nutrients uptake in case of 1:3 spentwash and requirements of livestock digestibility components were observed when compared with 1:1, 1:2 spentwash and raw water irrigations. This could be due to the maximum absorption of NPK by plants at more diluted condition of spentwash. This concludes that the diluted spentwash can be conveniently used for the effective cultivation without using any external fertilizers. Hence, spentwash serves as a liquid fertilizer, eco-friendly irrigation medium and without adverse effect on environment and soil.

Keywords: Distillery spentwash, Anjan Grass, Setaria Grass, Para Grass, Rhodes Grass, nutrients, Irrigation, Proximate principle

1. Introduction

Anjan Grass is a genus of Panicoid grasses with tereta and solid culms and fibrous roots comprising of both the annuals and perennial plants. Among the 20 species, C. Ciliaris and C. Setigerus are most commonly used for forage production. C. ciliaris is a native of tropical and subtropical Africa, India and Indonesia. It is widely distributed in the plains of Rajasthan, Gujarat, Punjab and western UP extending up to foot hills of Jammu up to an altitude of 400 m. It is one of the prominent grass species of Dichanthiu, Cenchrus, Lasiurus grass cover of India. It is polymorphic, perennial and warm season bunch grass with extensive native range in the form of various ecotypes and cytotypes. It is highly drought tolerant and well adapted to arid and semi-arid areas and thrives well in light textured soils.

Setaria Grass also called as Golden Timothy, grows well in areas having an annual rainfall ranging from 1000 to 1500 mm. It can also survive long, hot and dry seasons. The grass grows well at 20 to 25 ºC. It is more cold tolerant than most of tropical and subtropical grasses. It can come up in a variety of soil types. Setaria is usually too coarse to be of much value as preferred feed, but it has a place as low-quality roughage, as a supplement to urea-molasses feeding. It is used for this purpose in Kenya and Uganda. It is very palatable at young but becomes less palatable at maturity. This is a tufted perennial, 45–180 cm tall with the lower culm nodes compressed. Basal leaf-sheaths are often nearly flabellate in arrangement. False spike are dense with orange bristles and sub-acute spikelets, 2 to 3 mm long. The leaf blades are glabrous flat, 30 to 40 cm long, 6 to 10 mm wide, linear and lanceolate. Inflorescence is terminal, compressed panicle about 15 cm long, appearing as a dense cylindrical spike and orange to purple in colour.

Para grass is also known as Buffalo grass. The crop responds well to sewage irrigation and is usually grown near large sewage disposal forms. The leaf blades are dark green in colour, 25 to 30 cm long and 1 to 2 cm broad. Inflorescence is a panicle. Flowering is hastened in shorter photoperiods. The grass prefers hot and humid climate of the tropics and subtropics with high annual rainfall ranging between 1000 and 1500 mm. It can withstand short term flooding and waterlogging but cannot be grown in dry land, in arid and semi-arid regions. It is sensitive to cold. Growth is nil during winter months. The grass grows in moist, but not in highly wet soils. It thrives best on highly fertile clay loam to clayey textured soils with high moisture retention capacity. It can be grown even on sandy soils with good irrigation facility. It tolerates slightly acid to alkaline soils. It is highly tolerant to saline or sodic soil conditions. So it is an excellent grass in soil reclamation. It grows well on field bunds, banks of streams and canals, lowlands and soils too wet for normal farm crops. Planting can be done at any time other than winter months. The rain fed crop is planted with the first monsoon showers. It is a nutritious high yielding and palatable forage grass. The grass appears to be free of any toxic effect.

Rhodes grass is native to Africa but it can be found throughout the tropical and subtropical world as a naturalized species. It can grow in many types of habitat. It is a summer-growing, stoloniferous perennial is adapted to a wide range of soils. It is also cultivated in some areas as a palatable graze for animals and a groundcover to reduce erosion and quickly revegetate denuded soil. It is tolerant of moderately saline and alkaline soils and irrigation. It is difficult to establish and have it persist on heavy-cracking clay soils. It does not tolerate drought or flooding well and is best adapted to areas where annual rainfall exceeds 600 mm. It is only moderately tolerant of frost and it is a valuable pasture grass for livestock. It is a perennial grass which can reach one half to nearly three meters in height and spreads via stolons. It forms tufts and can spread into wide monotypic stands. The inflorescence is a single or double whorl of finger like racemes up to 15 centimetres long. Each spikelet in the raceme is a few millimetres long and contains one or two fertile florets and up to four sterile florets.

