EFFECT OF TRASH MULCH AND NITROGEN APPLICATION ON THE CANE YIELD AND QUALITY OFSUGARCANE VARIETY THATTA – 10.

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ABSTRACT: The study was carried out to investigate the effect of trash mulching and nitrogen application on the growth, yield and quality of sugarcane variety Thatta-10 at NSCRI, farm Thatta during 2008-09. The data revealed that the plots received 225 N kg ha^{-1}+ trash mulch showed better results for cane yield, yield components and quality. It was further observed that that the plots with mulching and varying doses of nitrogen application had low weed occurrence as compared to control plots receiving 175 N kg ha^{-1} + no mulch. Economic analysis data revealed that there could be no additional income from the control treatment, which received low levels of N fertilizer (175 N kg/ha) with no mulching. However, all fertilizer levels with trash mulching proved profitable over control. Moreover, better response was observed at 225 N kg/ha+ trash mulch. It is recommended that 225 N kg ha-1application with trash mulch was profitable for obtaining maximum production of sugarcane.

Key words: *Sugarcane, Nitrogen, Trash mulching, Cane yield, CCS%.*

INTRODUCTION

Sugarcane (*Sccharum offincinarum*, L) is a valuable cash crop of Pakistan and improves the socio economic status in various aspects. It is the main source of sugar production and meets the 75% requirements of sugar industry, which builds up the overall national economy through excise duty and also saves precious foreign exchange (Junejo *et al.* 2010). In Pakistan sugarcane cultivated on an area of 1,046,000 hectares with a production of 58,038,200 tonnes during 2011-12 (PSMA, 2012). Regardless of pronounced developments in sugarcane research and expansion in sugar industry, our national average sugarcane yield and sugar recovery is 55.48 tons per hectare and 9.64 percent, respectively, with reference to sugarcane production (PSMA, 2012), whereas, the yield potential is between 150-250 tons per hectare at research stations and progressive grower's farms (Arain *et al.* 2011). There are number of reasons for lower cane and sugar yield and one of those is impaired production technology (Junejo *et al.* 2010). Therefore, it is a need of the time to grow sugarcane with proper fertilization and production technology. Sugarcane growth and yield are loyal to better agronomic practices throughout growing period to keep soil loose and well aerated as well as to check weeds, which otherwise will inhibit the growth of young shoots (Deho *et al.* 2002).

Mulching is a practice employed in sugarcane crop for suppression of weeds (Nagaraju *et al.* 2000) and conserving soil moisture reducing evaporation losses and maintain soil moisture (Deho *et al.* 2002; Minhas *et al.* 2008). The trash mulching has been reported to improve the soil bulk density (Srivastava, 2003), microbial activity (Kalaisudarson *et al.* 2002), organic matter (Graham and Haynes 2005) and irrigation water use efficiency (Kavitha and Wahab, 2000). Mulching has been shown to increase the yield of sugarcane in plants and successive ratoon crops Gajera and Ahlawat, 2002, Singh *et al.* 2005). Other favourable effects on cane stalk yield and economic benefits from mulching with dead leaves (trash) have also been reported. Sugarcane is known as heavy feeder crop depletes the soil of essential nutrients (Tadesse, 2008). Sugarcane can utilize 4 to 7 kg N ha^{-1} per day during its rapid growth period. Nitrogen plays a vital role in all living plant tissues (Taiz and Zeiger, 2002; Sreewarome *et al.* 2007) and reduce the number of unwanted tillers and bring into constant number of millable canes ha^{-1} (Dev *et al.* 2011) Substantial amounts of N fertilizer are necessary for commercial sugarcane production due to large biomass produced by the crop (Thornburn *et al*. 2005). Nitrogen fertilization enhances the growth of sugarcane and increase the cane yield (Tadesse *et al*. 2009, Sime, 2013). In addition, juice quality may be reduced by excess N application (Wiedenfeld, 2000).

The average yield of sugarcane varieties is very low than their potential yield (Junejo *et al.* 2009), for instance, through application of balanced NPK fertilizers, the potential yield is obtained up to 165.176 t ha^{-1} (Khan *et al.* 2005). Proper fertilization is an important managemental factor in sugarcane production, therefore, it is necessary to supply sugarcane crop with the big three (NP and K) to secure good cane quantity (Elamin *et al.* 2007). Sugarcane growth is upright in early stages, under such conditions, leaves do not cover the soil properly and weeds are growing rapidly, and are competing with crop. Use of sugarcane trash material as mulch instead of burning in the field may prove to be the cheapest source for soil moisture conservation, suppression of weeds and increased nutrient use efficiency, which ultimately will result in vigorous growth, increasing yield and quality sugarcane crop. Keeping in view the importance of nitrogen fertilization and trash mulching for enhancing sugarcane yield and quality, the present study was therefore, conducted.

