Impact of distillery spentwash irrigation on the growth of leafy vegetables in untreated and treated soil

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ABSTRACT

A field experiment was conducted to study the impact of distillery spentwash on the growth of different leafy vegetables. The distillery spentwash *i.e.*, primary treated distillery spentwash (PTSW) and 33% distillery spentwash were analyzed for their physical and chemical parameters. Experimental soils plot 1(untreated soil) and plot 2 (treated soil) were tested for their physico-chemical parameters. The leafy vegetable seeds (Namadaries and Mahyco) were sowed in the prepared land dimension of 3' x 4' blocks in both plots. Seeds were irrigated with raw water and 33% spentwash. The nature of the growth of plants were studied and compared. Application of 33% spentwash shows the efficient growth of plants in plot 2 compared to plot 1.

Key words : Leafy vegetables, Experimental soil, 33% distillery spentwash, Growth rate, Potential growth, Treated, Untreated.

INTRODUCTION

Molasses (one of the important byproducts of sugar industry) is the chief raw material for the production of alcohol in distilleries. They produce about 40 billion liters of wastewater known as raw spentwash, which is characterized by high biological oxygen demand (BOD: 5000-8000mg/l) and chemical oxygen demand (COD: 25000-30000mg/l) (Joshi *et al.*, 1994).

Generally spentwash is discharged into open land or near by water bodies results number of environmental hazards including threat to plant and animal lives. The raw spentwash is highly acidic and containing easily oxidisable organic matter (Patil *et al.*, 1987). Spentwash contains highest content of nitrogen and plant nutrients (Ramadurai and Gearard, 1994). By adopting biomethenation plant in distilleries, reduces the oxygen demand of raw spentwash, this is called primary treated spentwash and is rich in nitrogen (N), potassium (K), and phosphorous (P) and decrease in calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl^-), and sulphate (SO_4^{2-}) (Mohamed Haron and Subash Chandra Bose, 2004). Also it contains easily biodegradable organic matter and its application to soil has been reported to be beneficial to increase the yield of sugar cane (Zalawadia *et al.*, 1997), rice (Deverajan and Oblisami, 1995), wheat (Pathak *et al.*, 1998), quality of groundnut (Amar B Singh *et al.*, 2003) and physiological response of soyabean (Ramana *et al.*, 2000). Diluted spentwash increases the growth of shoot length, leaf number per plant, leaf area and chlorophyll content of peas (Rani and Vastava, 1990). The spentwash consists excess of various forms of cations and anions, which are harmful to plant growth. The concentration of these constituents should be reduced to beneficial level by diluting the spentwash, which can be used as a substitute for chemical fertilizer (Sahai *et al.*, 1983). The spentwash could be used as a complement to mineral fertilizer to sugarcane (Chares, 1985) and thus valued as a fertilizer when applied to soil through irrigation water (Samuel, 1986). Higher percentage of spentwash irrigation causes decrease in seed germination, seedling growth and chlorophyll content in sunflowers (Helianthus annuus) and the spentwash could be safely used for irrigation purpose at lower concentration (Rajendran, 1990 and Ramana *et al.*, 2001) without adversely affecting soil fertility and crop productivity (Raverkar *et al.*, 2000, Kuntal *et al.*, 2004 and Kaushik *et al.*, 2005). Twelve pre sowing irrigations with the diluted spentwash had no adverse effect on the germination of maize but improved the growth and yield (Singh and Raj Bahadue, 1998). The diluted spentwash irrigation improved the physical and chemical properties of the soil and further increased soil microflora (Deverajan *et al.*, 1994, Kuntal *et al.*, 2004 and Kaushik *et al.*, 2005). Application of diluted spentwash increased the uptake of Zinc (Zn), Copper (Cu), Iron (Fe) and Manganese (Mn) in maize and wheat, the highest total uptake of these were found at lower dilution than at higher dilution levels (Pujar, 1995). The diluted spentwash increase the uptake of nutrients, height, growth and yield of leafy vegetables (Chandraju and Basavaraju, 2007, Basavaraju and Chandraju, 2008, and Chandraju *et al.*,

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2008), nutrients of pulses (Chandraju *et al.*, 2008), condiments and root vegetables (Chandraju *et al.*, 2008), top vegetables (Basavaraju and Chandraju, 2008), cabbage and mint (Chandraju *et al.*, 2008). In our previous investigations we noticed that 50% distillery spentwash irrigation was not favorable for the germination of seeds and growth of leafy vegetables. Therefore, the present investigation was carried out to investigate the impact of 33% spentwash on the growth and yield of different kinds of leafy vegetables in untreated and treated soils.

