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Effect of Distillery Spentwash on Yield Attributes and Quality of Groundnut Crop

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Abstract: Distillery spentwash is used in agriculture as a source of plant nutrients and irrigation water. Being plant originated the spentwash contains all plant nutrients and organic matter. The effect of different levels and methods of spentwash application on yield attributes and oil content was examined through a field experiment. The field experiment was conducted using Groundnut (*Arachis hypogea* L.) as a test crop at Research and Development Cane Farm, The Salem Co-operative Sugar Mills Ltd., Mohanur, Namakkal District. The different levels of spentwash was applied to the field in one time and continuous split doses of application. Among the spentwash applied plots, the plot which received spentwash equivalent to 120 m^3 ha^{-1} along with NP recorded the maximum values of the yield attributes *viz.,* number of gynophores, number of matured and immatured pods, 100 kernel weight, shelling percentage and number of nodules over the control. Similar to yield attributes, increase in the rate of application increased the protein and oil content significantly. The continuous application of split doses of spentwash was found better than one time application. The continuous supply of nutrients, greater uptake of nutrients and favourable physico-chemical condition existed in soil may be attributed for this.

Key words: Spentwash · Groundnut · Yield attributes · Protein · Oil content

INTRODUCTION

The biomethanated distillery spentwash is a nutrient rich liquid organic waste obtained from molasses based distillery industries after biomethanation process. Currently, about 40.72 million m^3 of spentwash is generated annually from Indian distilleries. The distillery spentwash is used as a source of plant nutrients and organic matter for various agricultural crops [1]. Agricultural utilization of distillery spentwash offers a low cost alternative. The presowing irrigations with distillery effluent had no adverse effect on the germination but improved the growth and yield [2]. In doing so, the manurial and irrigational potential of distillery spentwash invariably have a considerable economic value in the context of present energy and fertilizer nutrient crisis. It is also important that the environmental impact of the spentwash should be identified and efforts are needed to minimize such deleterious effects on plants, soil and environmental quality. The current study was, therefore, aimed at examining the impact of spentwash application on crops' yield attributes and quality parameters.

MATERIALS AND METHODS

Field Experiment: A field experiment was conducted using Groundnut (*Arachis hypogea* L.) as a test crop to examine the effect of spentwash on nutrient dynamics at Research and Development Cane Farm, The Salem Co-operative Sugar Mills Ltd., Mohanur, Namakkal, District Tamil Nadu, India during the rabi season (August 31, 2007 to December 11, 2007). The experimental soil was sandy loam in texture; taxonomically the soil belongs to the family *Typic Rhodustalfs*. A representative soil sample, at 0-15 cm depth, was collected from the experimental plot to determine the initial properties of the soil. The experiment was laid out in a split plot design with two main plots and eight sub plot treatments with three replications consisting of different levels of spentwash with and without NP fertilizers were allotted to plots of 13.5 m^2 size (6 m x 2.25 m) leaving 1 m between each replication for irrigation purpose following random principles.

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Treatment Details

Main Plots:

M_1 - One time application

M_2 - Continuous split doses of application

Sub Plots:

T_1 - Control

T_2 - RD of NP

T_3 - Spentwash @ 40 m^3 ha^{-1}

T_4 - Spentwash @ 40 m^3 ha^{-1}+ RD of NP

T_5 - Spentwash @ 80 m^3 ha^{-1}

T_6 - Spentwash @ 80 m^3 ha^{-1}+ RD of NP

T_7 - Spentwash @ 120 m^3 ha^{-1}

T_8 - Spentwash @ 120 m^3 ha^{-1}+ RD of NP

(RD – Recommended Dose)

The different levels of spentwash was applied to the field uniformly by spraying manually to each plot 15 days before sowing for first main plot treatment (M_1). In the second main plot treatment (M_2), the spentwash was applied in three equal splits along with irrigation water. The first split dose of spentwash was applied 15 days after sowing. The crop was supplied with N and P fertilizers, as per the treatments at the recommended dose of 17 and 34 kg ha^{-1}, respectively. The fertilizers were applied in the form of urea and single super phosphate. The K was entirely supplied through the spentwash. Sowing was done with groundnut seeds of TMV 7 by adopting a seed rate of 125 kg ha^{-1} and a spacing of 30 cm x 10 cm. All other routine cultural operations until the harvest of the crop were followed as per the recommendations of crop production guide of Tamil Nadu Agricultural University.