In sugar industry Molasses is one of the important by-products which is the chief source for the production of alcohol in distilleries by fermentation method. Nearly 10-12 litres of spentwash are discharged for every litre of rectified spirit produced and is known as raw spent wash (RSW), which is characterized by high biological oxygen demand (BOD: 5000-8000mg/l) and chemical oxygen demand (COD: 25000-30000mg/l) (Joshi,1994) [12], undesirable colour and foul odour. The discharge of spentwash into open field or water bodies result in environmental, soil & water pollution. Hence discharge of spent wash is a great problem. The RSW is highly acidic and consists of easily oxidisable organic matter with very high BOD and COD (Patil, 1987) [17]. The spentwash is rich in organic carbon & plant nutrients (Ramadurai and Gearard, 1994) [20]. Since it is from plant source extract it contains negligible heavy metals & other toxic substances (Eyini *et al*, 1990) [24]. Meanwhile it is rich in plant essential nutrients it can be used in agriculture so the problem of disposal becomes easy along with the utilisation of nutrients by plants. It also helps to utilise spentwash in a proper method to avoid adverse effects on the environment. Its application to soil has been reported to be beneficial to increase sugar cane (Zalwadia, 1997), rice (Devarajan and Oblisami, 1995) [10], wheat and rice yield (Pathak *et al*., 1998), quality of groundnut (Amar Singh *et al*., 2003) [1] and physiological response of soybean (Ramana *et al*.,2000) [21].

Diluted spent wash could be used for irrigation purpose without adversely affecting soil fertility(Kaushik *et al*.,2005; Kuntal *et al*., 2004; Raverkar *et al*., 2000) [14, 13], seed germination and crop productivity (Ramana *et al*., 2001). The diluted spent wash irrigation improved the physical and chemical properties of the soil and further increased soil micro flora (Devarajan, 1994; Kaushik *et al*, 2005; Kuntal *et al*., 2004) [11, 13, 14]. Twelve pre sowing irrigations with the diluted spent wash had no adverse effect on the germination of maize but improved the growth and yield (Singh and Raj Bahadur, 1998) [22]. Diluted spent wash increases the growth of shoot length, leaf number per plant, leaf area and chlorophyll content of peas (Ravi and Srivastava, 1990). Increased concentration of spent wash causes decreased seed germination, seedling growth and chlorophyll content in sunflowers (Helianthus annuus) and the spent wash could be safely used for irrigation purpose at lower concentration (Rajendra, 1990; Ramana *et al*., 2001) [23].The spent wash contained an excess of various forms of cations and anions, which are injurious to plant growth and these constituents should be reduced to beneficial level by diluting the spent wash, which can be used as a substitute for chemical fertilizer (Sahai *et al*., 1983). The spent wash could be used as a complement to mineral fertilizer to sugarcane (Chares, 1985) [4]. The spent wash contained N, P, K, Ca, Mg and S and thus valued as a fertilizer when applied to soil through irrigation with water (Samual, 1986). The application of diluted spent wash increased the uptake of Zinc(Zn), Copper(Cu), Iron(Fe) and Manganese (Mn) in maize and wheat as compared to control and the highest total uptake of these were found at lower dilution levels than at higher dilution levels(Pujar,1995) [19]. Mineralization of organic material as well as nutrients present in the spent wash was responsible for increased availability of plant nutrients.

Diluted spent wash increases the uptake of nutrients, height, growth and yield of leaves vegetables (Chandraju *et al*., 2007; Basvaraju and Chandraju, 2008) [5, 2, 3, 6, 7, 8, 9], nutrients of cabbage and mint leaf (Chandraju *et al*., 2008) [2, 3, 6, 7, 8, 9], nutrients of top vegetable (Basvaraju and Chandraju, 2008) [2, 3, 6, 7, 8, 9], pulses, condiments and root vegetables (Chandraju *et al*., 2008) [2, 3, 6, 7, 8, 9]. However, not much information is available on the impact of distillery spent wash on the production of quality additive graminacious forage crops. Therefore, the present investigation was carried out to investigate the impact of irrigation of different concentration of spentwash on the production of quality additive graminacious forage crops on livestock digestibility.