MATERIALS AND METHODS

Physico-chemical parameters and amount of nitrogen (N), potassium (K), phosphorous (P) and sulphur (S) present in the primary treated distillery spentwash (PTSW) and 33% spentwash were analyzed by standard methods (Table 1). The primary treated spentwash was used for irrigation with a dilution of 33% in the plot 1(untreated soil) and plot 2 (treated soil). The experiments were conducted at the field of Chamundi Distilleries Pvt. Ltd. Maliyur, Mysore District, Karnataka. Before initiation, plot 2 soil was treated with 33% spentwash for four times at an intervals of one week, each time land was ploughed and exposed to sunlight. A composite soil samples from both plots were collected from the experimental site at 25 cm depth, air-dried, powdered and analyzed for physico-chemical properties by standard methods (Table 2). The leafy vegetables selected were amaranth (*Amaranthus gangeticus*), Coriander leaves (*Coriandum sativum*), Fenugreek (*Trigonella foenum graceum*), Shepu (*Peucedanum graveolens*) and Spinach (*Spinacia oleracea*). The seeds were sowed in the prepared fields and irrigated with raw water and 33% spentwash at the dosage of twice a week and rest of the period with raw water. The natures of the growth of all plants were recorded at 8th, 18th, 25th days from plantation and also at the time of harvest.

Table 1: Chemical Composition of distillery spentwash

Chemical parameters	Units	PTSW	33% DSW
pH	--	7.36	7.24
Electrical conductivity	µS	28800	10020
Total solids	mg/l	46140	20870
Total dissolved solids	mg/l	35160	10140
Total suspended solids	mg/l	10540	4380
Settleable solids	mg/l	10070	3010
COD	mg/l	40530	10228
BOD	mg/l	16200	4800
Carbonate	mg/l	Nil	Nil
Bicarbonate	mg/l	13100	4200
Total phosphorous	mg/l	30.26	6.79
Total potassium	mg/l	7200	2400
Calcium	mg/l	940	380.0
Magnesium	mg/l	1652.16	542.22
Sulphur	mg/l	74.8	22.6
Sodium	mg/l	480	240
Chlorides	mg/l	5964	3164
Iron	mg/l	9.2	5.20
Manganese	mg/l	1424	368
Zinc	mg/l	1.28	0.41
Copper	mg/l	0.276	0.074
Cadmium	mg/l	0.039	0.010
Lead	mg/l	0.16	0.06
Chromium	mg/l	0.066	0.014
Nickel	mg/l	0.165	0.040
Ammonical nitrogen	mg/l	743.68	276.64

PTSW – Primary treated distillery spentwash
33% SW – 33% distillery spentwash

Table 2: Characteristics of experimental soils

Parameters	Units	Plot-1	Plot-2
Coarse sand	%	9.72	10.94
Fine sand	%	40.80	42.86
Slit	%	25.28	26.32
Clay	%	24.2	19.88
PH (1:2 soln)	%	8.16	8.15
Electrical conductivity	µS	526	451
Organic carbon	%	0.61	0.93
Available nitrogen	ppm	340	460
Available phosphorous	ppm	130	180
Available potassium	ppm	80	65
Exchangeable calcium	ppm	140	150
Exchangeable magnesium	ppm	220	190
Exchangeable sodium	ppm	90	180
Available sulphur	ppm	240	230
DTPA Iron	ppm	200	240
DTPA Manganese	ppm	220	260
DTPA Copper	ppm	5	8
DTPA Zinc	ppm	50	65

