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RESEARCH ARTICLE

EFFECT OF DISTILLERY WASTE ON SEED GERMINATION AND SEEDLING GROWTH AND ITS CONSEQUENTIAL EFFECT ON WHEAT YIELDS AND NITROGEN UPTAKE UNDER FIELD CONDITON

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ABSTRACT

Results of the studies conducted on seed germination and seedling growth of wheat, as affected by distillery waste have been incorporated. Seeds were kept for germination in petridishes and treated with eight different concentrations of the effluent (1,2.5,5,10,25,50,75 and 100 per cent). The undiluted effluent was lethal and its toxicity was reduced with dilution. The cent per cent germination was recorded up to 10% effluent concentration. The speed of germination index, however decreased progressively with increase in effluent concentration and it was more marker beyond 10% treatment. The length of radical and plumule, seedling biomass and the first leaf area was favourably affected by the lower concentrations of the effluent. It is concluded that distillery effluent after proper dilution can be used for irrigation. These observations were validated under field condition as well. Reclaimed alkali soil when treated with varying levels of distillery waste (0,1,2,4 t hac^{-1}) followed with submergence of field with good quality water revealed that distillery waste application @ 2 t ha^{-1} followed with water submergence responded to significantly higher wheat yield and N uptake.

Key Words : effluent, seedling growth, spent wash.

The disposal of industrial effluents is now becoming a serious problem all over the world. In India, for example, approximately 40 million tonnes of distillery spent wash are discharged annually from 285 distilleries. These waste waters are commonly discharged on land or nearby water bodies thus causing land or water pollution.

"Saraya Distillery" of Sardarnagar (District Gorakhpur) is a big industrial unit in which distilled spirit, rum, whisky and other alcoholic liquors are produced. The effluent from the distillery is discharged through an open drain into "Biacy Stream". During the course of its movement the effluent pollutes the soil of the adjacent crop fields by seepage and overflow causing heavy

damage to the crops growing therein. In the present investigation an attempt has been made to assess the extent of damage that is caused to wheat crop (var. Raj-3077.) in its initial stages of growth, by the effluent.

MATERIALS AND METHODS

In the present study effect of 1,2.5,5,10,25,50, 75 and 100 percent of distillery effluent was seen on percentage germination, speed of germination index and early seedling growth of the test plant (wheat, var. Raj-3077) in Petri plates on filter papers as well as on soil.

Effluent from the main outlet was analysed for its various physico-chemical properties by the procedures outlined by APHA, AWWA & WPCF (1975).

To study the effect of the effluent on seed germination without soil a counted number of healthy and sterilized seeds were soaked in different concentration of the effluent for twenty four hours and were washed thoroughly with distilled water and kept for germination on the moist filter papers in the Petri-dishes (3.5" diameter). The filter papers were kept moistened with distilled water throughout the study period.

To study the effect of effluent on the seed germination on soil, 50 gram of sterlized soil was kept in each of the Petri-dishes and a counted number of seeds (100) are place on it. The soil in Petri-dishes was irrigated with 10 ml of different concentrations of the effluent, on an interval of three days. Three replicates were kept for each set. A control set was also kept for comparison. The emergence of plumule was taken as a criterion in wheat. The observations were recorded daily at a prefixed time and the germinated seeds were removed every day.

The speed of germination index (SGI) was calculated as per formula given by Carley and Watson (1968).

To study the effect of effluent on seedling growth, the germinated seeds were kept in separate Petri-dishes (both on filter paper and on soil) and irrigated daily with different concentrations of the effluent. The lengths of radical, plumule, seedling biomass and first leaf area were measured after a lapse of seven days.

A field experiment was also conducted on a newly reclaimed site with objective to identify the optimum dose of distillery waste which could be most effective in enhancing wheat yields. The pH of initial soil on an average was 8.9, electrical conductivity (EC) 1.5 dsm^{-1}, sodium saturation 20.5 (ESP). The soil was low in organic carbon (0.12%) and available N content (175 hq ha^{-1}). The experiment consisted of 4 levels of distillery waste application i.e. 0,1,2 & 4 t ha^{-1} followed with immediate submergence of treated plots with good quality water at pre sowing stope of wheat crops. Experimental design was randomized block with four replication and each sub plot with a size of 20sq.mt. N,P,K each were applied uniformly @ 120, 60, 60 kg ha^{-1}. Cultural operations, irrigation etc. were timely done and the crop was harvested at maturity. Plot wise yields of grain and straw were recorded and the samples of grains and straw were retained for chemical analysis. Uptake of nitrogen as influenced by treatments was computed on the basis of N concentration in grain and straw and the yield of grain and straw. Results emerging from the study are presented in tabe No. 1,2, & 3.

