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Original Research Article

Effect of Distillery Effluent (Spent Wash Methanated) Application as Pre Sown Irrigation on Growth and Yield of Rice (*Oryza sativa*) and Wheat (*Triticum aestivum*)

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Keywords

Distillery effluent, Inorganic fertilizer, Dry matter yield, Rice, Wheat, Spent wash

A B S T R A C T

To assess the optimum dilution of pre-methanation distillery effluent, a rich source of potassium nutrient. A fixed plot experiments were conducted for two consecutive years during 2009 – 2011 with rice (*Oryza sativa* L.) and wheat (*Triticum aestivum* L.) crops grown in sequence. Dilutions of distillery effluent with irrigation water significantly affected the grain yield as well as biomass production. Average plant height measured at different days interval increase in all the treatments upto harvesting. Average plant height increase at slower rate upto 30 DAT/DAS followed by faster rate till 60 DAT/DAS and thereafter increase slightly upto harvesting. The maximum plant height was found in T_{12} and it was found statistically at par with T_8, T_9, T_{10} and T_{11} while minimum plant height was recorded in T_1 during both the years. The maximum numbers of tillers/ meter row length were recorded in T_{12} and it was found significantly better than T_1, T_2 and T_4 during 2009 and all the treatments during 2010 except T_9. The minimum numbers of tillers/ meter row length were found in T_1 during both the years while length of ear, number of grains per ear, test weight and dry matter accumulation were maximum in the treatment with $60 m^3$/ha DE was applied. Application of 75% recommended dose of NPK and 40 m^3/ha distillery effluent yielded significantly higher grain yield than 100 % of recommended dose of NPK and statistically at par to recommended dose of 125% NPK without deteriorating soil health. The study indicate that the application of inorganic fertilizer in the presence of distillery effluent was highly beneficial to rice and wheat crop. Pre-sowing irrigation with (spent wash methanated) distillery effluent along with inorganic fertilizers proved most effective in increasing the grain and straw yields of rice and wheat crop.

Introduction

Distilleries, producing alcohol from molasses are the recognized among the most polluting agro based industries. The waste water of distillery, generally known as spent wash is characterized by low pH, high BOD, COD and EC and having considerable amount of essential plant nutrients as well as toxic trace elements. Therefore unscientific use of such water for raising crops can degrade soil productivity and pollute underground water. The disposal of industrial effluent is a problem of increasing importance throughout the world although soil is the ultimate and probably the most logical sink for this waste water especially for the land locked state like Punjab their disposal into surface water is banned. Spent wash though a good organic amendment, contain an appreciable amount of toxicant/ heavy metals as their constituent. Use of some of these industrial wastes in agriculture though have some nutritional enrichment and / or beneficial effect on soil physico- chemical properties, but the danger of toxicant builds- up in soil is always there and therefore need a constant monitoring. Spent wash a distillery waste is quite acidic (pH 4.0) and capable to stabilize free the native $CaCO_3$ of the calcareous sodic soils can be used effectively for reclaiming sodic soil.