Plot-1: Untreated soil Plot-2: Treated soil

RESULTS AND DISCUSSION

Irrigation was done as per the requirement with raw water and 33% spentwash for all varieties in different blocks. in previous investigations, it was found that germination of seeds and growth were not favorable with 50% spentwash irrigation and that could be due to higher concentration of spentwash. In the case of amaranth (*Amaranthus gangeticus*) and shepu (*Peucedanu graveolens*), noticed that seeds germination was unaffected in 33% spentwash and raw water irrigation

Table 3: Thickness of stem, height and weight of amaranth (*Amaranth gangeticus*)

Observations	Plot-1				Plot-2			
	Thickness of stem (in mm)		Height of the plant (in cm)		Thickness of stem (in mm)		Height of the plant (in cm)	
	RW	33% SW	RW	33% SW	RW	33% SW	RW	33% SW
8th day from plantation	1.2	2.0	1.9	3.0	1.28	2.4	2.0	3.3
18th day from plantation	2.4	3.62	22.0	30.0	2.8	3.84	26.0	32.0
25th day from plantation	3.1	4.24	28.0	37.0	3.4	4.64	36.0	42.0
At the time of harvest	4.10	5.62	34.0	42.0	4.6	5.82	41.0	58.0
Weight of plants with root (bundle of 50 nos.)	145 g	360 g	--	--	350 g	410 g	--	--
Weight of edible portion of plants (bundle of 50 nos.)	75 g	180 g	--	--	170 g	210 g	--	--

RW– Raw water 33% SW – 33% distillery spentwash Plot-1– Untreated soil Plot-2 – Treated soil

Table 4 : Thickness of stem, height and weight of shepu (*Peucedanum graveolens*)

Observations	Plot-1				Plot-2			
	Thickness of stem (in mm)		Height of the plant (in cm)		Thickness of stem (in mm)		Height of the plant (in cm)	
	RW	33% SW	RW	33% SW	RW	33% SW	RW	33% SW
8th day from plantation	0.6	1.24	1.5	2.2	0.7	1.52	2.15	3.4
18th day from plantation	1.5	3.02	10.0	19.5	1.8	3.24	19.0	23.5
25th day from plantation	2.0	3.82	16.0	30.0	2.4	3.92	28.0	35.0
At the time of harvest	2.72	3.92	23.0	37.8	2.8	4.23	37.0	44.0
Weight of plants with root (bundle of 50 nos.)	50 g	170 g	--	--	160 g	240 g	--	--
Weight of edible portion of plants (bundle of 50 nos.)	35 g	140 g	--	--	130 g	210 g	--	--

RW– Raw water 33% SW – 33% distillery spentwash Plot-1– Untreated soil Plot-2 – Treated soil

