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Impact of distillery spentwash irrigation on the production of quality additive graminacious forage crops on livestock digestibility

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Abstract

Graminacious forages namely; Napier Grass (Pennisetum Purpureum Schumach), Guinea Grass (Panicum Maximum Jacq) and Signal Grass (Brachiaria Brizantha) 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, napier grass, guinea grass, signal grass, nutrients, irrigation, proximate principle

1. Introduction

Napier Grass (Elephant Grass) is a species native to the tropical grasslands of Africa. It has a very high productivity as a forage grass for livestock. It is most susceptible to frost. It grows well at sea level and up to 2000 m and grows best in high-rainfall areas (in excess of 1500 mm/year), but its deep root system allows it to survive in drought times. It provides good hay if cut at early stage and is usually made into silage of high quality without additives. It is a robust perennial with a vigorous root system, sometimes stoloniferous with a creeping rhizome. Culms are usually 180–360 cm high, branched upwards. Leaf-sheaths are glabrous or with tubercle-based hairs; leaf-blades 20–40 mm wide, margins thickened and shiny. Inflorescence a bristly false spike up to 30 cm long, dense, usually yellow-brown in colour, more rarely purplish. It provides high yield (250–300 t/ha/year) of green matter under irrigated condition. It is less fibrous, juicy and palatable.

Guinea Grass is an important multi-cut forage grass, because of its ease of propagation, fast growth and high quality forage during the rainy season. The tolerance of the crop to saline sodic conditions also. It is also used as silage at Tanzania, Brazil, Nigeria and Australia. The crop has been adopted well by the farmers in India because of its multi-cut nature and high yield of green fodder. It is cultivated in Haryana, Punjab and Himachal Pradesh. It has also wide adaptability in humid tracts of eastern and southern India. It has excellent growing habit, quick recovery after cutting and good quality herbage. Guinea grass is tolerant to the light stress and can perform very well under shaded condition. This crop is grown both as annual and perennial. Thus, it can give 7–8 cuttings annually. It is also suitable for rangelands receiving 900 to 1500 mm rainfall. Additionally, availability of annual as well as perennial types makes the crop suitable for cultivated as well as rain-fed conditions.

Signal grass is a native of tropical Africa (Uganda) and has been introduced and distributed to other tropical areas including the West Indies, Venezuela, Surinam, and Australia. It is a trailing perennial with upright, sword-shaped leaves. Signal grass is the single most important genus of forage grass for pastures in the tropics. Its hairy leaves are a key distinguishing feature. New shoots and roots develop from each node of its stoloniferous base. The flowering stem terminates in three or four spike-like stalks. This grass is adapted to humid tropical areas with a minimum rainfall of 60 inches per year and a dry season of not more than 4–5 months. Under favourable conditions of adequate moisture and soil fertility levels signal grass will aggressively spread and form a dense cover. It stands up well to heavy stocking and trampling it can grow in infertile and acidic soils. This grass is highly palatable but may form hard stems with extended pasture rest periods.

Molasses is one of the important by-products of sugar industry, 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), 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).

The spentwash is rich in organic carbon & plant nutrients (Ramadurai and Gearard, 1994) [19]. Since it is from plant source extract it contains negligible heavy metals & other toxic substances (Eyini et al, 1990) [22]. 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) [9], 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) [20]. 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) [12, 13], seed germination and crop productivity (Ramana *et al.*, 2001) [20]. 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) [10, 12, 13].

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) [21]. 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) [20]. 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). 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) [2, 3, 5, 6, 7, 8], nutrients of cabbage and mint leaf (Chandraju *et al.*, 2008) [2, 3, 5, 6, 7, 8], nutrients of top vegetable (Basvaraju and Chandraju, 2008) [2, 3, 5, 6, 7, 8], pulses, condiments and root vegetables (Chandraju *et al.*, 2008) [2, 3, 5, 6, 7, 8].

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-Napier Grass, Guinea Grass and Signal Grass on livestock digestibility.

2. Materials and Methods

Physio-chemical 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 physio-chemical properties. The graminacious forage plants selected for the present investigation were Napier Grass, Guinea Grass and Signal 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 Napier Grass at different irrigations (in %)

	Raw water	1:1 PTSW	1:2 PTSW	1:3 PTSW
Crude protein (CP)	6.9	5.8	10.7	15.5
Neutral detergent fibre (NDF)	70.6	75.6	69.9	60.1
Acid detergent fibre (ADF)	41.8	49.4	40.6	38.5
Total digestible nutrient (TDN)	51.0	45.3	51.9	53.5

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

	Raw water	1:1 PTSW	1:2 PTSW	1:3 PTSW
Crude protein (CP)	8.3	4.7	12.5	16.7
Neutral detergent fibre (NDF)	68.5	77.7	65.1	58.8
Acid detergent fibre (ADF)	35.5	44.9	37.4	29.9
Total digestible nutrient (TDN)	55.7	48.7	54.3	59.9

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

	Raw water	1:1 PTSW	1:2 PTSW	1:3 PTSW
Crude protein (CP)	4.7	2.1	7.7	10.8
Neutral detergent fibre (NDF)	69.8	74.7	68.4	60.4
Acid detergent fibre (ADF)	40.1	44.9	39.3	33.5
Total digestible nutrient (TDN)	52.3	48.7	52.9	57.2

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 and 6).

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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