RESULTS AND DISCUSSION

The physico-chemical analyses of effluent as shown in Table 4. revealed that it was highly acidic, rich in calcium, chloride, bicarbonate, total nitrogen, total solids and organic pollutants which is reflected by its high BOD.

Figure 1. shows the germination percentage and speed of germination index of wheat grains irrigated by different concentrations of the effluent. The figure

Table 1 : Effect of graded doses of distillery waste application on grain & straw yield of wheat (Raj-3071)

Treatment (Distillery waste t ha^{-1})	Yield kg ha^{-1}		Increase in grain yield over control	Response ratio
	Grain	Straw		
0 (Control)	3510	8195	-	-
1	3580	8200	70	0.07
2	4000	9100	490	0.24
4	3785	8280	275	0.06
SE ±	1.95	3.00	-	-
CD at 5%	3.10	8.10	-	-

indicates that the cent per cent germination in wheat was recorded up to 10 per cent effluent concentration and decreased progressively in higher concentrations. The speed of germination index went on decreasing with increase in effluent concentration the decrease being more pronounced beyond 25 per cent concentration. The values of germination percentage were slightly lower in seed germinated on filter paper than on soil up to 25 per cent concentration but in higher concentration a reverse trend was observed. In pure effluent 5 and 3 per cent seeds were germinated with 30.5 and 32.0 speed of germination index but the seedlings could not survive for more than 4 days.

The figure 2. shows the length of radicle and plumule of one week old seedlings treated by different concentrations of the effluent. The figure reveals that on soil the length of radicle and plumule increased upto 5 percent concentration and on filter paper up to 10 per cent effluent concentration. On soil, however, the plumule length in 10 per cent effluent concentration was nearly the same as in 5 percent effluent concentration but radicle length was lower. The minimum length of radicle and plumule was recorded in set treated with 75 per cent effluent concentration.

The data of biomass and first leaf area of the seedlings as shown in (fig.3) indicate that the values of seedling biomass increased up to 5 per cent concentration on soil and up to 10 per cent concentration on filter paper. The first leaf area, however, increased

Table 2 : Effect of graded doses of distillery waste application on N content of leaves at heading and grain and straw of wheat at maturity

Treatment	% N Content		
Distillery waste (t ha^{-1})	Leaves at heading stage	Grain	Straw
0 (Control)	2.32	1.88	0.54
1	2.34	1.88	0.56
2	2.59	2.13	0.60
4	2.36	1.90	0.56
SE ±	0.10	0.05	.02
CD at 5%	0.21	0.12	.02

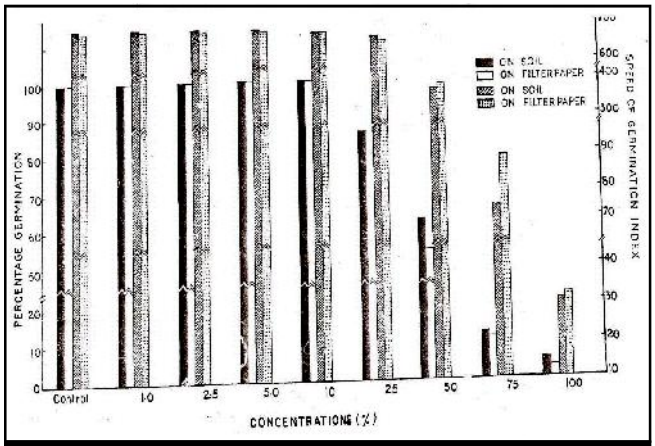

Fig 1 : Seed Germination and Speed of Germination Index of Triticum Aestivum L. in Various Effluent Concentrations

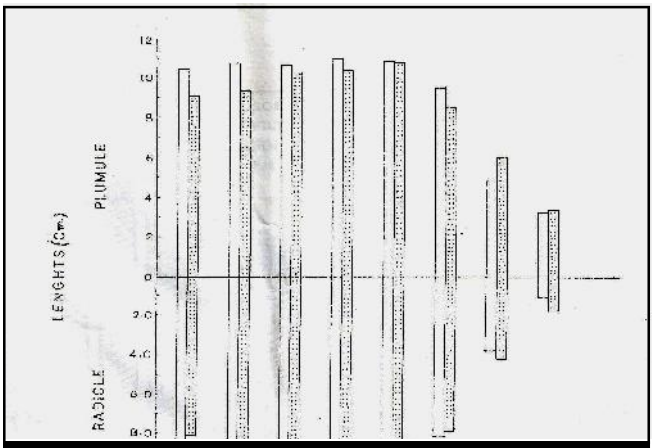

Fig 2 : Radicle and Plumule Lenghts of one Week Old Seedlings of Triticum Aestivum L.