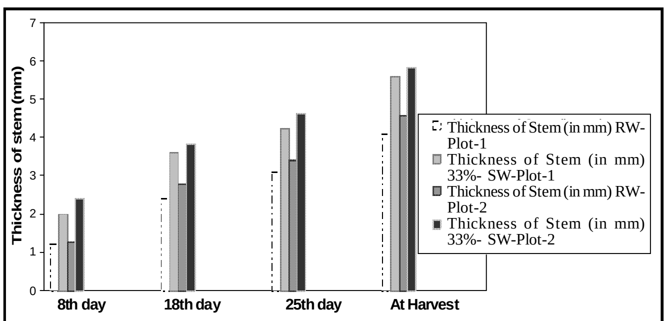

Fig. 1(a): Thickness of amaranth stem at different intervals

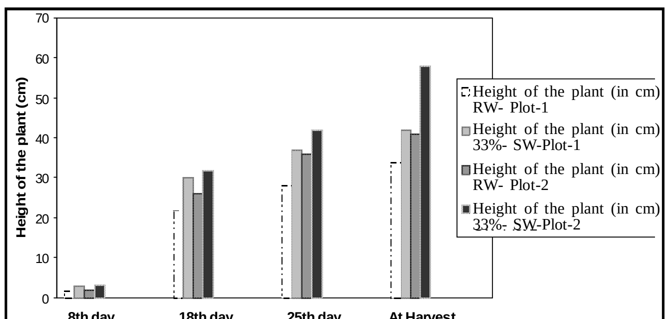

Fig. 1(b): Height of amaranth plant at different intervals

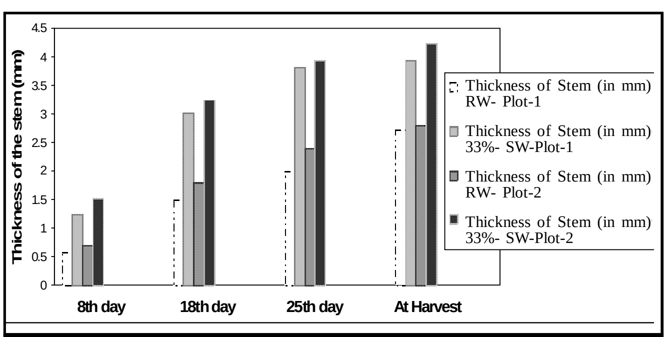

Fig. 2(a): Thickness of shepu stem at different intervals

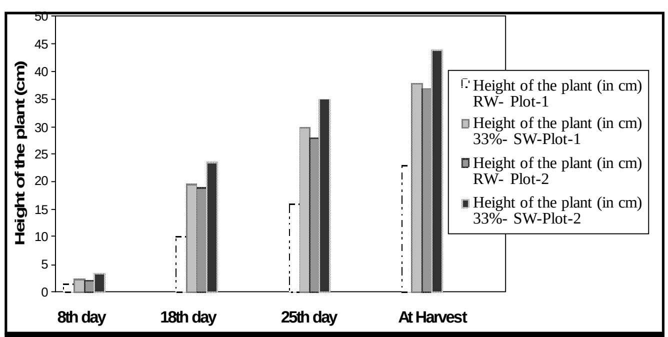

Fig. 2(b): Height of shepu plant at different intervals

Table 5 : Thickness of stem, height and weight of coriander leaves (*Coriandum sativum*)

Observations	Plot-1				Plot-2			
	Thickness of stem (in mm)		Height of the plant (in cm)		Thickness of stem (in mm)		Height of the plant (in cm)	
	RW	33% SW	RW	33% SW	RW	33% SW	RW	33% SW
8th day from plantation	0.01	0.03	2.0	3.0	0.01	0.03	2.5	3.7
18th day from plantation	0.03	0.08	8.0	10.0	0.04	0.09	9.85	13.2
25th day from plantation	0.04	0.09	11.0	19.0	0.05	0.10	18.0	24.0
At the time of harvest	0.06	0.12	13.0	25.0	0.07	0.14	24.5	35.0
Weight of plants with root (bundle of 50 nos.)	45 g	150 g	--	--	135 g	180 g	--	--
Weight of edible portion of plants (bundle of 50 nos.)	40 g	110 g	--	--	100 g	140 g	--	--

RW– Raw water 33% SW – 33% distillery spentwash Plot-1– Untreated soil Plot-2 – Treated soil

Table 6 : Thickness of stem, height and weight of fenugreek (*Trigonella foenum graceum*)

Observations	Plot-1				Plot-2			
	Thickness of stem (in mm)		Height of the plant (in cm)		Thickness of stem (in mm)		Height of the plant (in cm)	
	RW	33% SW	RW	33% SW	RW	33% SW	RW	33% SW
8th day from plantation	0.2	0.35	2.5	5.0	0.26	0.45	3.0	5.4
18th day from plantation	0.7	1.0	20.0	29.0	0.82	1.26	24.0	31.0
25th day from plantation	1.0	1.2	26.0	37.0	1.08	1.59	35.0	40.0
At the time of harvest	1.28	1.65	31.0	41.5	1.32	1.72	40.0	49.0
Weight of plants with root (bundle of 50 nos.)	80 g	125 g	--	--	110 g	240 g	--	--
Weight of edible portion of plants (bundle of 50 nos.)	45 g	85 g	--	--	70 g	120 g	--	--

RW– Raw water 33% SW – 33% distillery spentwash Plot-1– Untreated soil Plot-2 – Treated soil

Table 7 : Thickness of stem, height and weight of spinach (*Spinacia oleracea*)

