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ORIGINAL ARTICLE **OPEN ACCESS**

Impact of distillery effluent (spent wash methanated) application as pre sown irrigation with inorganic fertilizers on nutrient content of wheat (*Triticum aestivum*) crop

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ABSTRACT

Studies were conducted to know the response of wheat to application of different doses of distillery effluent on nutrient content in wheat crop for two consecutive rabi seasons of 2009-2010 and 2010-2011. Two years results indicated that the application of 75% recommended dose of NPK and 40 m3/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 nutrient contents in plants showed significant variation due to application of additional 50 % NPK over recommended dose during both the years. Nutrient content varied significantly due to application of a particular level of DE along with different NPK levels during both the years, although higher values were recorded with the application of higher level of NPK. Almost nutrient content of wheat at different day's interval was affected by different treatments. The nutrient content of plant sample decrease with the increased of plant growth. The study concluded that the application of inorganic fertilizer in the presence of distillery effluent was highly beneficial to wheat crop. Pre-sowing irrigation with (spent wash methenated) distillery effluent along with inorganic fertilizers proved most effective in increasing the grain and straw yields of wheat crop. The application of distillery effluent led to significant changes in the composition of major nutrients in wheat grain, straw and biomass.

Keywords: *distillery effluent, methanation, wheat, soil properties, nutrient content*

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INTRODUCTION

Distilleries producing alcohol from molasses would be considered as one of the most polluting agrobased industries. They generate large volume of foul smelling coloured wastewater, known as spent wash or stillage, with high organic load. In order to lower down the high biochemical oxygen demand (BOD) and chemical oxygen demand (COD) level, presently many distilleries are recycling this effluent for getting fuel in the form of methane [1]. The post methylation effluents still have considerable organic and salt load making its disposal a problem. The effluent contains potassium and sulphur in appreciable amounts along with nitrogen and phosphorus. If the effluent is used after proper dilution, it can be used for irrigation. Crops show good response to distillery effluent application [1, 2, 3, 4]. Dongale and Savant [5] opined that spent wash was as good as murate of potash as a source of potassium for sorghum. Kulkarni *et al.* (6) classified spent wash as dilute liquid organic fertilizer with high potassium contents and its nitrogen was mostly in colloidal form behaving as a slow release fertilizer better than most inorganic nitrogen sources. Water retaining characteristics of the soil has also been found to improve with distillery effluent application [4, 7]. Singh *et al.* (8) found that addition of spent wash without dilution was very effective in increasing water intake rate of sodic calcareous soil. However, Jagdale and Savant [9] indicated that non-judicious use of spent wash might adversely affect the crop growth and soil properties by increasing soil salinity. Jadhav and Savant [3] also noticed the adverse effect of water retention, hydraulic conductivity and water stable aggregates of soil with the application of spent wash in higher amount. However, most of the report on the use of distillery effluent in agriculture is based on incubation or pot culture studies whereas the effect is expected to be different when applied in field. Use of distillery effluent in agriculture is controversial as several researchers [1, 2, 3, 4] reported its beneficial effect on crop yield. While many other researches [3, 9] conducted by Central Pollution Control Board of India (personal communication) considered to be harmful. Therefore, field experiments were conducted to study the effect of soil amendment with distillery effluent on the yield of wheat and rice and its impact on soil properties.

MATERIAL AND METHODS

Distillery effluent (Spent wash methylated), collected from distillery division of Bajaj Hindusthan Limited unit Kinauni, Meerut was characterized by standard methods. Each parameter was compared with respective critical levels recommended for on land application. Matching effluent characteristics with relevant properties of dominant soil types, effluent was found suitable for use in acidic and preferably low saline land surface. A field experiment was carried out growing *rabi* season in sandy clay loam soil in 2009-10 and 2010-11 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 wheat crop at the experimental farm of Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology Modipuram, Meerut (Uttar Pradesh). The wheat variety PBW-343 was chosen for crop production with row to row spacing 22.5 cm. 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) [10] soil pH (7.18), soil EC (0.302 dSm^{-1}) [11] low in available nitrogen (123.80 kg/ha) [12] organic carbon (2.95 g/kg), medium in phosphorus (51.48 kg/ha) [13], 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 [14] 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. The treatment was applied in the fixed plots of 5 x 4 m size. Distillery effluent was applied by pre-plant (21 days before sowing) to give sufficient time for the natural oxidation of organic matter present in distillery effluent. Recommended dose of N P and K 150, 60, and 40 kg ha^{-1} was applied for wheat crops through urea, diammonium phosphate and muriate of potash. Full amount of phosphorus and potassium along with 50 % of nitrogen as per the treatments was applied before sowing of wheat crop. Rest amount of nitrogen as per treatment was applied in two equal split at 30 and 60 DAS for wheat crop.

