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Irrigational impact of distillery spentwash on the germination, growth and yield of leguminous forages: Lucerne (Medicago sativa), Cowpea (Vigna unguiculata) and Horsegram (Macrotyloma uniflorum)

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Abstract
Studies were conducted to study the germination, growth and yield of leguminous forages; Lucerne, Cowpea and Horse gram irrigated with distillery spent wash of different concentration. The spent wash in the ratio of 1:1, 1:2, and 1:3 was used and analysed for their plant nutrients such as Nitrogen, Phosphorous, Potassium and other physical and chemical characteristics. Experimental soil was tested for its chemical and physical parameters. Lucerne, Cowpea and Horse gram seeds were sowed in different pots and irrigated with raw water (RW) along with spent wash in the ratio of 1:1, 1:2, and 1:3. The results of the germination, growth and yield were studied. It was found that the germination, growth and yield was very good in 1:3 spent wash irrigation compared to 1:1 spent wash, 1:2 spent wash and raw water irrigation for all the plants. Hence, spent wash can be expediently used as a medium for irrigation in specific dilution without harming the atmosphere, water and soil.

Keywords: distillery spent wash, lucerne, cowpea, horse gram, raw water, germination, growth, yield, irrigation, soil

Introduction

Lucerne (alfalfa) is one of the oldest cultivated fodder crops. It is a native to south west Asia as indicated by occurrence in mountainous region of Afghanistan, Iran. The cultivated forms probably arose in western Persia and then spread to become widely cultivated throughout Asia, Europe and America and widely distributed in temperate regions. In India Lucerne is commonly called as Rijka. It is a perennial plant and can supply green fodder continuously for 3–4 years from the same crop stand. The root system is deep and so can be easily grown in the areas where water is in short supply. Lucerne has high palatability for all kinds of livestock as it provides nutritious fodder and possesses about 16-25% crude protein and 20–30% fiber. Due to its high protein and vitamin A content, it is included as a feed component for livestock. Lucerne provides green fodder for a longer period (November-June) in northern parts and throughout the year in other parts of the country where winters are not severe. In India, Lucerne occupies one million hectare area and provides 60 to 130 tonnes of green forage/ha. It is grown as a farm crop in Punjab, western districts of UP, Maharashtra, Gujarat, Tamil Nadu and West Bengal. After Sorghum and Berseem, Lucerne is third important forage crop in India.

Cowpea in Africa and China were considered as main centre of origin. Evidences suggest that Cowpea originated and possibly domesticated in western or central Africa very likely in Nigeria, where a profusion of wild and weedy species abound in both Savannah and forested zones. Cowpea was cultivated in prehistoric times in tropical Africa and must have reached Egypt, Arabia and India very early. Cowpea is grown throughout the lowland tropics of Africa, India, south eastern Asia, Australia and coastal areas of South and Central America. In India, Cowpea is grown only in some parts of Rajasthan, Gujarat, Maharashtra, Karnataka and Tamil Nadu. It has a great potential for sustainable agriculture in marginal lands and semi-arid regions of the country. It is estimated that about 6.5 lakh hectare is under different forms of cowpea and the share of fodder cowpea is 3 lakh ha.

Horse gram is an under-exploited legume crop. It is usually grown as catch crop for late kharif or with the rains after a prolonged drought conditions and aberrant weather conditions. It is used as an important pulse crop since seeds are rich in protein. The fodder being rich in protein; it is widely used as a feed to livestock. Most of the farmers are growing local varieties of their own since long time. These varieties although are of moderately high yielding but mature late besides they are non- synchronous in pod maturity. Twining annual or perennial farming dense growth of 30-60 cm high. Trifoliate leaves 3-7 cm long and 2-4 cm wide. Yellow flowers with violet blot on the standard pods 6-8 cm long and 4-8 mm wide with 6-7 seeds. It is drought resistant but cannot withstand waterlogging.

In sugar industry Molasses is the chief source of raw material for the manufacture of rectified spirit. Nearly 10-12 litres of spentwash are discharged for every litre of rectified spirit produced. The discharge of spentwash into open field or water bodies result in environmental, soil and water pollution. The spentwash is rich in organic carbon and plant nutrients. Since it is from plant source extract it contains negligible heavy metals and other toxic substances (Eyini *et al*, 1990). 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. So diluted spentwash can be used for irrigation purpose without adversely affecting soil fertility, growth and yield.

The diluted spentwash irrigation improves the physical and

chemical properties of the soil and further increases soil micro flora. Twelve pre-sowing irrigations with the diluted spentwash had no adverse effect on the germination of maize but improved the growth and yield (Singh Y. and Raj Bahadur, 1998). Diluted spent wash increases the growth of shoot length, leaf number per plant, leaf area and chlorophyll content of peas. Increased concentration of spent wash causes decreased seed germination, seedling growth and chlorophyll content in Sunflowers (Helianthus annuus) and the spent wash should be safely used for irrigation purpose at lower concentration. 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 the beneficial level by diluting spent wash, which can be used as a substitute for chemical fertilizer. The spent wash could be used as a complement to mineral fertilizer to sugarcane. The spent wash contains N, P, K, Ca, Mg and S and thus valued as a fertilizer when applied to soil through irrigation with water. 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.

