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Effect of distillery spent wash on growth and yield parameter of sunflower (*Helianthus annuus* L.) soil chemical properties and economics in dryland agro ecosystem

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ABSTRACT : A field experiment conducted during *Kharif* season of 2008 on sandy clay loam soil at G.K.V.K, Bangalore revealed that application of 1.5 times N through spent wash along with 1.5 times P through SSP gave significantly superior grain yield (1190.5 kg ha^{-1}). At harvest, plant height, number of leaves and total dry matter were significantly higher with treatment receiving 1.5 times N plus recommended P and 1.5 times K as in spent wash. However, it was found to be at par with 1.5 times N through spent wash along with 1.5 times P through SSP. The increase in seed yield was attributed to higher intake and recovery of nutrients from the spent wash. However, total dry matter production alone does not reflect the efficiency of a crop, but its accumulation in different parts is the real index of efficiency. Maximum uptake of nitrogen (29.4 kg ha^{-1}), phosphorus (14.2 kg ha^{-1}) and potassium (79.6 kg ha^{-1}) was associated with the same treatment. Further, it had higher available N (294 kg ha^{-1}), P (59.5 kg ha^{-1}) and K (1230 kg ha^{-1}) in soil after harvest. Highest net income (Rs.13,694 ha^{-1}) was noticed with 1.5 times N through spent wash along with 1.5 times P through SSP, whereas highest benefit cost ratio (2.21) was noticed with the recommended N through spent wash.

Key Words : Spent wash, Sunflower, Productivity, Soil chemical properties, Economics

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Urbanization and industrialization have led to the large volume of waste in the form of solid, liquid and gases. Distillery spent wash, a liquid waste from the distillery industry contains large quantities of soluble organic matter and plant nutrients. In the distillery industry, for every one litre of alcohol produced, about 15 litres of spent wash is released as wastewater. So there is a possibility of getting about 2.7 billion litres of wastewater from distillery industry in India. This spent wash is of purely plant origin and contains large quantities of soluble organic matter and plant nutrient and does not contain any toxic compounds. However, the spent wash could not be directly applied to the growing crops because of its excessive BOD and COD. These problems could be overcome by the application of distillery spent wash well before the planting of crop (30 days before planting) to give sufficient time for natural oxidation of organic matter (Rajukkannu *et al*., 1996 and Sidhu and Bains, 2010). Since, it contains major and micronutrient to sustain the soil fertility and yield of crops, an experiment was conducted to find out the effect of pre-plant application or one time application of distillery spent wash on soil properties and yield of sunflower.

RESEARCH PROCEDURE

The experiment was carried out at Zonal Agricultural Research Station, GKVK, Bangalore, during *Kharif* season of 2008 on sandy clay loam soil. The soil had 220.5, 35.4 and 351.0 kg ha^{-1} available N, P_2O_5 and K_2O, respectively with 0.68 per cent organic carbon, pH of 6.38 and EC of 0.157 dSm^{-1}. There were 10 treatments consisting of control,

recommended NP, NPK, and NP plus K as in spent wash, 1.5 times recommended N through spent wash along with balance P through SSP and 1.5 times recommended N through spent wash along with 1.5 times P through SSP. The treatments were replicated four times and laid out in Complete Randomized Block Design. The treatment details are T_1- Absolute control, T_2- recommended NP, T_3- recommended NPK, T_4 - recommended N, P + K equivalent of spent wash through KCl, T_5- 1.5 times recommended N + recommended P and K, T_6- 1.5 times recommended N + recommended P + 1.5 times K as in spent wash, T_7 - recommended N through spent wash and no P through SSP, T_8 - recommended N thorough spent wash (balance P through SSP), T_9 - 1.5 times recommended N though spent wash (balance P through SSP) and T_{10}- 1.5 times recommended N though spent wash (1.5 times recommended P through SSP). The preliminary analysis of liquid effluent indicated that it contained good amount of nutrients (Table A). Sunflower variety used was KBSH-1, which was sown in third week of July and harvested, in first week of November 2008. Fifty per cent inorganic nitrogen and entire dose of P and K were applied at the time of planting. Remaining 50 per cent N was top-dressed at 30 days after sowing. Whereas, spent wash was applied 30 days before planting. Growth parameters and yield attributing characters were recorded. The harvest index (HI) was worked out. The economic parameters were worked out using cost of cultivation, inputs cost and gross return considering the existing market price of produces. B: C ratio was calculated by ratio of net profit to cost of cultivation.