Sugar mills are one of the most important agro-based industries and 600 of these are operating in sugar production in India. The sugar industry is contributing significant role in the Indian economy not only to the domestic sugar demand, but also in earning valuable foreign exchange through export. The sugar production in India is about 15 million tonnes achieved by crushing 150 million tonnes of cane with a recovery of 10 per cent. In the process of sugar production, by-products such as pressmud, bagasse, molasses *etc*. are produced. For every 100 tonnes of cane crushed 30 per cent goes as bagasse and 70 per cent is in the form of juice. Bagasse is generally used in co-generation plant as a fuel, while cane juice is diverted to the sugar production. Of this 70 per cent of juice, 14.3 per cent is recovered as table sugar while, 7.1 per cent as molasses and press mud. The remaining constitutes moisture. Molasses is one of the most significant and economically important by-products of sugar industries. This has many industrial uses including generation of alcohol, in preparation of animal feeds and food stuffs. Molasses which primarily constitutes a large fraction of fermentable sugar is diluted 3 times with good water and allowed to ferment in presence of yeast cell culture either by batch or continuous process of fermentation. The fermentable sugars are recovered by the action of yeast as alcohol (rectified spirit). It is generally estimated that nearly 20-26 per cent of the molasses is recovered as alcohol or rectified spirit. In the process of recovery of alcohol, fermentable sugars are reduced to alcohol or ethanol leaving unfermented lower order sugars (such as dioses, trioses, tetroses, pentoses *etc*.). Water soluble amino acids, lignins, other organic fractions *etc*. remain in water. These organic fractions present in higher fraction undergo reduction to generate spentwash with unacceptable odour in the vicinity of the industry. Generally in the process of one litre alcohol production, 8-15 litres of spentwash is generated in India and there are 329 distilleries which produce 3.2 billion litres of alcohol per annum. With this installed capacity, potential generation of spentwash is around 30-40 billion litres. This liquid is dark brown in colour with unacceptable odour and colour. It has higher level of suspended and/or soluble solids, salts *etc.* A higher soluble solids and salts contribute to higher COD (32800-43200 mg/litre) with the presence of higher suspended solids especially organic fractions *etc*. contribute to higher BOD (12472-17576 mg/litre). These undesirable properties make the spentwash environmentally unacceptable for direct disposal in any facets of environment and therefore, distilleries are classified as one of the most (among 14 major) polluting industries by the Central Pollution Control Board (CPCB). This dark brown liquid has a new found application in crop nutrition management as it has all the major, secondary, micronutrients, growth regulators *etc*., in higher quantities. The spentwash is generally disposed on land not from the point of use as a source of nutrient for the crop, but as a waste. The industries have limited capacity to store this liquid in lagoons and from the point of reducing the volume and to rid of this unwanted liquid as well as to save time and cost, industries resort to illegal disposal of distillery spentwash in the nearest possible location. When the applications are repeated in a small area, it leads to salinisation of land, surface and ground water contamination.

The use of distillery effluent either in liquid or solid form in agriculture has been practised in India since the inception of the industry. In certain areas, the scarcity of water has forced the farmers to use the effluent as a substitute for irrigation water over the years. The indiscriminate disposal in the open area and near natural water bodies causes high water table and contaminate surface and ground waters making them unsuitable for use. Since the conventional methods of waste treatment are uneconomical and especially the difficulty in handling and transporting of large quantities, alternative methods like application of distillery effluents to agricultural land is receiving increasing attention. The increasing cost of fertilizers and most essential nutrients also demand the attention. This is an important problem of the industries and challenge for the scientists is to use this resource as a source of nutrients and irrigation in crop production. (Tara, 2007)