Yield Attributes: The total number of gynophores, number of matured pods and number of immatured pods per plant were counted in the plant samples at harvest. The hundred kernel weight was recorded from randomly selected kernels in each treatment and expressed in grams. The shelling percentage was calculated from randomly selected one hundred pods from each plot, the pods were weighed, shelled and the weight of the kernels was recorded. The number of nodules per plant was counted in the sample plants at harvest.

Oil Content: The oil content in groundnut kernels was determined using Nuclear Magnetic Resonance Spectrometer [3].

Seed Crude Protein Content: The seed samples were taken at random from each plot and analysed for total N by microkjeldhal method. The N content of the seed was multiplied by the factor 6.25 for getting the crude protein content of the seeds [4].

Statistical Analysis: The data on various characters studied during the investigation were statistically analysed by the method given by [5]. The critical difference was worked out at 5 per cent (0.05) probability levels.

RESULTS AND DISCUSSION

Effect on Yield Attributes: The yield attributes namely gynophores, number of matured and immatured pods, 100 kernel weight, shelling percentage and number of nodules in groundnut were significantly influenced by the different levels of spentwash (Table 1 and 2).

The number of gynophores ranged between 24.9 and 37.8 per plant due to one time application (M_1); whereas, it was between 25.1 and 40.1 per plant due to continuous application of split doses of spentwash (M_2). Irrespective of the methods of application increase in the rate of spentwash had significantly increased the number of gynophores and the largest number was observed due to the application of spentwash at the rate of 120 m^3 ha^{-1} plus NP fertilizer (T_8). The application of recommended dose of NP fertilizers had significant influence on gynophores. Continuous application of split doses of spentwash produced more number of gynophores per plant than one time application of spentwash. The interaction effect of methods of application and different levels of spentwash was significant.

The number of matured and immatured pods ranged from 16.0 to 23.5 and 3.2 to 4.1, respectively. Significant difference was observed between main plot treatments and also between sub-plot treatments. Application of different levels of spentwash markedly increased the number of matured pods and such effect was more pronounced when spentwash was applied in split doses continuously. Plants that didn't receive spentwash (control) had lesser number of matured pods (16); whereas, plants with the application of spentwash at the rate of 120 m^3 ha^{-1} plus recommended dose of NP fertilizers (T_8) had greater number of matured pods. However, the interaction effect of methods of application and the rate of spentwash was found non-significant.

Table 1: Effect of different levels of spent wash application on yield attributes of groundnut.

	No. of gynophores plant^{-1}			No. of matured pods plant^{-1}			No. of immatured pods plant^{-1}		
Treatments	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
T_1- Control	24.9	25.1	25.0	16.1	16.0	16.1	4.0	4.1	4.1
T_2 - NP alone	28.2	28.8	28.5	18.2	18.5	18.4	4.0	4.0	4.0
T_3 - Spentwash @ 40 m^3 ha^{-1}	26.0	30.2	28.1	19.9	20.5	20.2	4.3	3.9	4.1
T_4- Spentwash @ 40 m^3 ha^{-1}+ NP	31.5	35.1	33.3	21.9	22.8	22.4	3.8	3.6	3.7
T_5- Spentwash @ 80 m^3 ha^{-1}	28.0	32.6	30.3	20.3	21.9	21.1	4.2	3.7	4.0
T_6- Spentwash @ 80 m^3 ha^{-1} + NP	32.3	39.3	35.8	22.6	23.1	22.9	3.8	3.3	3.6
T_7- Spentwash @ 120 m^3 ha^{-1}	29.8	33.7	31.8	21.1	22.2	21.7	3.9	3.8	3.9
T_8- Spentwash @ 120 m^3 ha^{-1}+ NP	37.8	40.1	39.0	22.8	23.5	23.2	3.6	3.2	3.4
Mean	29.8	33.1	31.5	20.4	21.1	20.7	4.0	3.7	3.8
	SEd		CD (0.05)	SEd		CD (0.05)	SEd		CD (0.05)
T	0.89		1.90	0.57		1.22	0.11		0.23
M	0.48		1.02	0.32		0.67	0.06		0.13
T x M	1.31		2.78	0.85		NS	0.16		NS
M x T	1.36		2.88	0.90		NS	0.17		NS

M_1: One time application; M_2: Continuous application

Table 2: Effect of different levels of spentwash application on yield attributes of groundnut.