Observations	Plot-1				Plot-2			
	Thickness of stem (in mm)		Height of the plant (in cm)		Thickness of stem (in mm)		Height of the plant (in cm)	
	RW	33% SW	RW	33% SW	RW	33% SW	RW	33% SW
8th day from plantation	0.08	0.14	4.0	6.3	0.09	0.16	4.6	6.6
18th day from plantation	0.31	0.39	14.0	17.0	0.36	0.42	16.0	19.0
25th day from plantation	0.52	0.60	23.0	27.0	0.58	0.66	24.0	29.0
At the time of harvest	0.60	0.68	24.0	30.0	0.67	0.80	26.0	34.0
Weight of plants with root (bundle of 50 nos.)	170 g	330 g	--	--	300 g	420 g	--	--
Weight of edible portion of plants (bundle of 50 nos.)	120 g	275 g	--	--	260 g	350 g	--	--

RW– Raw water 33% SW – 33% distillery spentwash Plot-1– Untreated soil Plot-2 – Treated soil

(100% germination). But the growth was very good in 33% spentwash and poor in the case of raw water in both plots. However, the growth of plants was highly potential (dark greenish) in plot 2 as compared to plot 1 with raw water and 33% spentwash irrigation. This indicates that, the presence of nutrients (nitrogen, phosphorous and potassium) in 33% spentwash favoured the potential growth of plants. The growth rate *i.e.*, thickness of the stem, height of the plants at 8th, 18th, 25th days, at the time of harvest and yield were recorded (Table 3 and 4). The thickness of stem and height of the plants increased at different intervals of time in plot 2 as compared to plot 1 [Fig.1 (a), Fig.1 (b), Fig.2 (a) and Fig.2 (b)]. It was observed that the potential growth of plants (stem thickness, height and yield) are in the order, 33% spentwash (plot 2) > 33% spentwash (plot 1) > raw