Materials and Methods

The field experiment was conducted for two consecutive years during rainy (*kharif*) and winter (*rabi*) seasons of 2009 and 2011 in randomized block design with three replication to assess the effect of distillery effluent application as pre sown irrigation with high and low doses on rice and wheat crops at the experimental farm of Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology Modipuram, Meerut (Uttar Pradesh). Vallabh-21 rice and PBW-343 wheat were chosen for crop production. Geographically Meerut is located at 29° 04^1 N latitude and 77° 42^1 E longitude at an altitude of 237 meters above the mean sea level, and from 28.4° South and 28.0° North latitude and between 77.0° and 78.0° longitude of the District of Meerut. The experimental soil was sandy clay loam in texture having low organic carbon, available nitrogen and medium in phosphorus and potassium. Surface soil was characterized as in texture (sand 56.68, silt 20.0, clay 23.32), soil pH (7.18), soil EC (0.302 dSm^{-1}), low in available nitrogen (123.80 kg/ha), organic carbon (2.95 g/kg), medium in phosphorus (51.48 kg/ha) and potassium (279.23 kg/ha) at the initiation of the experiment. Distillery effluent contained pH 8.08, EC 31.2 dSm^{-1} total dissolved solid 40200 mg/l, nitrogen1600 mg/l, phosphorus 185 mg/l, potassium 6000 mg/l. The treatments details were $T_{1,}$ 100 % recommended dose of fertilizer; T_2, 125 % recommended dose of fertilizer;$T_{3,}$ 150 % recommended dose of fertilizer; T_4, 50 % recommended dose of fertilizer + 20 m^3/ha distillery effluent;$T_{5,}$ 75 % recommended dose of fertilizer + 20 m^3/ha distillery effluent; T_6, 100 % recommended dose of fertilizer + 20 m^3/ha distillery effluent;T_7, 50 % recommended dose of fertilizer + 40 m^3/ha distillery effluent;T_8, 75 % recommended dose of fertilizer + 40 m^3/ha distillery effluent;T_9, 100% recommended dose of fertilizer + 40 m^3/ha distillery effluent;T_{10}, 50 % recommended dose of fertilizer + 60 m^3/ha distillery effluent; T_{11} 75 % recommended dose of fertilizer + 60 m^3/ha distillery effluent and T_{12} 100 % recommended dose of fertilizer + 60 m^3/ha distillery effluent. Same treatments were applied in the rice subsequently in wheat. After filled the plots with water for pre sown irrigation required distillery effluent was applied as per treatments for each crops. Recommended dose of N P and K (100, 50, and 50) and 150, 60, 40 kg ha^{-1} was applied for rice and wheat crops respectively through urea, diammonium phosphate and muriate of potash. Full amount of phosphorus and potassium along with 50 % of nitrogen as per the treatments were applied before transplanting of rice and sowing of wheat crop. Rest amount of nitrogen as per treatment was applied in two equal split at 30 and 60 DAT/ DAS for rice and wheat crops. Attempts were made to keep standing water in rice and wheat was irrigated at its critical stages. The spacing of 20 x 10 cm and 22.5 cm in rice and wheat crops was maintained respectively.

Results and Discussion

Growth parameters

The application of distillery effluent under pre-sown irrigation had significant influence on most of the growth and yield attributes of rice and wheat. The plant height of rice and wheat crops was affected significantly by different treatments at different day's interval. The plant height of rice at 30 and 60 DAT did not varied significantly due to application of super optimal level of NPK during 2009 but a significant effect was noticed during 2010 where 150 % NPK produce taller plant than 100 % NPK. Substitution of 25 to 50 % NPK with different level of distillery effluent resulted in significantly taller plant than 100 % NPK. The application of a particular level of DE with different doses of NPK did not result any significant effect on plant height. The significant effect of DE application over 100 % NPK may be due to additional nutrient supply. The similar results were also reported by Mbagwu and Ekwealor (1990). At harvest the rice plant height varied significantly with super optimal application of NPK during 2009 but no such effect was noticed during 2010. With exception of T_4 rest of the treatments of integration produce taller plant than 100 % NPK during 2009 but no clear cut effect was noticed during 2010. This effect may be explained by better utilization of available nitrogen from soil as the available nitrogen in soil at harvest decline much more during 2009 than 2010 and nutrient uptake by plant between 60 DAT and harvesting was also more during 2009 as compare to 2010. Plant height of wheat with the application of various doses of NPK and DE was found significantly higher than 100 % NPK with few exceptions at all day's interval. Plant height did not varied significantly due to application of a particular level of DE with graded doses of NPK. Table-1

The number of tillers/meter row length did not varied significantly due to application of super optimal level of NPK during 2009 but a significant effect at 60 DAT and harvesting was noticed during 2010. The application of either level of DE along with 100 % NPK recorded significantly higher number of tillers/ meter row length than 100 % NPK but application of these levels with 50 or 75 % NPK could not showed a clear cut effect. The effect of 20 or 40 m^3/ha DE application along with a particular NPK level was more or less similar but 60 m^3/ha show a significant effect over 20 m^3/ha during 2010 significant different during 2010 may be suppose due to enough water availability since the transplanting of rice to almost flowering stages while inadequate rainfall at transplanting time during 2009 might have found some mobility. So why such difference was observed Tripathi *et al.* (2007).