MATERIALS AND METHOD

The experiment was carried out at National Sugar Crops Research Institute, Thatta during 2008-09 to examine the response of sugarcane variety Thatta-10 to different nitrogen levels and trash mulch on the growth, yield and quality attributes. The experiment was laid out in a three replicated Randomized Complete Block Design. In each treatment, five rows of Thatta-10 sugarcane variety were planted at one meter row to row distance. Treatments under study were (T-1) 175 N kg ha^{-1} + No mulch (control), (T-2) 175 N kg ha^{-1} + trash mulch, (T-3) 225 N kg ha^{-1} + trash mulch, (T-4) 275 N kg ha^{-1} + trash mulch and (T-5) 325 N kg ha^{-1} + trash mulch. The rate of trash mulching was 3 t ha^{-1} used equally in each treatment. $1/3^{rd}$ of N + total trash mulch and full dose of 115 and 125 P and K kg ha^{-1} was applied in all treatments at the time of planting and remaining dose of N was applied at the time of 1^{st} and 2^{nd} earthing up. The crop was planted during October 2008 and harvested during December 2009. The data for different parameters such as cane thickness, number of internodes per cane, cane height, millable canes per hectare and cane yield was recorded at harvest on plot basis and then converted into hectares. Five canes were randomly selected from the bulk produced in each plot for juice analysis. The canes were crushed in the crusher and their juice was analyzed in the laboratory for the assessment of commercial cane sugar percentage (CCS%) by Australian commercial cane sugar (CCS) formula given by (Meade and Chen 1977) as:

$$\textbf{CCS\%} = \frac{3 \times P}{2} \times \left(1 - \frac{F+5}{100}\right) - \frac{B}{2} \times \left(1 - \frac{F+3}{100}\right)$$

Where P is the Pol: percentage of the first expressed juice, B is brix percentage of the first expressed juice and F is the fiber percentage in the cane.

The data recorded was statistically analyzed through MSTATC, Micro computer statistical programme, Michigan State University (1991).

RESULTS AND DISCUSSION

The analysis of variance and mean squires indicated that there were highly significant (P<0.01%) differences among the treatments for germination in Thatta-10 sugarcane variety (Table-1). The data in Table-2 revealed that fertilizer application @ 225 N kg ha^{-1} + trash mulch significantly favored the germination of sugarcane in all treated plots. However, the plots receiving 275 kg N ha^{-1} + trash mulch exhibited next best results. In contrast, the plots receiving reduced N application (175N kg ha^{-1}) with and without trash mulching responded statistically at par with results of lowest germination. Likewise, the higher N application (325N kg ha^{-1}) with trash mulching also resulted into reduced germination in all treated plots. This was possibly due to the fact that application of N fertilizer had made the applied N available for the sprouting buds to be easily utilized for emergence. (Tadesse *et al.*, 2009) reported highest sprouting percentage with increased level of nitrogen as compared with the lowest level (the control). (Kanchann 2009) reported that increasing N rates although affects the growth and yield of sugarcane, but germination had little association with top dressing of fertilizers.

As regards the cane thickness statistically non-significant (P<0.05%) differences were exhibited in all the treatments (Table-1). The perusal of data in Table-2 further revealed that there existed a non pronounced impact due to different levels of nitrogen and mulching on cane thickness. However, the crop fertilized with 225 N kg ha^{-1} + trash mulch responded with slightly higher cane thickness as compared to rests of the treatments. (Rita *et al*,. 2003) reported that although higher N levels improve the cane thickness but if N was applied at excessive rate, the cane length might increase, but cane thickness followed adverse trend.

In case of cane height the treatment differences were highly significant (P<0.01%). The cane height was statistically higher in the plots fertilized with 275 N kg ha^{-1} + trash mulch as compared to the plots receiving 225 and 325 N kg ha^{-1} with trash mulch respectively, displayed next good performance with statistically similar results of cane height. In contrast, the plots treated with reduced N levels (175 N kg ha^{-1}) with and without trash mulch produced comparatively lower cane height (Table-2). Research findings conducted in Egypt also revealed that increasing nitrogen level increased stalk height, stalk diameter and quality of setts/seed cane as compared with the lowest rate (Azzay and Elhan 2000 and Sime, 2013). (Dahiya and Malik 2000) reported that variance in cane height may be due to genetic factors, but the internodes could be associated with cane length (Chattha2007) reported that under mulching and higher N levels, the number of internodes were increased, but this trait was genetically associated with cane length.