RESULT AND DISCUSSION

Nitrogen content

Nitrogen content in wheat was significantly affected by different treatments during 2009-10 and 2010-11. At 30 and 60 DAS plant N content did not varied significantly due to application of additional 25% NPK over 100% NPK while a significant effect of additional 50% NPK application was noticed. In most cases the treatments consisting DE application showed significantly higher plant N content than the treatment consisting 100% NPK. The nitrogen content at 30 DAS varied significantly due to application of a particular level of DE along with different NPK levels during both the years. The application effect of 20 and 40 m^3/ha DE along with a particular NPK levels was found statistically similar DE during both the years but such effect was not noticed with higher dose of DE (Table 1). The treatment consisting application of DE along with graded dose of NPK showed a significantly higher plant N content than T_1 (100% NPK) during both the years. The application effect of a particular level of DE with 50 and 75% NPK on plant N content was similar and significantly lower than the combination of 100% NPK and DE.

Biomass N content did not varied significantly due to additional application of NPK over recommended NPK level during 2009-10 while a significant effect of additional 50% NPK application was noticed during

2010-11. Nitrogen content of biomass produced by the application of different level of DE and 100% NPK from the N content of plant treated with 100% NPK.

Nitrogen content in wheat grain did not varied significantly due to additional application of 25% NPK over optimal level but additional 50% NPK application resulted in a significant effect during both the years. The N content of the grain receiving 75 or 100% NPK along with different levels of DE was significantly higher than T1 (100% NPK) in most cases. Nitrogen content in straw remained unaffected by different treatments during 2009-10 while a significant effect was noticed during 2010-11. Straw nitrogen content did not varied significantly due to application of super optimal level of NPK over optimal during 2010-11 with exception of T4 and T7 rest treatments showed significantly higher straw N content than T1, (100% NPK). The higher plant N content at different steps may be related with the nitrogen availability in soil with the higher N availability higher plant N is well expected in the super optimal treatments. Kalaiselvi and Mahimairaja [15] also reported greater amount of NH4-N and NO3-N is soil receiving 120 m3 of DE with the recommended dose of NP fertilizers. Results shows that the DE not only adds mineral N (NH4-N and NO3-N) to soil, but also promotes the mineralization of soil organic N, thus resulting in larger amounts of NH4-N and NO3-N in soil.

Phosphorus content

At 30 DAS phosphorus content of wheat remained unaffected due to application of different treatments during 2009-10 while a significant effect was noticed during 2010-11. Phosphorus content did not varied significantly due to application of additional 25% NPK over 100% NPK while a significant effect of additional 50% NPK application was noticed during 2010-11. In most cases the treatment consisting DE application showed significantly higher phosphorus content than the 100% NPK. The application effect of a particular level of DE with different NPK levels was almost similar.

At 60 DAS phosphorus content of wheat did not varied due to different treatments during 2009-10 while a significant effect was noticed during 2010-11. Phosphorus content remained unaffected due to application of additional 50% NPK over recommended dose of NPK during 2010-11. The application effect of a different levels of DE with 50% NPK was almost similar with few exception plant P content was almost similar in treatments consisting a particular DE level with graded NPK levels (Table 2). Phosphorus content of wheat biomass was affected significantly by different treatments during both the years. Phosphorus content varied significantly due to the application of super optimal level of NPK over recommended dose of NPK during 2009-10 while remained unaffected during 2010-11. The application effect of a particular level of DE with 100% NPK on biomass content was significantly higher than 50% NPK.