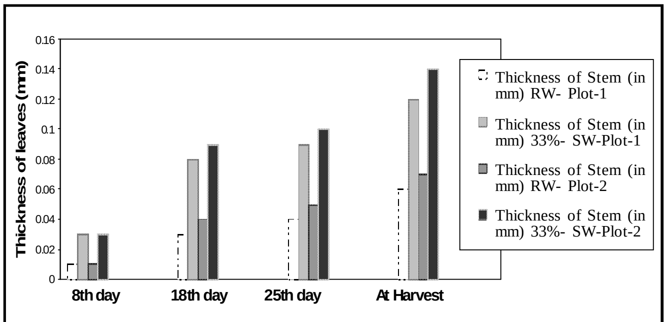

Fig. 3(a): Thickness of coriander leaves at different intervals

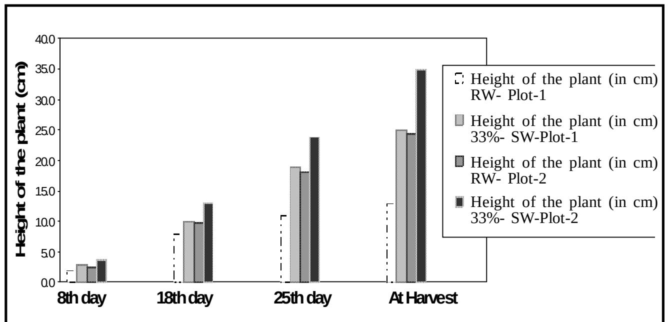

Fig. 3(b): Height of coriander plant at different intervals

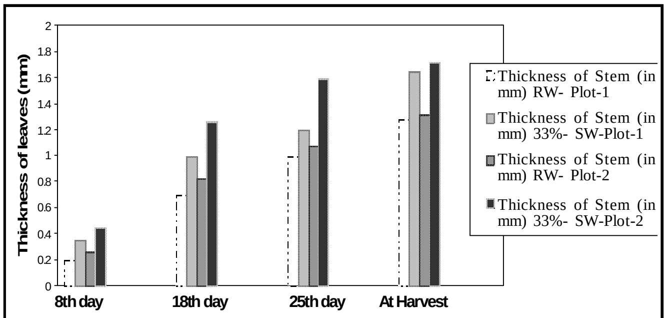

Fig. 4(a): Thickness of fenugreek leaves at different intervals

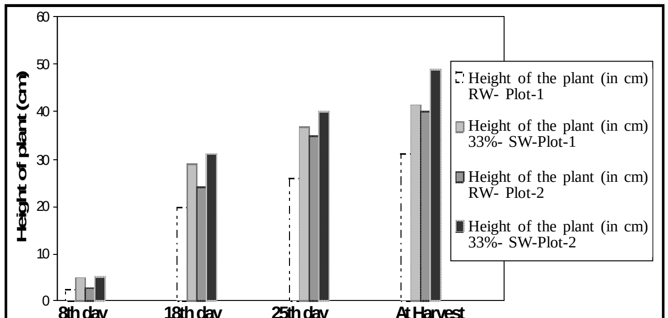

Fig. 4(b): Height of fenugreek plant at different intervals

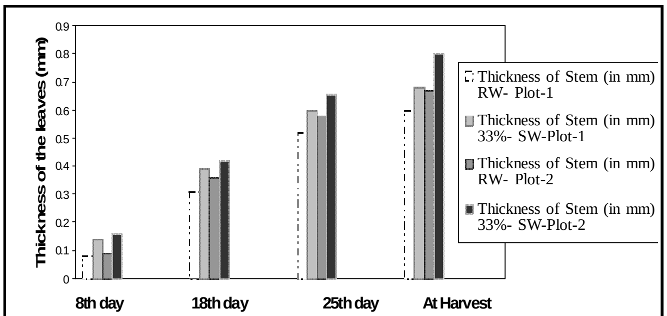

Fig. 5(a): Thickness of spinach leaves at different intervals

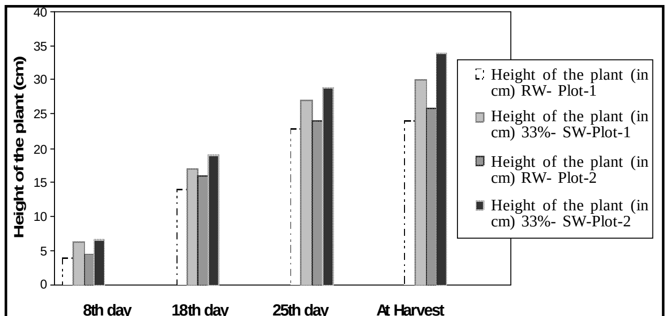

Fig. 5(b): Height of spinach plant at different intervals

water (plot 2) > raw water (plot 1).

It the case of Coriander leaves (*Coriandum sativum*), Fenugreek (*Trigonella foenum graceum*) and Spinach (*Spinacia oleracea*) germination of seeds were almost similar in raw water and 33% spentwash in both plots 1 and 2. The plants were highly potential (dark greenish) in 33% spentwash in plot 2 and plot 1 than raw water. However, the growth of all plants was highly potential (dark greenish) in plot 2 than plot 1 with raw water and 33 per cent spentwash irrigation. Rate of growth of thickness of the leaf, height of the plants at 8^{th}, 18^{th}, 25^{th} days, at the time of harvest and yield were recorded (Table 5, 6 and 7). The thickness of the leaf and height of the plants increased at different intervals in plot 2 as compared to plot 1 [Fig.3 (a), Fig. 4(a), Fig. 5(a)]. It was observed that growth and yield are in the order, 33% spentwash (plot 2) > 33% spentwash (plot 1) > raw water (plot 2) > raw water (plot 1).

Conclusion:

Among the irrigation with 33% spentwash and raw water in both untreated and treated soil, it concluded that, the growth of all leafy vegetable plants are highly potential and yield is more in the case of 33% spentwash as compared to raw water. Also in treated soil (plot 2) growth and yield are much more greater than the untreated soil (plot 1). This concludes that, the spentwash treated soil (plot 2) is enriched with the plant nutrients. It further concludes that, the subsequent use of spentwash for irrigation enriches the soil fertility and hence, the diluted distillery spentwash (33%) can be conveniently used for the cultivation of leafy vegetable.

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