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DISTILLERY SPENT WASH AS A POTASSIUM SOURCE ON YIELD ATTRIBUTES, YIELD AND ECONOMICS OF MAIZE

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Abstract- The field experiment was conducted to study the effect of application of spent wash as a potassium source on yield attributing characters and yield of maize crop near Godavari Bio-refineries at Sameerwadi (Karnataka) during *Kharif* 2012 by using randomized block design with seven treatments and four replications. The soils were sandy clay loam in texture. The recommended potassium dose to the maize crop (150:75:37.5 N:P_2O_5:K_2O kg/ha) was supplied through spent wash at 0, 25, 50, 75, 100, 150 and 200 per cent levels. From this experiment, it was observed that the application of spent wash to substitute 50 per cent (T_3) of recommended dose of potassium significantly improved the yield attributing characters *viz*., length of cob and its circumference, grains per cob, weight of 100 grains, grain and stover yield of maize compared to the higher levels of spent wash application (75, 100, 150 and 200 per cent), respectively. The application of spent wash in conjunction with potassic fertilizer (MOP) each at 50 per cent (T_3) level to supply recommended dose of potassium to the crop produced grain yield of 7.3 t ha^{-1} that was on par with T_1 treatment which received recommended dose of potassium through only chemical fertilizer (MOP) and T_2 treatment which received recommended dose of potassium through spent wash at 25 per cent substitution level but, significantly superior to the treatment T_4 and thereafter, received spent wash at higher levels.

Keywords- Spent wash, Muriate of Potash (MOP), RCBD design, Maize, Yield attributes, Grain yield, Stover yield, Economics.

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Introduction

India stands second in fertilizer consumption in the World, after China, consuming about 26.5 million tonnes per annum. It accounts for 15.3 per cent, 19 per cent and 14.4 per cent of the world's nitrogen, phosphorus and potassium consumption, respectively [5]. It is estimated that by 2025 the food requirement for the estimated population of 1,400 million may reach to 300 million tonnes. In contrast to this, demand for fertilizers in the country may also increase to about 41.6 million tonnes by 2020 [1]. Increase in fertilizer consumption is mainly due to the indiscriminate use of HYV's to meet out the food requirement of the ever growing population. Under the present condition of exploitative agriculture in the country, inherent soil fertility can no longer be maintained on the sustainable basis.

India ranks first in sugar production in the world. At present, there are 579 sugar mills producing 28.5 metric tonnes of sugar by crushing 281.57 metric tonnes of sugarcane annually [3]. These sugar mills expel large volume of bagasse, press mud and molasses as byproducts during sugar manufacture. Among different byproducts, molasses is fermented by yeast (*Saccharomyces cerevisiae)* and this is subsequently distilled for extracting alcohol and the liquid left over after distillation is generally known as spent wash. About 12-15 liters of spent wash is being produced during production of 1 liter of alcohol. The spent wash causes concern of environmental pollution and safe disposal of spent wash is a major problem for most of the sugar industries due to its very high organic load and total solids. In order to decrease its BOD and COD levels, it is made to pass through the biomethanation digesters and the effluent obtained is known as biomethanated effluent (BME). The study carried out at University of Agricultural Sciences, GKVK, Bangalore and University of Agricultural Sciences, Dharwad proposed a protocol for one time controlled land application of treated post biomethanated spent wash as liquid manure for the crops based on their recommended dose of nitrogen. Keeping in view the nutrient content of biomethanated spent wash and its beneficial role in present agriculture, present investigation was carried out.

MaterialsandMethods

The experiment was conducted in farmer's field during *Kharif* 2012 near Godavari Bio-refineries, Sameerwadi by using maize as a test crop. This experiment was carried out using randomized block design with seven treatments and four replication. The treatments included were seven potassium substitution levels *viz*., T_1 = RDF(150:75:37.5 N:P_2O_5:K_2O kg/ha) (Control), T_2 = 75% recommended dose of potassium with MOP + 25% recommended dose of potassium with spent wash, T_3 = 50% recommended dose of potassium with MOP + 50% recommended dose of potassium with spent wash, T_4 = 25% recommended dose of potassium with MOP + 75% recommended dose of potassium with spent wash, T_5 = 100% recommended dose of potassium with spent wash, T_6 = 150% recommended dose of potassium with spent wash and T_7 = 200% recommended dose of potassium with spent wash. The preliminary analysis of bio-methanated spent wash and soil was carried out and are presented in [Table-1 and 2]. The required quantity of bio-methanated distillery effluent and recommended FYM were applied uniformly one month before sowing on the surface and the plots were lightly irrigated. Half of recommended dose of nitrogen and full dose phosphorus were applied through urea and single super phosphate, respectively and the remaining 50 per cent of nitrogen was applied 30 days after sowing. The quantity of potassium through muriate of potash was calculated for different treatments and applied along with other fertilizers as basal dose.