Phosphorus content of wheat grain remained unaffected due to application of different treatments during both the years. In general phosphorus content in grain increased with the increasing level of DE and NPK levels during both the years. Phosphorus content of wheat straw under different treatments remained unaffected during 2009-10 while a significant effect was noticed during 2010-11. Phosphorus content did not varied significantly due to application of additional 50% NPK over recommended dose of NPK. The application effect of a particular level of DE with 100% NPK was significantly higher than 100% NPK in respect of plant P content. Plant P content at some growth stage remained unaffected under different treatments while in some cases different significantly. This may be explained due to very less variability in soil available P at different stages during 2009-10 to while a slightly higher variability among the different treatments might have resulted in a significant variation in plant P content during 2010-11.

Potassium content

Potassium content of wheat plant at 30 DAS was affected significantly due to application of different treatments during both the years. Potassium content increased significantly due to application of super optimal level of NPK. In all cases application of DE along with variable dose of NPK resulted significantly higher potassium content than 100 % NPK during both the years. In general potassium content increased with the application of increasing DE levels at a particular level. At 60 DAS potassium content was affected significantly due to application of different treatments during both the years. Potassium content remained unaffected due to application of super optimal level of NPK over 100 % NPK during 2009-10 while a significant effect was noticed during 2010-11 with few exception, potassium content of wheat plant with the application of various doses of NPK and DE was found significantly higher than 100 % NPK (Table 3).

Potassium content of wheat biomass was affected significantly due to application of different treatments. Potassium content did not varied significantly due to application of additional 25 % NPK over 100 % NPK while a significant effect of 50 % NPK application was noticed during 2009-10 while a significant effect was found due to application of additional 50 and 25 % NPK over 100 % NPK during 2010-11 with few exception potassium content of biomass with the application of various doses of NPK with DE was found significantly higher than the 100 % NPK.

Potassium content of wheat grain and straw was significantly affected by different treatments during both the years. Grain and straw potassium content did not varied significantly due to application of additional 25 % NPK over 100 % NPK during both the years. Application of 50 % additional NPK resulted in significantly higher grain potassium content during 2010-11 and straw potassium content during both the years. Grain and straw potassium content varied significantly from T_1due to application of DE with 100 % NPK. The application of a particular DE level with 50 and 75 % NPK on grain and straw potassium content was similar but significantly higher potassium content was noticed due to application of 100 % NPK and DE than 50 % NPK and DE. Since the DE contain a substantial amount of potassium its application in soil as pre sown irrigation will enrich the soil potassium (as evidence by higher availability in soil) and thereby more availability to plant which will cause higher plant potassium content. Although the effect of undiluted application of distillery effluent had been reported by the Khosla [16] and Sahai *et al.* [17] but suitable dilution had significantly improved in N, P and K content of wheat Sukanya and Meli [18]. Since in the present study DE application as pre sown irrigation had been made at 20, 40 and 60 m^3/ha. The ratio of DE to irrigation water is 0.04, 0.06 and 0.12 respectively which is very low therefore it will leave a positive effect on availability of these nutrients in soil.

Table 1. Effect of different treatments on nitrogen content in wheat crop at different days of interval

Treatment	30 DAS		60 DAS		At harvest					
					Grain		Straw		Biomass	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
T1	1.30	1.33	1.15	1.17	1.80	1.83	0.25	0.28	0.82	0.92
T2	1.32	1.35	1.18	1.21	1.87	1.90	0.27	0.30	0.83	0.92
T3	1.35	1.39	1.22	1.25	1.99	2.02	0.28	0.31	0.88	0.98
T4	1.31	1.36	1.17	1.20	1.83	1.87	0.26	0.33	0.78	0.91
T5	1.36	1.40	1.20	1.24	1.89	1.92	0.27	0.35	0.85	0.95
T6	1.40	1.44	1.25	1.30	2.03	2.06	0.28	0.37	0.94	1.00
T7	1.33	1.38	1.18	1.24	1.84	1.89	0.26	0.34	0.82	0.92
T8	1.38	1.43	1.23	1.27	1.92	1.95	0.28	0.37	0.90	0.97
T9	1.42	1.47	1.28	1.34	2.12	2.15	0.30	0.39	0.96	1.04
T10	1.38	1.41	1.21	1.26	1.86	1.90	0.27	0.35	0.83	0.93
T11	1.41	1.46	1.24	1.31	1.96	1.98	0.29	0.39	0.95	0.98
T12	1.45	1.50	1.30	1.36	2.20	2.23	0.31	0.43	0.98	1.10
SEm ±	0.01	0.01	0.01	0.01	0.03	0.03		0.02	0.02	0.01
CD at 5 %	0.024	0.03	0.038	0.05	0.09	0.09	NS	0.06	0.06	0.05

