EFFECT OF TRASH MULCH AND N LEVELS ON CANE YIELD AND RECOVERY OF SUGARCANE VARIETY THATTA-10

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ABSTRACT

A field trial was conducted during the year 2009-10 to investigate the effect of trash mulch and various N levels on the cane yield and recovery of sugarcane variety Thatta-10. The treatments included: Control (No mulch, 225 kg N ha^{-1}), trash mulch + 225 kg N ha^{-1}, trash mulch + 250 kg N ha^{-1}, trash mulch + 275 kg N ha^{-1} and trash mulch + 300 kg N ha^{-1}. The experiment was laid out in a three replicated randomized complete block design in a plot size of 14m x 3m ($42m^2$). The results revealed that regardless the N levels, the mulching showed positive and significant impact on cane yield and recovery of sugarcane variety Thatta-10. However, trash mulch + 250 kg N ha^{-1} treatment resulted economically superior performance over rest of the treatments with 64 percent germination, 246 cm cane length, 2.67 cm cane girth, 22.2 internodes $cane^{-1}$, 117.67 tons ha^{-1} cane yield and 10.90 percent sugar recovery. It was concluded that systematically applied trash mulch showed positive impact on all the studied traits of sugarcane variety Thatta-10 including cane yield and recovery. Moreover, higher N levels of 300 and 275 kg ha^{-1} slightly increases cane length, but cane girth, internodes, cane yield and recovery decreased over 250 kg ha^{-1} N level. This indicates that for obtaining economically maximum crop performance for sugarcane variety Thatta-10, the sugarcane may be trash-mulched and N may be applied at the rate of 250 kg ha^{-1}.

Keywords: Sugarcane, trash mulch, Nitrogen, cane length, cane girth, cane yield, recovery

INTRODUCTION

Sugarcane is a major cash crop of Pakistan and source of livelihood for hundreds of thousands people in Pakistan (Afghan *et al.* 2010). It belongs to the family Gramineae (Miller and Gilbert, 2010); and it contributes 3.6 percent in value added to agriculture and 0.8 percent to GDP. The sugarcane was cultivated on an area of 1046 thousand hectares in Pakistan (2011-2012) with a total cane production of 58.038 million tons (GoP, 2012). Out of total seventy eight sugar mills in Pakistan, only in Sindh province has 31 sugar mills and the province is considered as second highest contributor to total sugarcane production in Pakistan after Punjab. The sugarcane in Sindh province of Pakistan was cultivated on an area of 280 thousand hectares with a production of 15350 thousand tons (Carroll and Rehman, 2010) during 2009-2010; and actual area under sugarcane cultivation during 2010-2011 was 292.5 thousand hectares against the targeted area of 270 thousand hectares (GoS, 2011). Mulch is a protective cover placed over the soil to retain moisture, reduce erosion, provide nutrients, and suppress weed growth and seed germination. Organic mulching has importance by environmental concerns. Increasing cost of herbicides/ weedicides on one hand and their undesirable impacts on the soil health on the other hand call for immediate inclusive of organic mulch materials. Due to wider use of short statured high yielding varieties and hybrids in different crops, the availability of crop residue as a source of organic matter for soil is very much limited. Farmyard manure and green manure are used only on limited scale as organic sources since most of the plant residues are consumed as fuel (Yadahalli, 2008).

Soil organic matter is an important feature of soil fertility. Ways of increasing soil organic matter are by growing a cover crop (green manure) or by mulching with compost or crop residues. These practices also help to control weed growth. Mulching has been shown increased crop yields (Kaniszewski, 1994). Mulching by crop residues was superior to polyethylene sheets (used to control weeds) in terms of incremental cost-benefit ratios (Khalak and Kumaraswamy, 1993). There are several reports of improvement of soil fertility as a result of mulching with crop residues (Kitou and Yoshida 1994).

Mulching reduces the deterioration of soil by way of preventing the runoff and soil loss, minimizes the weed infestation and checks the water evaporation. Thus, it facilitates for more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops (Dilipkumar *et al*. 1990). Crop residues are

tremendous natural resource for recycling. Crop residues of common cultivated crops are important resources not only as a source of significant quantity of nutrients but also affecting soil physical, chemical and biological functions and properties, water and soil quality (Gaur *et al*. 1995). The soil is living only when it will have a microbial population of 108 per cubic centimeter of soil. These microbial populations need adequate quantity of organic manures as feed for their survival and multiplication (Babalad, 2008).

Nutrient requirement of sugarcane can be determined on the basis of respective nutrient in selected index tissues at specific crop stages. Higher growth rate of sugarcane is mainly associated with enhanced uptake of N, P and K (Nasir *et al.,* 2000). N, P and K are essential nutrient elements that contribute to optimum sugarcane yield and uptake (Morris *et al*. 2002). N, P and K application beyond 100 percent of the recommended dose produce only marginal increase in cane and sugar yield (Alexander *et al*., 2003). The use of nitrogen, phosphorous and potassium fertilizers play key role in development of cane and sugar yields, because sugarcane is known as a heavy feeder crop that depletes the soil of essential nutrients and therefore, adequate nutrient addition is of utmost importance (Korndorfer, 1990). The average yield of the sugarcane varieties is much lower than their potential yield. For instance, through application of balanced NPK fertilizers, the potential yields are obtained upto 165.176 t ha^{-1} (Khan *et al*., 2002). Fertilizer use for sugarcane cultivation in Pakistan is imbalance and inappropriate; only 4 percent of the cane growers use NPK and 73 percent of them rely only on NP fertilization (Karstens *et al*., 1992). Proper fertilization is an important management function in sugarcane production (Khan *et al.,* 2005). Therefore, it is necessary to supply sugarcane crop with the big three (N, P and K) to secure good cane quantity and quality (Elamin *et al*., 2007). With these ideas in view, an experiment was conducted to study the effect of trash mulch and N levels on growth, cane yield and recovery of sugarcane variety Thatta-10.