The cultural practices followed were as recommended in package of practice and crop performance was monitored through growth parameters (plant height, leaf area index, dry matter yield and chlorophyll content) and yield attributing parameters (length of cob and its circumference, weight of 100 seeds, grains per cob and grain yield per plant) at both grand growth and harvest stage.

Table-1 *Characterization of biomethanated spent wash*

Parameters	Values
Colour	Dark brown
Odour	Foul smell
pH	7.1
EC (dS/m)	30
BOD (mg/l)	7510
COD (mg/l)	20,400
Organic carbon (%)	15.1
Total dissolved solids (%)	2.92
CO_3^{2-} (meq/l)	Traces
HCO_3^- (meq/l)	270
Cl^- (meq/l)	330
Available nutrients (%)	
Nitrogen	0.18
Phosphorus	0.07
Potassium	0.61
Sodium	0.05
Calcium	0.57
Magnesium	0.40
Sulphur	0.04
Micronutrients (mg/l)	
Copper	1.5
Iron	15.2
Manganese	5.4
Zinc	3.3

Table-2 *Initial soil properties of the experimental site*

Sl. No.	Particulars	Value
I.	**Physical properties**	
1.	Particle size distribution (%)	
	Sand	66.3
	Silt	10.1
	Clay	23.6
	Texture	Sandy clay loam
2.	Bulk Density (Mg m^{-3})	1.58
3.	Porosity (%)	31.08
4.	MWHC (%)	21.4
II.	**Chemical properties**	
1.	Soil pH (1:2.5 soil water suspension)	7.30
2.	Electrical conductivity (dSm^{-1}) (1:2.5 soil water extract)	0.21
3.	Organic carbon (g kg^{-1})	1.98
4.	**Exchangeable cations (cmol (p+) kg^{-1})**	
i.	Calcium and magnesium	13.50
ii.	Sodium	0.73
iii.	Potassium	1.20
5.	CEC	20.3
6.	**Water soluble cations (meq l^{-1})**	
i.	Calcium and magnesium	12.10
ii.	Sodium	0.85
iii.	Potassium	0.72
7.	**Water soluble anions (meq l^{-1})**	
i.	Carbonates	Traces
ii.	Bicarbonates	1.01
iii	Chlorides	1.65
iv.	Sulphates	0.70
III.	**Available nutrient status** (kg ha^{-1})	
1.	Nitrogen	215.4
2.	Phosphorus	15.7
3.	Potassium	238.0
4.	Sulphur (mg kg^{-1})	11.2
5.	**DTPA–extractable micronutrients (mg kg^{-1})**	
i.	Copper	0.72
ii.	Iron	2.10
iii.	Manganese	5.30
iv.	Zinc	0.51

Results and Discussion

Yield attributes and yield

The data presented in the [Table-3] depicts effect of application of spent wash as a source of potassium on yield attributing characters, grain and stover yield of maize.

The yield attributing characters and yield of maize differed significantly due to the application of two different sources of potassium *viz*., spent wash and muriate of potash to supply recommended dose of potassium. The yield attributing characters namely, cob length and its circumference, grains per cob, 100 seed weight and grain yield per plant were 18.1 cm, 14.7 cm, 559, 29.20 g and 167.04 g in control (T_1) which increased to 19.7 cm, 16.0 cm, 583, 32.47 g and 184.24 g, respectively in the treatment received recommended dose of potassium both through spent wash and inorganic source (MOP) each at 50 per cent level (T_3)but there was no significant difference in cob length and cob circumference by different substitution levels of spent wash. Application of recommended dose of potassium with potassic fertilizer and spent wash at 50 per cent level each (T_3) resulted in higher grain and stover yield (7.3 and 10.1 t ha^{-1}) when compared with control (6.4 and 9.2 t ha^{-1}). Further increase in the substitution levels of spent wash to 75 per cent and above significantly reduced the yield attributes and ultimately the yield of maize.

Similarly significant increase in growth attributes (height of plant, leaves per plant and leaf area index) and yield attributes (length of cob and its circumference, grains per cob and weight of 100 grains) and yield of maize due to substitution of recommended nitrogen through both solid effluent and inorganic source each at 50 per cent level which was on par with the treatment receiving 25 per cent nitrogen substitution through solid effluent and remaining 75 per cent through inorganic source [11].

Lower grain yield of maize was recorded in the treatment received spent wash at 75 per cent and still higher levels. The decrease in grain yield of 4.5 t ha^{-1} was noticed in the treatment received spent wash at 200 per cent level (T_7). The lower grain yield recorded in T_4, T_5, T_6 and T_7 (75, 100, 150 and 200 per cent recommended K with spent wash, respectively) might be due to reduction in dry matter yield of maize at higher levels of spent wash which might be due to nutrients imbalance and metabolic disturbance in plants [8].