The number of tillers of wheat/meter row length varied significantly due to application of super optimal levels of NPK at 30 and 60 DAS during both the years. The application of DE along with NPK in most cases recorded significantly higher tillers than 100 % NPK during both the years. With exception of 2010-11 the effect of 20 and 40 m^3/ha doses of DE application at a particular nutrient levels on tiller was significant and number of tiller increase significantly at 30 and 60 DAS. The effect of 40 and 60 m^3/ha was more or less similar. At harvest no significant effect was observed during 2010-11. However, number of tillers increase significantly due to application of super optimal level of NPK. Additional application of DE over 100 % NPK showed significant effect by recording higher number of tillers. The effect of DE application along with graded level of NPK was not clear. The growth parameter of rice and wheat are presented in Table 1.

Yield attributes

Different yield attributing characters of rice viz panicle length, number of grains/ panicle and test weight were affected significantly due to different treatments. Non of the characters differ significantly due to application of super optimal level of NPK over optimal level 2009-10. However, in integration a significant effect was noticed. The application of DE along with 100 % NPK produce significantly larger panicle, number of grains/ panicle and test weight than the 100 % NPK. This may be due to better crop growth in the treatments of integration which will affect photosynthesis and thereby these yield attributing characters. With exception of number of grains/ ear during 2010-11, rest of the yield attributing characters of wheat i.e. ear length, number of grains /ear and test weight were affected significantly by different treatments. The ear length varied significantly due to application of super optimal level of NPK while such effect was not noticed in case of number of grains / ear and test weight although slightly higher values were found with higher NPK levels. With few exceptions number of grains / ear and test weight was more or less similar in the most of the treatments of integration. Only these characters were slightly higher in T_9 and T_{12} than T_1. Application of DE along with graded dose of NPK produced slightly larger ear than 100 % NPK Tripathi *et al.* (2007) also reported a significant effect of DE application along with nitrogen on test weight of wheat and rice. Chatterjee *et al.* (2003) also reported a significant effect of distillery and paper mill effluent application over 100 % NPK on test weight of rice. The yield attributing characters of rice and wheat are presented in Table 2.

The dry matter accumulation by rice plant increase consistently. Maximum dry matter was accumulated after 60 DAT. At 30 DAT dry matter accumulation did not varied significantly due to application of super optimal level of NPK during 2009 but a significant effect were notice during 2010. At 60 DAT dry matter accumulation varied significantly due to application of super optimal level of NPK but no such effect was noticed up to 125 % NPK. Dry matter accumulation increase significantly in most cases over 100 % NPK due to application of different level of DE along with graded levels of NPK.

Total biomass yield also increases significantly due to application of super optimal levels of NPK. In all cases application of DE along with variable dose of NPK yielded significantly higher biomass than 100 % NPK. In general biomass increased with the application increasing DE levels at a particular level.