Table A : Chemical characteristics of distillery effluent

Parameters	Values
pH	7.62
EC (dSm^{-1})	15.47
Total solids (%)	2.97
Dissolved solids (%)	1.24
Suspended solids (%)	1.69
BOD ($mg\ l^{-1}$)	11309
COD ($mg\ l^{-1}$)	29760
Chloride ($mg\ l^{-1}$)	6825
Sodium ($mg\ l^{-1}$)	2086
Total nitrogen (%)	0.1
Total phosphorus (%)	0.02
Total potassium (%)	1.15
Total calcium ($mg\ l^{-1}$)	1925
Total magnesium ($mg\ l^{-1}$)	1733

RESEARCH ANALYSIS AND REASONING

The experimental findings obtained from the present study have been discussed in following heads:

Growth parameters:

The data revealed significant differences in plant height among various treatments at all the stages of crop growth (Table 1). At 30 and 60 days after sowing, the treatment which received 1.5 times N through spent wash along with 1.5 times P through SSP recorded higher plant height (27.1, 139 cm) which found to be at par with T_5 (25.5, 137.8 cm) and T_9 (25.4, 137.8 cm) and lowest plant highest was recorded with T_6 (7.2, 91.5 cm) and T_4 (7.8, 98.6 cm), respectively. The increase in plant height with increased nitrogen application may be attributed to promotion of metabolic activity and cell division. Stunted growth may be due to crop suffering from osmotic potential in view of presence appreciable amounts of traits. But, at later stages, the treatment T_4 and T_6 recovered from osmotic potential and was found to be at par with T_{10}. These

Table 1: Plant height, number of leaves and total dry matter of sunflower as influenced by spent wash application

Treatments	Plant height (cm)				Number of leaves			Total dry weight (g)			
	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	Harvest
T_1	20.6	119.0	123.9	124.2	8.5	18.5	13.2	1.5	19.6	46.6	58.8
T_2	23.8	136.6	138.9	139.1	10.2	21.1	14.5	2.1	22.6	77.1	80.2
T_3	24.6	137.3	140.1	140.8	10.6	21.6	15.1	2.3	23.6	78.5	81.7
T_4	7.8	98.6	151.8	152.6	5.8	20.5	16.0	0.8	18.5	71.4	90.3
T_5	25.5	137.8	147.7	142.2	11.3	22.8	15.5	2.4	27.6	81.2	85.1
T_6	7.2	91.5	158.8	158.9	4.4	18.4	16.8	0.5	15.8	81.8	92.7
T_7	24.1	137.1	139.1	139.9	10.2	21.2	14.6	2.2	23.2	77.1	80.2
T_8	24.7	137.5	140.7	141.2	10.6	21.7	15.2	2.2	24.8	78.7	83.5
T_9	25.4	137.8	141.5	142.1	11.2	22.8	15.4	2.3	26.8	81.2	84.6
T_{10}	27.1	139.0	143.2	143.8	12.4	23.6	16.0	2.6	28.6	84.3	89.2
S.E.±	0.92	3.70	4.59	4.70	0.58	0.39	0.55	0.3	2.5	5.2	3.5
C.D. at 5%	2.97	10.74	13.32	14.5	1.70	1.13	1.62	0.88	7.24	15.0	10.2

results are in conformity with Singh *et al*. (2004). At 30 and 60 days after sowing, number of leaves per plant was significantly higher (12.4, 23.6) with the application of 1.5 times N through spent wash along with 1.5 times P through SSP (T_{10}) which was found to be at par with T_5 (11.3, 22.8) and T_9 (11.2, 22.8), respectively. Lowest number of leaves per plant was noticed with T_6 (4.4, 18.4) and T_4 (5.8, 20.5), respectively. But, at later stages, these T_6 and T_4 treatments recorded from higher osmotic due to leaching of salts. Increase in number of leaves was mainly due to increase in plant height, number of internodes and higher availability of major and micronutrients.