2. Materials and Methods

Physiochemical parameters and amount of nitrogen (N), potassium (K), phosphorous (P) and sulphur (S) present in the primary treated diluted spentwash (1:1, 1:2, 1:3 SW) were analysed by standard methods. The PTSW was used for irrigation with a dilution of 1:1, 1:2 and 1:3. A composite soil sample collected prior to spentwash irrigation was air-dried, powdered and analysed for physiochemical properties. The graminacious forage plants selected for the present investigation were Anjan Grass, Setaria Grass, Para Grass and Rhodes Grass root slips (3 inch) which were sowed in different pots [25.5cm (h), 45.5cm (dia)] and irrigated by applying 0.75 to 1 lit/pot (depending upon the climatic condition) with raw water (RW), 1:1 SW, 1:2 SW and 1:3 SW at the dosage of once a week and rest of the period with raw water as required. At the maturity time, forage samples were harvested air dried and proximate principles on forage quality were analysed.

Table 1: Characteristics of experimental soil

Parameters	Values
Coarse sand^c	8.99
Fine sand^c	41.06
Slit^c	25.87
Clay^c	21.80
pH (1:2 soln)	8.32
Electrical conductivity ^{a}	562
Organic carbon^c	0.98
Available Nitrogen^b	392
Available Phosphorous^b	239
Available Potassium^b	99
Exchangeable Calcium^b	163
Exchangeable Magnesium^b	251
Exchangeable Sodium^b	119
Available Sulphur^b	296
DTPA Iron^b	201
DTPA Manganese^b	210
DTPA Copper^b	9
DTPA Zinc^b	62

Units: **a**-µS, **b**- mg/L, **c**-%

Table 2: Chemical characteristics of distillery Spentwash

Chemical parameters	PTSW	1:1 PTSW	1:2 PTSW	1:3 PTSW
PH	7.52	7.60	7.66	7.70
Electrical conductivity[a]	28600	19900	8650	5290
Total solids[b]	46300	31090	22380	15890
Total dissolved solids[b]	36250	16930	11565	6420
Total suspended solids[b]	10360	6031	5119	1930
Settleable solids[b]	9690	4260	3390	2840
COD [b]	40820	19190	9998	3010
BOD [b]	15880	6960	4285	2620
Carbonate [b]	Nil	Nil	Nil	Nil
Bicarbonate [b]	12800	7030	3320	1120
Total Phosphorous [b]	39.20	23.39	16.20	9.97
Total Potassium [b]	7200	4590	2990	1860
Calcium [b]	920	602	391	203
Magnesium [b]	1552.68	892.19	201.3	101.6
Sulphur [b]	75.2	35.6	18.9	9.9
Sodium [b]	502	296	218	172
Chlorides [b]	6122	3829	3212	2868
Iron [b]	7.9	6.2	3.4	2.3
Manganese [b]	1020	829	442	201
Zinc [b]	1.5	0.98	0.59	0.51
Copper [b]	0.272	0.201	0.092	0.056
Cadmium [b]	0.005	0.003	0.002	0.001
Lead [b]	0.15	0.09	0.07	0.014
Chromium [b]	0.05	0.021	0.01	0.007
Nikel [b]	0.08	0.049	0.03	0.011
Ammonical Nitrogen [b]	744.7	332.42	274.4	155.09
Carbohydrates[c]	21.64	11.32	7.93	5.92

Units: a-µS, b- mg/L, c-%, PTSW- Primary treated distillery Spentwash

Table 3: Amount of N, P, K and S (Nutrients) in distillery Spentwash

Chemical parameters	PTSW	1:1 PTSW	1:2 PTSW	1:3 PTSW
Ammonical Nitrogen [b]	744.7	332.42	274.4	155.09
Total Phosphorous [b]	39.20	23.39	16.20	9.97
Total Potassium [b]	7200	4590	2990	1860
Sulphur [b]	75.2	35.6	18.9	9.9

Unit: b- mg/L, PTSW- Primary treated distillery spentwash

Table 4: Proximate principles of Anjan Grass at different irrigations (in %)