	100 kernel weight (g)			Shelling percentage			No. of nodules plant^{-1}		
Treatments	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
T_1- Control	33.1	33.2	33.1	67.1	66.4	66.8	32	32	32
T_2 - NP alone	33.2	33.5	33.4	67.6	67.7	67.7	37	39	38
T_3 - Spentwash @ 40 m^3 ha^{-1}	33.7	33.9	33.8	67.7	69.5	68.6	42	43	43
T_4- Spentwash @ 40 m^3 ha^{-1}+ NP	34.9	35.0	34.9	69.8	70.9	70.4	47	55	51
T_5- Spentwash @ 80 m^3 ha^{-1}	33.9	34.2	34.1	68.1	69.9	69.0	44	45	45
T_6- Spentwash @ 80 m^3 ha^{-1} + NP	34.0	35.6	34.8	70.5	71.2	70.9	49	58	54
T_7- Spentwash @ 120 m^3 ha^{-1}	34.0	34.5	34.3	68.5	70.0	69.3	46	49	48
T_8- Spentwash @ 120 m^3 ha^{-1}+ NP	35.1	35.9	35.5	70.9	71.4	71.2	51	62	57
Mean	34.0	34.5	34.2	68.8	69.6	69.2	44	48	46
	SEd		CD (0.05)	SEd		CD (0.05)	SEd		CD (0.05)
T	0.93		NS	1.89		NS	1.37		2.94
M	0.52		NS	1.05		NS	0.65		1.37
T x M	1.41		NS	2.83		NS	1.88		4.02
M x T	1.48		NS	2.98		NS	1.83		3.87

M_1: One time application; M_2: Continuous application

Table 3: Effect of different levels of spentwash application on quality characters of groundnut.

	Seed crude protein content (%)			Oil content (%)		
Treatments	M_1	M_2	Mean	M_1	M_2	Mean
T_1- Control	22.3	22.4	22.3	37.1	40.4	38.8
T_2 - NP alone	22.9	23.2	22.9	40.4	41.4	40.9
T_3 - Spentwash @ 40 m^3 ha^{-1}	23.4	24.0	23.4	41.0	42.2	41.6
T_4- Spentwash @ 40 m^3 ha^{-1}+ NP	24.4	24.9	24.4	42.6	43.3	42.9
T_5- Spentwash @ 80 m^3 ha^{-1}	23.7	24.1	23.7	41.0	41.8	41.4
T_6- Spentwash @ 80 m^3 ha^{-1} + NP	24.5	24.9	24.5	42.9	43.7	43.3
T_7- Spentwash @ 120 m^3 ha^{-1}	24.2	24.7	24.2	42.5	43.0	42.7
T_8- Spentwash @ 120 m^3 ha^{-1}+ NP	24.6	25.1	24.6	42.9	44.2	43.6
Mean	23.7	24.2	23.7	41.3	42.5	41.9
	SEd	CD (0.05)		SEd		CD (0.05)
T	0.65	1.39		0.52		1.12
M	0.37	NS		0.21		0.45
T x M	0.98	NS		0.67		NS
M x T	1.04	NS		0.60		NS

M_1: One time application; M_2: Continuous application

The spentwash application (rates and methods of application) also had significant effect on number of immatured pods present in the plants. Unlike matured pods the number of immatured pods was found reduced due to spentwash application. The number of immatured pods was relatively more (4-4.1 per plant) in control (T_1). In general, irrespective of methods of application, increase in the rate of spentwash resulted in marked reduction in the number of immatured pods and such reduction was relatively more due to continuous application (M_2) than one time application (M_1). The interaction effect was found non-significant.

The 100 kernel weight and the shelling percentage varied from 33.1 to 35.9 g and 66.4 to 71.4 per cent, respectively. The data have shown that both the methods of application (main plot treatments) and different levels of spentwash (sub plot treatments) had no significant effect on these parameters.

There were only 32 nodules observed in control plants; whereas, it ranged between 37 and 62 in plants that received spentwash application. Both the methods of application and the rate of spentwash had significant effect on number of nodules present. Irrespective of methods of application, increase in the rate of spentwash application significantly increased the number of nodules. It was more due to continuous application of split doses of spentwash (M_2) than due to one time application (M_1). The number of nodules was the greatest when spentwash was applied at a rate of 120 m^3 ha^{-1} plus NP fertilizers. Application of recommended dose of NP also had significantly increased the number of nodules present.