Table.1 Effect of different treatments on growth parameters of rice and wheat

Treatments	Plant height Rice (cm)						Plant height Wheat (cm)						No. of tillers/meter row length Rice						No. of tillers/meter row length Wheat					
	30 DAT		60 DAT		At harvest		30 DAS		60 DAS		At harvest		30 DAT		60 DAT		At harvest		30 DAS		60 DAS		At harvest	
	2009	2010	2009	2010	2009	2010	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009	2010	2009	2010	2009	2010	2009-10	2010-11	2009-10	2010- 11	2009-10	2010-11
T_1	49.25	50.63	73.87	82.87	88.67	94.33	18.27	11.73	25.30	25.87	70.87	86.87	25.67	43.67	32.33	48.00	24.00	39.00	92.33	101.33	107.00	114.00	82.67	88.33
T_2	50.28	55.90	75.47	88.67	92.10	97.00	18.47	15.67	29.67	31.60	77.93	89.87	34.33	45.33	36.67	54.33	32.33	47.67	101.67	110.67	115.00	130.00	84.33	91.67
T_3	51.08	60.77	77.53	97.13	98.97	99.27	18.67	16.87	29.93	38.00	81.47	92.33	42.67	49.00	44.33	62.67	41.67	50.00	113.00	129.00	126.67	151.67	98.33	100.33
T_4	52.83	63.27	78.07	84.67	94.87	96.73	20.00	16.53	30.27	32.33	80.93	87.07	32.00	50.33	47.00	53.67	35.67	42.33	95.33	105.67	110.00	130.67	85.67	102.67
T_5	53.35	69.13	82.40	90.93	98.87	98.93	20.47	17.73	30.40	41.33	83.40	89.93	41.67	51.00	53.00	57.67	43.00	48.00	103.67	116.33	112.00	142.67	88.00	103.00
T_6	53.86	67.70	87.33	97.17	99.03	101.13	20.67	17.33	31.00	49.00	84.80	92.47	53.00	54.00	58.33	59.67	48.67	54.67	118.33	134.00	132.33	157.33	99.00	106.00
T_7	54.35	64.33	83.20	86.73	97.73	99.87	20.47	19.73	31.20	37.07	85.73	90.60	39.33	53.00	51.67	56.00	41.00	50.00	105.67	111.00	128.00	145.67	91.33	109.00
T_8	55.88	68.50	84.87	92.27	100.67	101.07	20.80	19.40	32.33	48.57	85.80	91.33	49.67	55.67	54.33	61.33	47.00	52.00	116.33	121.33	130.00	149.00	99.33	110.33
T_9	56.85	71.50	88.67	99.40	101.40	102.40	20.87	19.87	32.80	56.67	88.53	93.27	56.67	63.33	61.33	67.00	51.00	58.33	121.33	138.33	133.67	161.00	101.33	112.67
T_{10}	55.44	65.13	85.73	87.80	101.53	102.13	21.20	19.47	34.73	57.07	86.60	91.93	50.67	53.67	52.00	59.00	45.67	51.33	109.67	119.33	128.00	156.67	95.00	110.33
T_{11}	56.78	72.33	87.67	95.87	103.53	108.60	21.47	21.00	36.07	60.47	87.00	94.13	51.33	57.67	55.33	65.67	48.67	53.67	118.33	124.00	135.33	160.00	101.00	115.33
T_{12}	57.89	74.77	90.67	106.47	107.67	110.07	22.33	20.07	37.07	69.87	92.00	95.13	57.33	67.00	63.00	72.00	51.33	61.00	125.67	147.00	141.00	167.00	109.33	118.67
SEm ±	1.13	3.42	1.87	4.46	2.17	2.28	0.60	1.34	1.35	6.76	3.29	0.80	6.31	2.40	5.88	2.92	5.46	1.79	2.10	2.45	2.39	2.61	2.66	
CD 5%	3.34	10.11	5.52	13.17	6.39	6.73	1.77	3.95	3.99	19.95	9.71	2.36	18.61	7.08	17.34	8.60	16.11	5.29	6.21	7.24	7.07	7.72	7.84	NS

Table.3 Effect of different treatments on dry matter accumulation and yield of rice and wheat