There were significant (P<0.05%) differences among the treatments for millable canes (Table-1). The data in relation to millable canes in Table-2 further revealed that the plots fertilized with 225 N kg ha^{-1} + trash mulch exhibited statistically higher millable canes per hectares. Likewise, the increased N fertilizer levels

(275 and 325 N kg ha^{-1}) with trash mulching resulted into next good performance with statistically similar results of millable canes. In contrast, the plots treated with reduced N fertilizer level (175 N kg ha^{-1}) with and without trash mulch produced comparatively less number of millable canes. The trend was evidenced from the results that germination percentage was comparatively higher under trash mulching and optimum N supply (225 N Kg ha^{-1}) which might have increased the plant population per hectare in sugarcane and ultimately contributed towards sufficient millable canes formation.

The analysis of variance and mean squires indicated that there were highly significant (P<0.01%) differences among the treatments for cane yield (Table-1). The data in Table-2 further revealed that plots receiving 225 and 275 N kg ha^{-1} with trash mulch, respectively, remained on top by producing statistically at par results of maximum cane yield. However, the cane yield tended to decrease slightly in plots treated by higher N levels (325 N kg ha^{-1}) with trash mulch. Likewise, the trend of reduced cane yield was exhibited in plots treated by low N levels (175 N kg ha^{-1}) with and without trash mulch.

The sufficient moisture conservation, reduced soil temperature and suppression of weeds under trash mulching and optimum N supply (22 N Kg ha^{-1}) possibly had facilitated efficient utilization of N and other nutrients from the soil which eventually had improved the vegetative growth of cane stalks and yield. The higher number of millable canes per hectare with fairly thicker cane stalks in plots under optimal N supply and trash mulching might have caused increase in cane yield. It was likely that an addition stimulated growth of roots and shoots and, ipso facto, increased the area of uptake. These results were further supported by Tadesse *et al.* 2009 and Sime, 2013), who were of the view that nitrogen fertilization enhanced the growth of sugarcane and enabled the plants to take up other nutrients.

The data regarding different quality parameters of sugarcane variety Thatta-10 under different N levels with and without trash mulching is presented in Table-3, which revealed that the trend of increased brix was exhibited in plots treated with higher levels of N (325 and 275 N kg ha^{-1}) with trash mulch. While, brix was not affected due to reduced N levels with mulching in rests of the treated plots including control.

Pol percent was comparatively higher in plots receiving 225 and 275 N kg ha^{-1} with trash mulch, respectively. While, slight decline in Pol was exhibited in plots receiving increased and decreased N fertilizer level (325 and (175 N kg ha^{-1}) with trash mulching, respectively. Minimum Pol value was exhibited from control treatment (175 N kg ha^{-1} trash mulch).

Purity percent was higher in the plots receiving 225 N kg ha^{-1} with trash mulch. However, Purity values tended to decline slightly under higher (275 and 325 N kg ha^{-1} with trash mulch) and lower N fertilizer levels (175 N kg ha^{-1} with and without trash mulch). (Dev *et al.* 2011) reported that on increasing nitrogen levels, decreasing trend of juice sucrose and purity coefficient were recorded because sucrose percentage was markedly influenced by nitrogen doses as higher doses of nitrogen lowered down the sucrose percentage. (Nassar *et al*. 2005) reported that the purity coefficient was statistically negatively influenced by increasing the nitrogen levels.

In case of Commercial Cane Sugar Percentage (CCS) best results were recorded from plots receiving 225 and 275 N kg ha^{-1} with trash mulching, respectively. While, trend of reduced results was exhibited due to further increase and decrease in N fertilizers levels with trash mulching in rests of the treatments including control (175 N kg ha^{-1} + No mulch). The reduction in CCS% in sugarcane may be attributed to excess or reduced N supply, which was because of the reasons that excessive nitrogen application might have delayed the ripening and produced immature cane stalks of low sugar content in sugarcane, while, under reduced application improper N supply impeded the efficient utilization and assimilation of N and other nutrients which might have caused low sugar accumulation in cane stalks. The results are in agreement with the findings of Malik, (2009) who reported that the increased level of N resulted in higher percentage of reducing sugars and was detrimental to sugar recoveries. Similarly, (Solomon *et al*,. 2000) reported that every increase in 10 ppm N in sugarcane juice brought a 0.07 percent decrease in sugar recovery.

Weed occurrence was noted from each treatment, the data regarding the weed frequency and density is presented in Table-4, which revealed that maximum weed frequency and density was observed in plot receiving 175 N kg ha^{-1}+ no mulch. However, the plots with mulching and varying doses of nitrogen applications had low weed occurrence. It was also noted that the weed frequency and density were slightly increased with increased level of nitrogen under mulching.