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, nutrients of cabbage and mint leaf, nutrients of top vegetable, pulses, condiments, root vegetables in untreated and spent wash treated soil, yields of top vegetables (creepers), yields of tuber/root medicinal plants, yields of leafy medicinal plants nutrients of creeper medicinal plants, yields of leafy medicinal plants in normal and spent wash treated soil, nutrients of ginger and turmeric in normal and spent wash treated soil, nutrients of tubers/roots medicinal plants. Studies on growth and yield of Mustard, Castor, Cotton, Groundnut, Zinnia, Vinca, Sesame and Jatropha seeds (Chandraju. S *et al*). However, no information is available on the germination, growth and yield of Leguminous forages-Lucerne, Cowpea and Horsegram seeds irrigated by distillery spentwash. Therefore, the present investigation was carried out to study the influence of different proportions of spentwash on the germination, growth and yield of Lucerne, Cowpea and Horsegram.

Materials and Methods

Physio-chemical parameters and amount of Nitrogen (N), Potassium (K), Phosphorous (P) and Sulphur (S) present in the primary treated diluted spent wash (1:1, 1:2, 1:3 SW) were analysed by standard methods (Table-2 and Table-3). The PTSW was used for irrigation with a dilution of 1:1, 1:2 and 1:3. A composite soil sample collected prior and later to spent wash irrigation was air-dried, powdered and analysed for physio-chemical properties (Table-1 and Table-4). Leguminous forage plants selected for the present investigation were Lucerne, Cowpea and Horse gram seeds were sowed in different pots [25.5cm (h), 45.5cm (dia)] and irrigated by applying 0.75 to 1 lit/pot (depends 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. Trials were conducted and the germination, growth and yield was recorded (Table-5, Table-6 and Table-7).

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
Nickel [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

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

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

Table 4: Characteristics of experimental soil (After harvest)

Parameters	Values
Coarse sand [c]	9.03
Fine sand [c]	41.53
Slit [c]	26.02
Clay [c]	22.46
pH (1:2 soln)	8.19
Electrical conductivity [a]	601
Organic carbon [c]	1.51
Available Nitrogen [b]	449
Available Phosphorous [b]	263
Available Potassium [b]	114
Exchangeable Calcium [b]	166
Exchangeable Magnesium [b]	250
Exchangeable Sodium [b]	120
Available Sulphur [b]	298
DTPA Iron [b]	211
DTPA Manganese [b]	214
DTPA Copper [b]	10
DTPA Zinc[b]	62

Units: a-µS, **b-** mg/L, **c**

Table 5: Germination of Leguminous forages (%)

Name of plants	RW	1:1PTSW	1:2PTSW	1:3PTSW
Lucerne	70	50	80	90
Cowpea	80	55	85	95
Horsegram	75	50	80	95

Table 6: Growth of Leguminous forages at different irrigations (ft)

Name of the plant	RW (Day)			1:1 SW (Day)			1:2 SW (Day)			1:3 SW (Day)		
	30th	60th	90th	30th	60th	90th	30th	60th	90th	30th	60th	90th
Lucerne	1.1	1.5	2.6	0.6	0.9	2.0	1.1	1.6	2.9	1.6	2.4	3.3
Cowpea	0.9	1.6	2.3	0.6	1.1	1.9	1.3	1.9	2.5	1.4	2.5	3.1
Horsegram	0.8	1.3	2.2	0.5	0.9	1.8	1.0	1.8	2.6	1.3	2.1	2.9

Table 7: Average yield of Leguminous forages (Kg)

Name of the plant	Average Weight (Kg)			
	RW	1:1PTSW	1:2PTSW	1:3PTSW
Lucerne	359	280	381	452
Cowpea	438	303	501	619
Horsegram	497	375	596	705

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), chloride (Cl), iron (Fe), Manganese (Mn), zinc (Zn), copper (Cu), cadmium (Cd), lead (Pb), chromium (Cr) and nickel (Ni), were analysed and tabulated (Manivasakam N,1987; Piper,1996) (Table-2). Amount of N, P, K and S contents are presented in Table-3. In case of germination, it was very good in 1:3 SW than in 1:2 SW, 1:1 SW and RW irrigations. Then in all the cases, maximum growth was observed in 1:3 SW compared to RW, 1:1 SW and 1:2 SW irrigation. Growth rate was very poor in 1:1 SW irrigation compared to RW, 1:2 SW and 1:3 SW irrigations and yield was maximum in 1:3 SW, poor in 1:1 SW, moderate in 1:2 SW and RW irrigations (Table-5, Table-6 and Table-7).

Conclusion

The study found that the germination, growth and yield was good in 1:3 SW irrigation, while very poor in 1:1 SW, moderate in 1:2 SW and in RW irrigation. In 1:3 SW dilution the plants were able to absorb maximum nutrients both from the soil and spent wash resulting in good germination, growth and yield. This concludes that we can use 1:3 SW dilution for cultivation of forage crops than other dilutions and raw water.

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