Table 3 : Effect of graded doses of distillery waste application on uptake of N by wheat.

Treatment	N uptake (hg ha^{-1})		
Distillery waste (t ha^{-1})	Grain	Straw	Total
0 (Control)	65.98	44.25	110.23
1	67.30	45.92	113.22
2	85.50	54.60	140.10
4	68.11	46.36	114.47

up to 10 per cent effluent concentration both on soil and on filter paper. The values then decreased progressively in higher concentrations like other parameters.

The reduction in percentage germination and speed of germination index in the seeds treated with pure effluent and its higher concentrations was most probably because of the depletion in oxygen content and accumulation of high concentration of carbon-dioxide in the medium (Thabraj eg. al. 1964; Sahai et. al. 1983 & 1985 and Misra and Pandey, 2002). Further, high concentratin of salts of sodium, potassium and calcium as reported by Rajanan and Oblisamy (1979), would have also reduced the amount of available water to the seeds by increasing osmotic pressure of the medium.

The length of radicle and plumule, seedling biomass and the first leaf area was enhanced by the effluent in its lower concentrations (up to 10 cent). Pandey and Niraliya (2002) also found an increase in seedling growth in Bengal gram at lower concentration of the distillery effluent. These results are also in conformity with Sahai et al (1983 and 1985), Shinde and Trivedi (1983) and Joshi et. al. (1996).

Besides being highly polluting (Rita et. al. 2008), the spent wash in distilleries is a potential source of inorganic substances which are highly valuable as a source of nutrient material for plants (Jabeen, 1986). The concentration of these constituents should be reduced to beneficial level by diluting the effluent up to 10 per cent (volume/volume with water) and used for irrigation purpose as a substitute for liquid fertilizer.

Table 4: Physico-chemical characteristics of Sarya Distillery Waste.

Parameters	Value
Colour	Dark Brown
pH	4.6
Total solids (mg/l)	109000
Dissolved oxygen (mg/l)	Nil
BOD (mg/l)	32000
Bicarbonate (mg/l)	15000
Carbonates (mg/l)	Nil
Calcium (mg/l)	1875
Chloride (mg/l)	5000
Total nitrogen (mg/l)	205
Phosphate (mg/l)	21
Ammonia (mg/l)	30

Data presented in tables 1,2 & 3 revealed that average grain yield of wheat under control was 3510 kg per hectare which increased to the level of 3580, 4000 & 3785 kg ha^{-1} with application of destillery waste @ 0,1,2,4 t ha^{-1} followed with ponding plots with good quality water respectively. Apparently increase in grain yield due to treatments was significant upto distillery waste application @ 2 t ha^{-1} followed with appreciable decline in wheat yields to 3785 kg ha^{-1} when dose of distillery waste increased from 2 to 4 t ha^{-1}. Response to added distillery waste application at varying levels of its applications as compared to control was 70, 490, 275 being, maximum when applied @ 2 t ha^{-1}. Response to each kg of distillery waste application i.e. 1,2, 4 t ha^{-1} were of the order 0.07, 0.24, 0.06 respectively.

Like grain yields, concentration of N in leaves at heading, grain and straw at maturity increased markedly, being maximum in distillery waste application @ 2 t ha^{-1} as would be evident from observations presented in table 2 and 3.

On the basis of these of these results it is inferred that distillery waste application @ 2 t ha^{-1} followed with submergence of field with good quality water provide favourable soil ambient for enhanced germination and

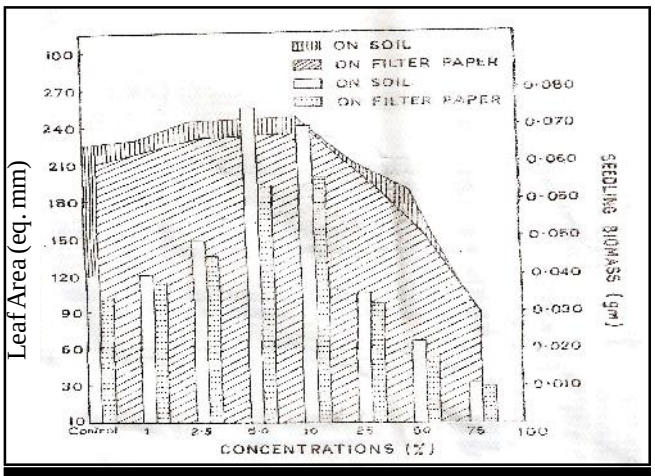

Fig 3 : First Leaf Area and Biomass of one Week old Seedlings of Triticum Aestivum L. in Various Effluent Concentrations

wheat crop nutrition which led to significant enhanced crop productivity.

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