The dry matter production was influenced by application of distillery spent wash (Table 1). Application of 1.5 times N through spent wash along with 1.5 times P through SSP recorded significantly higher total dry matter (2.6, 28.6 g/ plant) and lowest dry matter was recorded with T_6 (0.5, 15.8) and T_4 (0.5, 18.5 g/plant) at 30 and 60 days after sowing, respectively. But, at later stages these treatments recorded from high salt injury and were found to be at par with T_{10} treatment. Total dry matter production alone does not reflect the efficiency of a crop but its accumulation in different parts in the real index of efficiency. In the present study, accumulation of dry matter in the head was lower with the treatment T_6 and T_4. These results are in conformity with the Ramanna *et al*. (2001).

Yield and yield components:

Application of 1.5 times N supplied through spent was along with 1.5 times P through SSP produced the highest seed yield of 1190.5 kg ha^{-1} followed by 1.5 times N plus recommended P and K (1154.5 kg ha^{-1}) and 1.5 times N supplied through spent wash along with balance P through SSP (1145.3 kg ha^{-1}) (Table 2). Singh *et al*. (2004) also obtained in their studies that higher seed yield of sunflower with spent wash as compared to application of only recommended NPK. The increase in seed yield was mainly attributed to increase in components like head diameter, number of filled seeds, head dry weight, seed filling percentage and decrease in number of unfilled seeds. Large head size must have accommodated more number of seeds, with higher sink capacity thus, more photosynthates might have been translocated to the head. Significant and positive correlation was observed between yield and yield attributes like total number of seeds per head, number of filled seeds per head, seed filling percentage and head diameter. All the yield attributes increased due to application of N and P applied in N: P ratio of one or more than one. These results are in conformity with Sharma (1999) and Burns (2001).

Harvest index is useful parameters to assess the translocation efficiency of photosynthates from source to sink. Higher harvest index of 0.328 was noticed with the 1.5 times N through spent wash along with 1.5 times P through SSP (T_{10}) and T_9 (Table 2). This is due to proportionate increase in seed to biological yield and lower harvest index was noticed in T_6. This was mainly due to increase in stalk yield and reduction in grain yield (Burns, 2001).

Significant and positive correlation was observed between yield and yield attributes like total number of seeds per head, number of filled seeds per head, seed filling percentage and head diameter (Table 3). The results are also in conformity with Burns (2001). All the yield attributes increased due to application of N and P applied in N: P ratio of one or more than one.

Soil properties and nutrient uptake:

The pH of the soil was significantly increased from the

Table 2: Yield and yield attributes of sunflower at harvest as influenced by application of distillery spent wash

Treatments	Head diameter (cm)	Total number of seeds per head	Number of filled seeds per head	Number of unfilled seeds per head	Seed filling percentage	Test weight (g/100 seeds)	Seed yield (Kg/ha)	Stalk yield (kg ha^{-1})	Harvest index
T_1	13.5	651.1	391.1	260.0	60.3	4.6	825.5	1795.3	0.315
T_2	15.1	822.1	597.0	226.3	72.6	4.7	1110.3	2300.7	0.326
T_3	15.2	843.8	623.0	220.8	73.8	4.7	1140.5	2337.3	0.327
T_4	14.4	715.1	473.1	242.0	66.2	4.7	995.1	2468.4	0.292
T_5	15.5	854.5	644.5	210.5	75.4	4.8	1154.5	2367.6	0.327
T_6	14.0	680.1	420.1	260.0	61.8	4.7	810.3	2550.5	0.241
T_7	15.1	825.5	595.5	230.0	72.2	4.7	1095.5	2270.1	0.325
T_8	15.3	842.5	622.0	235.5	73.8	4.8	1142.2	2343.4	0.327
T_9	15.4	853.1	643.0	210.0	75.4	4.8	1145.3	2364.7	0.328
T_{10}	16.4	876.5	679.0	197.5	77.5	4.8	1190.5	2435.4	0.328
S.E.±	0.60	18.47	7.99	7.89	1.22	0.13	34	168.52	0.0043
C.D. at 5%	1.72	53.6	23.2	22.91	3.53	NS	100	498.00	0.013