Treatments	Dry matter accumulation (q/ha) of rice										Dry matter accumulation (q/ha) of wheat									
	30 DAT		60 DAT		At harvest						30 DAS		60 DAS		At harvest					
					Biomass yield		Grain yield		Straw yield						Grain yield		Straw yield		Biomass yield	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
T_1	10.67	17.33	19.33	37.83	115.30	115.83	42.70	42.83	72.60	73.00	3.10	3.23	9.72	11.70	46.50	46.67	66.33	66.67	112.83	113.33
T_2	11.33	20.17	22.33	40.67	119.40	120.00	44.03	44.33	75.37	75.67	3.26	3.50	10.09	13.20	49.83	50.08	79.76	80.08	129.60	130.17
T_3	13.00	21.33	30.67	44.17	123.04	123.67	45.61	46.00	77.44	77.67	4.15	6.97	11.93	16.80	52.33	52.67	82.08	82.92	134.42	135.58
T_4	11.67	21.50	37.00	41.33	123.30	125.00	47.37	48.33	75.94	76.67	3.90	6.90	10.82	12.90	47.67	47.83	79.33	79.83	127.00	127.67
T_5	13.33	22.83	40.00	45.83	126.59	127.90	48.63	49.83	77.96	78.07	4.50	7.17	12.90	15.90	51.42	51.83	83.75	83.83	135.17	135.67
T_6	14.33	23.33	42.00	49.33	128.88	130.33	49.81	51.00	79.07	79.33	6.30	7.20	13.05	17.40	54.00	54.67	91.50	91.67	145.50	146.33
T_7	12.17	22.17	38.00	49.50	127.15	130.00	49.22	51.33	77.93	78.67	4.12	7.23	12.19	13.20	48.50	48.58	81.92	82.17	130.42	130.75
T_8	14.00	24.33	41.67	51.33	137.24	138.00	51.78	52.33	85.46	85.67	5.40	7.27	13.35	16.20	51.92	52.00	84.50	84.83	136.42	136.83
T_9	14.67	25.50	42.33	54.83	140.50	140.83	52.94	53.00	87.57	87.83	7.05	7.47	13.65	17.70	54.17	54.75	92.83	93.17	147.00	147.92
T_{10}	15.33	24.50	40.33	53.83	135.72	138.57	51.22	53.50	84.50	85.07	4.70	7.50	13.47	16.50	51.25	51.83	87.17	87.50	138.42	139.33
T_{11}	20.33	26.33	42.00	55.33	139.72	140.67	53.41	54.00	86.31	86.67	6.45	8.40	13.80	17.40	52.75	53.00	88.75	88.92	141.50	141.92
T_{12}	26.67	28.17	45.67	58.83	142.97	143.33	54.53	54.67	88.44	88.67	7.95	7.80	14.57	18.30	55.17	55.42	93.67	93.92	148.83	149.33
SEm ±	1.25	0.88	3.54	1.32	2.12	1.57	1.15	0.90	1.22	1.38	0.80	0.53	0.88	1.19	0.93	1.42	2.79	2.41	3.07	3.06
CD at 5 %	3.70	2.60	10.44	3.91	6.26	4.62	3.39	2.64	3.61	4.07	2.35	1.55	2.58	3.50	2.74	4.18	8.23	7.13	9.06	9.03

Table.2 Effect of different treatments on yield attributing characters of rice and wheat

Treatments	Rice						Wheat					
	Length of panicle(cm)		No. of grain/ Panicle		Test wt.1000 grain (g)		Length of ear (cm)		No. of grain/ ear		Test wt.1000 grain (g)	
	2009	2010	2009	2010	2009	2010	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
T_1	24.82	25.20	79.67	86.00	21.13	21.50	9.35	12.00	27.43	28.97	40.04	40.83
T_2	25.05	25.44	86.33	90.67	21.93	22.10	10.90	13.83	27.60	29.90	41.57	41.63
T_3	25.60	25.72	99.33	101.00	22.20	22.40	13.45	13.50	27.73	30.02	41.92	42.00
T_4	25.51	25.80	90.00	92.00	23.83	23.93	10.30	12.98	27.17	29.17	41.17	41.73
T_5	25.75	25.84	94.67	97.67	24.13	24.33	13.68	13.70	27.83	29.60	42.10	42.30
T_6	26.57	26.62	105.67	107.67	24.53	24.63	13.75	14.00	28.60	29.43	43.60	43.83
T_7	25.71	25.95	101.00	101.00	24.20	24.77	12.84	13.70	28.33	29.60	41.30	41.80
T_8	26.12	26.43	106.00	109.33	25.13	25.23	13.75	13.77	29.43	30.07	42.87	42.93
T_9	26.61	26.73	112.67	114.67	25.40	25.70	13.86	14.03	30.20	30.17	43.77	43.87
T_{10}	26.17	26.18	108.33	109.00	24.93	25.27	13.38	14.03	28.97	30.17	41.53	41.93
T_{11}	26.92	27.04	110.67	121.33	25.47	26.07	13.90	14.07	29.83	30.43	43.20	43.37
T_{12}	27.72	27.90	119.33	130.00	26.27	26.57	13.88	14.57	30.23	30.70	43.97	44.20
SEm ±	0.52	0.48	5.40	7.25	0.48	0.69	0.31	0.33	0.80		1.26	0.95
CD at 5 %	1.53	1.41	15.93	21.41	1.41	2.05	0.92	0.96	2.37	NS	3.73	2.80