On the basis of current market prices of fertilizer and mill prices of sugarcane, the obtainable income from additional yield was worked out (Table-5). Evidently, there could be no additional income from the control treatment, which received low levels of N fertilizer (175 N kg ha^{-1}) with no mulching. However, all fertilizer levels with trash mulching proved profitable over control. Moreover, better response was observed at 225 N kg ha^{-1}+ trash mulch.

The perusal of data in Table-6 indicated that maximum cost benefit ratio was due to 225 N kg ha^{-1} with trash mulch. However, the results did not favor excessive nitrogen application for its judicial and economic use. The best economic dose 225 N kg ha^{-1} with trash mulch was recommended for profitable production in sugarcane.

Table-1. Mean squires of cane yield and yield parameters

Source	DF	Germination	Cane thickness	Cane height	Millable Canes	Cane Yield
Replication	2	12.791	3.574	3437.481	189.375	51.844
Factor A	4	170.484**	0.185 NS	1162.269**	95.319*	1202.526**
Error	8	0.952	0.304	164.432	28.382	4.359

Table-2. Cane yield and yield components of Thatta-10 variety under trash mulching with different nitrogen levels at NSCRI, farm Thatta during 2008-09.

Treatments	Germination %	Cane thickness (mm)	Cane height (cm)	Millable canes 000 ha^{-1}	Cane yield (t ha^{-1})
T-1= 175 N kg ha^{-1} + No mulch	49.23 d	26.43	251.11 c	116.15 b	68.10 d
T-2 =175 N kg ha^{-1} + trash mulch	49.80 d	26.50	265.55 bc	115.04 b	84.32 c
T-3 =225 N kg ha^{-1} + trash mulch	65.83 a	26.70	289.41 ab	128.81 a	114.03 a
T-4 =275 N kg ha^{-1} + trash mulch	61.70 b	26.16	301.32 a	123.33 ab	111.50 a
T-5 =325 N kg ha^{-1} + trash mulch	52.23 c	26.10	277.58 ab	119.36 ab	107.35 b
CV%	1.75	2.09	4.63	4.42	3.93
LSD-5%	1.83	NS	24.14	10.03	7.63

Table-3. Different quality parameters of Thatta-10 sugarcane variety under trash mulching and different nitrogen levels at NSCRI, farm Thatta during 2008-09.

Treatments	Brix%	Pol%	Purity%	CCS%
T-1= 175 N kg ha^{-1} + No mulch	22.40	18.78	83.83	13.57
T-2 =175 N kg ha^{-1} + trash mulch	22.60	19.10	84.52	13.89
T-3 =225 N kg ha^{-1} + trash mulch	22.76	19.55	85.87	14.36
T-4 =275 N kg ha^{-1} + trash mulch	23.46	19.50	82.97	14.02
T-5 =325 N kg ha^{-1} + trash mulch	23.60	19.23	81.50	13.65

Table-4. Weed occurrence under trash mulching with different nitrogen levels at NSCRI, farm Thatta during 2008-09.

Treatments	Frequency%	Density%
T-1= 175 N kg ha^{-1} + No mulch	30.00	13.52
T-2 =175 N kg ha^{-1} + trash mulch	8.33	5.00
T-3 =225 N kg ha^{-1} + trash mulch	9.00	5.81
T-4 =275 N kg ha^{-1} + trash mulch	10.66	6.19
T-5 =325 N kg ha^{-1} + trash mulch	11.14	7.25

Table-5. Effect of different N levels with and with out mulching on economic returns of sugarcane at NSCRI, Farm Thatta during 2008-09.

Treatments	Gross income in Rs.	Value of increased yield in Rs.	Cost of fertilizer in Rs.	Net return due to fertilizer	Cost benefit ratio
T-1= 175 Kg N + No mulch	173655.0	--	32215.0	--	--
T-2 =175 Kg N + trash mulch	215016.0	41361.0	32215.0	9146.0	--
T-3 =225 Kg N + trash mulch	290776.5	117121.5	33535.0	83586.5	1:2.49
T-4 =275 Kg N + trash mulch	284325.0	110670.0	34855.0	75815.0	1:2.17
T-5 =325 Kg N + trash mulch	273742.5	100087.5	36175.0	63812.5	1:1.76

Price/40 kg sugarcane= Rs. 102/-, Price/50 kg Urea= Rs. 660/-, Price/50 kg DAP= Rs. 3087/-, Price/50 kg SOP= Rs. 2300/-.

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