	Raw water	1:1 PTSW	1:2 PTSW	1:3 PTSW
Crude protein (CP)	4.3	3.2	5.1	6.8
Neutral detergent fibre (NDF)	79.8	82.6	77.4	70.5
Acid detergent fibre (ADF)	51.5	55.7	50.7	44.9
Total digestible nutrient (TDN)	43.7	40.5	44.3	48.7

Table 5: Proximate principles of Seteria Grass at different irrigations (in %)

	Raw water	1:1 PTSW	1:2 PTSW	1:3 PTSW
Crude protein (CP)	5.2	3.1	6.5	8.1
Neutral detergent fibre (NDF)	72.2	77.1	71.8	67.7
Acid detergent fibre (ADF)	44.1	48.0	43.3	40.4
Total digestible nutrient (TDN)	49.3	46.3	49.9	52.0

Table 6: Proximate principles of Para Grass at different irrigations (in %)

	Raw water	1:1 PTSW	1:2 PTSW	1:3 PTSW
Crude protein (CP)	3.9	2.2	6.0	7.3
Neutral detergent fibre (NDF)	73.1	79.8	71.7	68.3
Acid detergent fibre (ADF)	43.4	48.3	42.5	39.9
Total digestible nutrient (TDN)	49.8	46.1	50.5	52.4

Table 7: Proximate principles of Rhodes Grass at different irrigations (in %)

	Raw water	1:1 PTSW	1:2 PTSW	1:3 PTSW
Crude protein (CP)	4.1	3.2	6.6	8.8
Neutral detergent fibre (NDF)	73.3	77.6	72.7	70.6
Acid detergent fibre (ADF)	43.1	45.8	41.9	40.4
Total digestible nutrient (TDN)	50.0	48.0	50.9	52.0

3. Results and Discussion

Characteristics of experimental soils such as pH, electrical conductivity, the amount of organic carbon, available nitrogen(N), phosphorous(p), Potassium(K), sulphur(S), exchangeable calcium(Ca), Magnesium(Mg), Sodium(Na), DTPA Iron(Fe), Manganese(Mn), Copper(Cu) and Zinc(Zn) were analysed and tabulated (Table-1). It was found that the soil composition is fit for the cultivation of plants, because it fulfils all the requirements for the growth of plants. Chemical composition of PTSW, 1:1, 1:2 and 1:3 SW such as pH, Electrical conductivity, total solids(TS), Total dissolved solids(TDS), Total suspended solids(TSS), Settelable solids(SS), Chemical oxygen demand(COD), Biological oxygen demand(BOD), carbonates, bicarbonates, Total phosphorous(P), Total potassium (K), Ammonical Nitrogen(N), Calcium(Ca) Magnesium(Mg), Sulphur(S), Sodium(Na), Chlorides(Cl), Iron(Fe), Manganese(Mn), Zinc(Zn), Copper(Cu), Cadmium(Cd), Lead(Pb), Chromium(Cr) and Nickel(Ni), were analysed and tabulated (Table-2). Amount of N, P, K and S contents are presented in Table-3. The proximate principles for quality forage: Crude protein, Neutral detergent fibre, Acid detergent fibre and Total digestible nutrient of all plants were very good in 1:3 spentwash as compared to 1:1, 1:2 and raw water irrigations. However, nutrients uptakes were high in 1:3 than in all other types of irrigations for both plants and there was no negative impact of spentwash on the quality of graminacious forage crops on livestock digestibility (Table 4, 5, 6 and 7).

4. Conclusion
It was observed that the nutrients uptake for all the graminacious forage crops was largely influenced in case of 1:3 and 1:2 diluted spent wash irrigation than with raw water and 1:1. But 1:3 spent wash irrigation shows more uptake of nutrients when compared to 1:2 and 1:1 diluted spent wash in all the tested graminacious forage crops. This concludes that, the treated soil is enriched with the plant nutrients such as nitrogen, potassium and phosphorous. It further concludes that, the subsequent use of diluted spent wash for irrigation enriches the soil fertility and hence the diluted spent wash (1:3) is effective eco-friendly irrigation medium for cultivation of graminacious forage crops and also fulfils all the plant constituents for the production of quality forages without any adverse effect.

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