The results of the yield attributes revealed that the number of gynophores, number of matured and immatured pods, 100 kernel weight, shelling percentage and number of nodules, were enhanced significantly due to the application of spentwash over the control. Among the spentwash applied plots, the plot which received spentwash equivalent to 120 m^3 ha^{-1} along with NP recorded the maximum values. This might be due to the favourable effect of distillery spentwash, which enhanced the fertility status of soil and improved soil physical environment that might have promoted better germination, root proliferation, nutrient and water uptake by the crops [6]. [7] reported a significant increase in the number of productive tillers and yield of rice (TRY-1) due to the spentwash application. Similarly [8] observed marked improvement in cob length, cob weight, 100 grain weight and grain yield of maize due to the application of spentwash at a rate of 150 kilo litres ha^{-1}. Application of NP fertilizers alone (T_2) resulted in a small increase in the yield attributes. The split doses of spentwash application was found relatively better in improving the yield attributes than the one time application. This might be due to continuous supply of optimum level of nutrients made possible to the crop throughout its growth. This result corroborates with the finding of [9] who revealed that diluted (3:1 – water + effluent) effluent application after tillering phase (from 110 days after planting to harvest) registered significantly more number of millable cane (98.6 t ha^{-1}) and higher cane (105.6 t ha^{-1}) and sugar yield (12.6 t ha^{-1}) than irrigations commencing from germination to grand growth phase. Similarly [10] found that the 50 and 40 times diluted effluent irrigations recorded higher yield attributes of the groundnut variety TMV 7.

Effect on Protein and Oil Content of Groundnut: The protein and oil content of groundnut seeds were improved significantly due to the application of spentwash (Table 3). In the control (T_1) the seed protein content was only 22.3 to 22.4 per cent. Due to spentwash application, it was improved up to 25.1 per cent. The seed protein content markedly increased with increase in the levels of spentwash and at a rate of 120 m^3 ha^{-1} plus NP fertilizers resulted in the highest seed protein content with one time application (24.6 %) and continuous application (25.1 %). Though not always significant addition of recommended dose of NP fertilizers further improved the protein content. Significant difference was not observed between the methods of application. However, the continuous application of spentwash (M_2) resulted in relatively higher protein content than the one time application (M_1).

The oil content of groundnut seeds ranged from 37.14 to 42.94 per cent. The different levels of spentwash and its methods of application had remarkable influence on the oil content. The lowest oil content was recorded in plants with no spentwash application (T_1) followed by NP fertilizer alone (T_2). The spentwash at the rate of 120 m^3 ha^{-1} plus NP fertilizers (T_8) applied continuously in split doses recorded the highest oil content of 44.16 per cent; followed by one time application of spentwash (42.94 %). Though the two methods of application differed significantly in affecting the oil content. The interaction effect of methods (main plot treatments) and levels of spentwash (sub plot treatments) on oil content was found non-significant.

The addition of spentwash resulted in a substantial increase in protein and oil content of groundnut seeds. Similar to yield, increase in the rate of application increased the protein and oil content significantly.

The crop applied with 120 m^3 of spentwash with NP fertilizers had higher amount of protein and oil content, however, it was not statistically different from the crop that received spentwash alone. There was only a small increase in seed protein and oil content due to the application of NP fertilizers alone (T_2). This shows that the improvement in protein and oil content was mainly due to the application of spentwash. The nutrients, particularly, N and S present in the spentwash and higher rate of mineralization in soil would have resulted in greater amounts of N and S uptake by groundnut crops. The N and S nutrition might have favoured the synthesis of aminoacids, methionine and cystine in plants and presented in higher amounts of protein and oil content. [11] reported that the contents of methionine and cystine in seeds were higher due to the application of spentwash.The reason for higher methionine and cystine content might be due to high S content of the spentwash. Sulphur addition is being recommended for groundnut to improve the oil content. The continuous application of split doses of spentwash was found better than one time application in improving the protein and oil content. The continuous supply of nutrients, greater uptake of nutrients and favourable physico-chemical condition existed in soil may be attributed for this. This corroborates the results of [10] who observed improvement in seed protein and oil content in groundnut (var. TMV 7), due to application of 40 and 50 times diluted spentwash.

CONCLUSION

The continuous application of split doses of spentwash was found better in improving the yield attributes which was reflected on groundnut yield. The protein and oil content of groundnut seeds were also improved markedly.

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