Further higher application rate of spent wash leads to addition of high BOD and COD containing organic matter, which may cause adverse effect on soil health by creating anaerobic conditions due to increased CO_2 and forming organic acids during decomposition, which may leads to the immobilization of nutrients [10]. Application of increase doses of spent wash likely to increase the total soluble salts content in soil, which may also affect the crop growth due to lesser availability of nutrients. The present findings are in accordance with the observations of Kumar and Chopra, (2012) in Fenugreek. The irrigation with distillery effluent adds sufficient quantities of salts (sulfates, phosphates, bicarbonates, chlorides of the cations sodium, calcium, potassium and magnesium) to the soil, which improves growth and yield at lower concentration but has detrimental effect at higher concentration [9].

Table-3 *Effect of application of spent wash as a source of potassium on yield attributing characters, grain and stover yield of maize.*

Treatments	Cob length	Cob circumference	Grains/cob	Weight of 100 seeds	Grain yield/plant	Grain yield	Stover yield
	cm			g		t ha^{-1}	
T_1 – RDF (control)	18.1	14.7	559	29.20	167.04	6.4	9.2
T_2 – 75% K with fertilizer + 25% K with SW	18.6	15.4	568	30.40	172.93	6.9	9.5
T_3 – 50% K with fertilizer + 50% K with SW	19.7	16.0	583	32.47	184.24	7.3	10.1
T_4 – 25% K with fertilizer + 75% K with SW	17.9	14.4	546	27.65	140.57	5.9	8.0
T_5 – 100% K with SW	17.4	14.2	538	25.96	134.76	5.2	7.2
T_6 – 150% K with SW	16.9	13.8	530	24.96	125.41	4.8	6.6
T_7 – 200% K with SW	16.8	13.2	512	23.07	118.24	4.5	6.1
S.Em±	**0.7**	**0.5**	**8.4**	**1.1**	**6.2**	**0.36**	**0.60**
CD @ 5%	**NS**	**NS**	**25.9**	**3.4**	**19.1**	**1.10**	**1.83**

SW – Spentwash
NS-Non-significant

Economics

The data presented in the [Table-4] depicts effect of distillery spent wash application based on recommend dose of potassium on cost of cultivation, gross returns, net returns and B:C ratio.

Net returns in the treatment with only potassic fertilizer (T_1) was Rs. 64630/- per ha and increased to Rs. 76183/- per ha due to substitution of 50 per cent RDK to the crop with spent wash (T_3). Similarly, there was increase in the B: C ratio in T_3 when compared to T_1. Increasing the levels of spent wash application above 50 per cent level was not beneficial but in fact there was decreased net returns and also B:C ratio.

Treatment received combined application of potassic fertilizer and spent wash recorded higher net returns than the treatment received only potassic fertilizer and 75 and 100 per cent spent wash. Similar observations were recorded by the application of spent wash at the recommended N level, which remained comparable with chemical fertilizer providing an opportunity of substitution in maize crop [2]. Higher returns recorded were due to saving on the cost of chemical fertilizer and numerically higher yield in that treatment. Increasing the substitution level above 50 per cent was not beneficial and in fact there was reduction in the net returns. These observations were similar to the findings of Kavitha *et al.* (2008) [6] who noticed that by using spent wash at different levels they could substitute 40-90 per cent of inorganic fertilizer cost. The spent wash could be conveniently used for the cultivation of condiments without external fertilizers. Results were similar with respect to B: C ratio also [4].

Table -4 *Effect of distillery spent wash application based on recommend dose of potassium on cost of cultivation, gross returns, net returns and B:C ratio.*

Treatments	Cost of cultivation (`ha^{-1})	Gross returns (`ha^{-1})	Net returns (`ha^{-1})	B : C ratio
T_1 - RDF+ FYM	23990	88620	64630	2.7
T_2 - 75% K with fertilizer+25% K with SW	24887	95355	70468	2.8
T_3 - 50% K with fertilizer+50% K with SW	24722	100905	76183	3.1
T_4 - 25% K with fertilizer+75% K with SW	24419	81480	57061	2.3
T_5 - 100% K with SW	24517	71880	47636	1.9
T_6 - 150% K with SW	24802	66330	41528	1.7
T_7 - 200% K with SW	25039	59505	34466	1.4

SW – Spentwash

Conclusions

Combined application of spent wash and potassic fertilizer each at 50 per cent level to supply recommended dose of potassium to maize crop resulted in saving of 50 per cent cost on potassic fertilizer without reduction in crop productivity. In addition, it also improved soil fertility.

Conflict of Interest: None declared

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