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Table 3: Correlation between growth parameters, yield and yield attributes of sunflower influenced by spent wash

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	1.00														
X_2	0.229	1.00													
X_3	0.621**	0.141	1.00												
X_4	0.572**	0.108	0.287	1.00											
X_5	0.144	0.140	0.054	0.613**	1.00										
X_6	0.562**	0.016	0.405**	0.400*	0.092	1.00									
X_7	0.334*	0.322*	0.437**	0.230	-0.097	0.194	1.00								
X_8	0.322*	0.036	0.011	0.849**	0.550**	0.349*	0.049	1.00							
X_9	0.546**	0.080	0.292	0.727**	0.430**	0.453**	0.258	0.581**	1.00						
X_{10}	0.722**	0.219	0.685**	0.562**	0.179	0.446**	0.395*	0.263	0.460**	1.00					
X_{11}	-0.345*	-0.090	-0.304	-0.329*	-0.098	-0.346*	-0.216	-0.110	-0.425**	-0.346	1.00				
X_{12}	0.613**	0.371*	0.652**	0.484**	0.094	0.511**	0.341*	0.280	0.347*	0.630**	-0.411**	1.00			
X_{13}	0.573**	0.198	0.556**	0.333*	-0.085	0.295	0.583**	0.080	0.306	0.637**	-0.271	0.548**	1.00		
X_{14}	0.040	0.036	-0.024	0.258	0.237	0.146	0.223	0.160	0.455**	0.135	-0.012	0.125	0.121	1.00	
X_{15}	0.287	0.161	0.139	-0.009	0.097	0.006	0.152	-0.200	-0.200	0.269	-0.056	0.370*	0.304	0.079	1.00

X_1 – Yield
X_2 – Total dry at 30 DAS
X_3 – Total dry at 60 DAS
X_4 – Total dry at 90 DAS
X_5 – Total dry at harvest
X_6 – Head diameter
X_7 – LAI 60 DAS
X_8 – CGR 60-90 DAS
X_9 – Head dry weight at harvest
X_{10} – No. of filled seeds
X_{11} – No. of unfilled seeds
X_{12} – Total no. of seeds
X_{13} – Seed filling percentage
X_{14} – Test weight
X_{15} – Harvest index

* and ** significance of values at P=0.05 and 0.01, respectively

initial level due to application of distillery spent wash (Table 4). This could be due to organic matter oxidation brought about by microbial activity which was responsible for increased pH of soil and applied spent wash was neutral in nature. As the rate of spent wash application increased, EC values were also increased significantly. This is due to the fact that the spent wash contained appreciable amount of soluble salts. Organic carbon indicates the nutrient supplying power and microbial activity of the soil. As the level of spent wash application increased organic carbon content was increased. This could be attributed to the fact that spent wash had high organic load thus triggering microbial activity. These results are in agreement with Mattiazzo and Ada Gloria (1985).

Application of 1.5 times N supplied through spent wash along with 1.5 times P through SSP recorded higher total uptake of N (29.4 kg ha^{-1}), P (14.2 kg ha^{-1}) and K (79.6 kg ha^{1}) (Table 4). This increased uptake of nutrients is due to both high nutrient contents coupled with higher dry matter production. The higher uptake of N, P and K might be due to improvement in physico-chemical properties in the root environment.