Grain yield of rice did not varied significantly between 100 and 125% NPK. However, 150% NPK yielded significantly higher than 100% NPK. The application of DE along with higher levels of NPK yielded significantly higher grain yielded than 100% NPK. Application of 20, 40 and 60 m^3/ha DE along with 100% NPK yielded 16.7, 24.0, 27.7 percent higher yield respectively than 100% NPK during 2009 and 12.8 23.7 and 27.6 percent during 2010. Straw yield of rice also remain unaffected due to application of 100 and 125% NPK a significant effect of 50% additional NPK over 100% NPK was observed. With exception of T_4 rest of the treatments of inter integration produce significantly higher straw yield than 100% NPK. Straw and grain yield increased consistently due to application increasing DE level at a particular nutrient level. The higher biomass accumulation and yield in these treatments can be explain due to better growth in the form of plant height and tiller density and better yield attributing characters. Chatterjee *et al.* (2003) and Tripathi (2007) also reported significantly higher biomass and grain yield of rice of wheat due to application of effluent over 100% NPK

Dry matter accumulation in wheat was also affected significantly by different treatments at different day's interval. Maximum dry matter was accumulated after 60 DAS At 30 DAS dry matter accumulation did not varied significantly due to application of super optimal levels of NPK during 2009-10 while a significant effect was noticed during 2010-11 and application of 150% NPK produced significantly higher dry matter than 100 and 125% NPK. At 60 DAS dry matter accumulation did not varied significantly due to application of super optimal level of NPK over optimal level of NPK during 2009-10 however, a significant effect was noticed during 2010-11. At 30 as well as 60 DAS dry matter accumulation increase significantly due to application of DE over

100% NPK during 2009-10 and 2010-11. The dry matter accumulation and yield of rice and wheat are presented in Table 3.

Biomass yield during 2009-10 and 2010-11 varied significantly due to application of super optimal levels of NPK over optimal levels. All the treatments consisting application of DE were found significantly better than T_1 where only 100% NPK applied. The Application effect of a particular level of DE at with 50 and 75% NPK was similar but significantly higher biomass was produced due to the application of DE with 100% NPK.

Grain yield increased significantly due to application of additional 25% NPK over 100% during 2009-10. The grain yield obtain due to application of DE with graded levels of NPK was either statistical at par or significantly higher than T_1 (100% NPK). The effect of increasing DE dose application at a particular NPK levels was non-significant. Grain yield increased by 16.1 and 17.1% during 2009-10 and 2010-11 respectively due to application of 20 m^3/ha DE over 100% NPK.

Straw yield increase significantly up to 125% NPK during both the years. All the treatments consisting application of DE produced significantly higher straw yield than T_1 (100% NPK). The application effect of a particular level of DE 50 and 75% NPK on straw yield was similar but a significantly higher straw yield was obtained with the application of 100% NPK and DE than 50% NPK and DE. The variation in dry matter accumulation and grain as well as straw yield may be supposed due to better crop growth either through increased NPK levels or application of DE which contains essential plant nutrients. The application of DE to the also affect the microbial activity in the soil positively and there was the transformation of the various nutrient in the soil and their availability crop. The similar results were also reported by Kolar and Mitiska (1965).

The application of inorganic fertilizer in the presence of distillery effluent was highly beneficial to rice and wheat crop. Pre-sowing irrigation with (spent wash methanated) distillery effluent along with inorganic fertilizers proved most effective in increasing the grain and straw yields of rice and wheat crop. The application of distillery effluent led to significant changes in the composition of major and minor nutrients in both rice and wheat grain and straw.

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