Table 2. Effect of different treatments on phosphorus content in wheat crop at different days of interval

Treatment	30 DAS		60 DAS		At harvest					
					Grain		Straw		Biomass	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
T1	0.32	0.34	0.26	0.29	0.32	0.34	0.16	0.18	0.15	0.25
T2	0.33	0.38	0.27	0.31	0.34	0.37	0.17	0.20	0.16	0.27
T3	0.38	0.42	0.30	0.34	0.35	0.40	0.20	0.21	0.21	0.29
T4	0.34	0.37	0.27	0.32	0.33	0.36	0.17	0.20	0.19	0.26
T5	0.36	0.41	0.28	0.35	0.35	0.39	0.18	0.23	0.21	0.29
T6	0.4	0.45	0.31	0.36	0.36	0.43	0.21	0.25	0.26	0.32
T7	0.37	0.41	0.27	0.34	0.35	0.39	0.18	0.23	0.24	0.29
T8	0.38	0.44	0.29	0.38	0.37	0.42	0.19	0.24	0.26	0.31
T9	0.41	0.48	0.32	0.40	0.39	0.44	0.22	0.26	0.29	0.33
T10	0.37	0.43	0.28	0.37	0.36	0.41	0.18	0.24	0.25	0.30
T11	0.39	0.46	0.29	0.41	0.38	0.43	0.20	0.26	0.28	0.33
T12	0.42	0.49	0.32	0.42	0.40	0.46	0.22	0.29	0.30	0.35
SEm ±		0.02		0.02				0.02	0.015	0.01
CD at 5 %	NS	0.07	NS	0.05	NS	NS	NS	0.06	0.044	0.05

Table 3. Effect of different treatments on potassium content in wheat crop at different days of interval

Treatments	30 DAS		60 DAS		At harvest					
					Grain		Straw		Biomass	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
T1	2.20	2.25	1.70	1.73	0.40	0.43	1.24	1.26	0.90	0.92
T2	2.44	2.46	1.73	1.76	0.43	0.47	1.27	1.30	0.94	0.98
T3	2.51	2.54	1.85	1.87	0.45	0.48	1.30	1.33	0.97	1.00
T4	2.32	2.36	1.71	1.75	0.41	0.45	1.25	1.28	0.94	0.97
T5	2.47	2.50	1.85	1.87	0.46	0.50	1.29	1.33	0.98	1.01
T6	2.59	2.61	1.92	1.95	0.48	0.53	1.32	1.38	1.01	1.06
T7	2.35	2.38	1.72	1.77	0.43	0.48	1.26	1.32	0.95	1.01
T8	2.50	2.54	1.87	1.90	0.49	0.52	1.31	1.36	1.00	1.04
T9	2.65	2.68	1.96	1.99	0.52	0.56	1.34	1.41	1.04	1.09
T10	2.49	2.52	1.83	1.85	0.44	0.51	1.28	1.35	0.97	1.04
T11	2.66	2.69	1.91	1.95	0.50	0.53	1.33	1.40	1.02	1.08
T12	2.70	2.73	2.00	2.05	0.55	0.58	1.35	1.43	1.05	1.12
SEm ±	0.028	0.02	0.05	0.02	0.02	0.01	0.01	0.02	0.01	0.01
CD at 5 %	0.084	0.06	0.16	0.06	0.06	0.04	0.04	0.06	0.04	0.05

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