Available nutrients:

Increasing rate of spent wash application markedly increased the available N status in the soil. This may be due to the presence of considerable amount of nitrogen in the spent wash itself and increased microbial activity due to added organic matter which inturn increased the availability of nitrogen. Available P was higher with the treatment receiving 1.5 times N through spent wash along with 1.5 times P through SSP compared to control (Table 4). The increase in available P was due to P contribution (0.02%) from spent wash, inorganic fertilizer and higher phosphatase activity in the soil. Available K in soil was significantly increased with increasing rate of spent wash application. This may be probably due to the fact that spent wash contained appreciable amount of potassium (1.15%). These results are in conformity with the Jadhav and

Table 4: Effect of spent wash on soil chemical properties uptake and available NPK after harvest of sunflower crop

Treatments	Properties			Nutrient uptake (Kg ha^{-1})			Available nutrient (Kg ha^{-1})		
	pH	EC	OC	N	P_2O_5	K_2O	N	P_2O_5	K_2O
At initial stage	6.38	0.157	0.68	-	-	-	220.5	35.4	315
T_1	6.4	0.07	0.70	17.8	8.6	54.5	212	23.5	319
T_2	6.4	0.08	0.74	25.4	12.6	71.9	260	41.4	328
T_3	6.4	0.08	0.78	26.5	13.0	75.0	277	52.2	353
T_4	6.6	0.09	0.75	25.4	13.0	77.3	269	48.2	960
T_5	6.5	0.08	0.81	28.4	13.4	76.2	295	54.5	358
T_6	6.6	0.10	0.75	25.1	13.4	76.9	294	53.1	1238
T_7	6.8	0.15	0.81	25.9	11.9	74.9	264	28.1	945
T_8	6.8	0.15	0.81	27.1	13.2	75.8	266	52.4	958
T_9	6.9	0.22	0.92	28.3	13.6	77.2	293	54.8	1210
T_{10}	6.9	0.22	0.93	29.4	14.2	79.6	294	59.5	1230
S.E.±	0.14	0.003	0.02	1.77	1.04	2.9	4.68	1.43	27.5
C.D. at 5%	0.47	0.008	0.05	5.14	3.0	8.5	13.59	4.15	83.5

Table 5: Cost of cultivation, gross income, net returns and cost benefit ratio of sunflower as influenced by application of distillery spent wash

Treatments	Cost of cultivation	Gross return	Net return	B:C ratio
T_1	5545.0	14859.0	9314.0	1.68
T_2	7207.5	19985.4	12777.9	1.75
T_3	7497.5	20529.0	13031.5	1.74
T_4	10544.3	17911.8	7367.5	0.70
T_5	7703.8	20781.0	13077.2	1.70
T_6	12232.7	14585.4	2352.7	0.20
T_7	6145.0	19719.0	13574.0	2.21
T_8	7205.0	20559.6	13354.6	1.85
T_9	7110.2	20777.4	13667.2	1.92
T_{10}	7735.0	21429.0	13694.0	1.77

Savant (2005) and Sidhu and Bains (2010).

Higher cost of cultivation was noticed with T_6 (Rs. 12232.7 Ha^{-1}) because of higher application of KCl and N_2 and high cost of fertilizer (Table 5). Net returns and B: C ratio was higher with spent wash treated plot as compared to other treatment. Application of T_{10} gave higher net returns because of maximum yield obtained. However, from the point of benefit cost analysis, recommended N through spent wash was found to be best in providing high returns because of low cost of cultivation (Sidhu and Bains, 2010).

It could be concluded that application of spent wash can be effectively and safely utilized as manure in crop production. The spent wash was found to influence grain and stalk yield of sunflower through improved growth components and better availability of nutrients. Besides safe disposal of spent wash could be achieved which further prevents the environmental pollution of soil and ground water in the vicinity of distilleries.

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