MATERIALS AND METHODS

The experiment was laid out at the experimental fields of Sugarcane Section, Agriculture Research Institute, Tandojam in a three replicated Randomized Complete Block Design having plot size of 14m x 3m ($42m^2$). A good seedbed was prepared adopting recommended land preparation practices. Ridges were prepared to place the seed setts by end-to-end method. Trash mulch was used in all the treatments except the control, while N was applied at different rates i.e. 225, 250, 275 and 300 kg ha^{-1} in the form of urea (46% N). The trash mulch was used to cover the surface when the germination of planted crop was completed. The mulching was practiced in such a way not to hurdle the sprouting of the seedlings. The P and

K fertilizers were applied at the rates of 120 kg and 100 kg ha^{-1}. All P and K and $1/3^{rd}$ of N was applied at planting time and remaining N in two equal doses at first earthing (3-1/2 months after planting) and 1-1/2 month after first earthing respectively.

Methods for recording observations

Germination: The germination was calculated in percentage on the basis of total number of buds in the seed setts planted and number of sprouts.

Cane length: Cane length was recorded at the field in the labelled sugarcane plants by measuring tape from bottom of the cane upto the last internode in centimetres and averaged.

Cane girth: Cane girth was measured in each plot on the basis of randomly selected (tagged) plants by means of Vernier Caliper in centimetres and average was worked out.

Internodes $cane^{-1}$: Internodes $cane^{-1}$ were counted from the bottom of the cane upto the last internode for all the tillers in each plant in each labelled plant in each treatment plot and averaged.

Cane yield ha^{-1}(mt): The cane yield ha^{-1} was calculated on the basis of following formula:

$$\text{Cane yield (m.t ha}^{-1}) = \frac{\text{Yield plot}^{-1} \text{ of given treatment}}{\text{X 10000 Plot area (m}^2)}$$

Sugar recovery (%): Polarity was determined by the procedure and method described in laboratory manual for Queensland sugar mills (Anonymous, 1970) in order to calculate Pol, CCS and recovery.

The data on the above characters will be collected and subjected to statistical analysis. Analysis of variance and mean separation tests will be applied (Steel *et al.* 1997.

RESULTS AND DISCUSSION

Germination (%)

Seed germination influences the crop production significantly; the results in regards to cane length percentage of sugarcane variety Thatta-10 as affected by trash mulch and various N levels (Table-1) indicated that highest cane length (64.00%) was recorded in plots with trash mulch + 250 kg N ha^{-1}, while the cane length was 59.00, 54.00 and 51.00 percent in case of control (no

much), mulch + 275 kg N ha^{-1}, and mulch + 225 kg ha^{-1} N, respectively. The lowest cane length (48.00%) was recorded in plots receiving trash mulch + 300 kg ha^{-1} N. This indicates that there was no linear impact of mulching or N application levels on the cane length of sugarcane. However, the differences in cane length were statistically significant ($P<0.05$). These results are further supported by Tan (1995) who have reported positive impacts of mulching on germination, and Kanchann (2009) reported that increasing N rates although affects the growth and yield of sugarcane, but germination has little association with top dressing of fertilizers.

Cane length (cm)

Cane length is a major growth and yield component in sugarcane and it has direct effect on the crop yields. The data in relation to cane length of sugarcane variety Thatta-10 as influenced by trash mulch + different N levels (Table-1) suggested that highest cane length (248.33 cm) was recorded given trash mulch + 300 kg N ha^{-1}, while the cane length slightly reduced to 248.00 and 246.00 cm when the surface was covered with trash mulch and fertilized with 275 kg N ha^{-1} and 250 kg N ha^{-1}, respectively. The crop treated with trash mulch + 225 kg N ha^{-1} resulted in average cane length of 236.33 cm, while the minimum cane length of 232.33 cm was achieved from the plots given N @ 225 kg ha^{-1} and no mulching (control). This indicates that mulching affected cane length significantly ($P<0.05$), while the differences in cane length of the crop receiving N @ 250, 275 and 300 kg ha^{-1} were statistically non-significant ($P<0.05$), suggesting that N application beyond 250 kg ha^{-1} would be uneconomical and excessive. Similar results have also been reported by Dahiya and Malik (2000) who found considerable increase in cane length due to mulching, while Basanta *et al.* (2003) reported that higher NPK levels increase cane length significantly.

Cane girth (cm)

Cane girth is also one of main yield traits and the results on this character of sugarcane variety Thatta-10 as influenced by trash mulch + different N levels are presented in (Table-1). It is evident from the results that maximum cane girth (2.67 cm) was observed in plots given trash mulch + 250 kg N ha^{-1}, while the cane girth decreased to 2.38 and 2.36 cm when the surface was covered with trash mulch and fertilized with 225 kg N ha^{-1} and 275 kg N ha^{-1}, respectively. The crop treated with trash mulch + 300 kg N ha^{-1} resulted in average cane girth of 2.31 cm, while the minimum cane girth of 2.26 cm was achieved from the plots given N @ 225 kg ha^{-1} and no mulching (control). This suggested that mulching produced positive and significant ($P<0.05$) impacts on cane girth ($P<0.05$), while with increasing N level beyond 250 kg N ha^{-1} the cane girth consecutively decreased under N application of 275 and 300 kg ha^{-1}. This clearly indicates that regardless the mulching practice; 250 kg N ha^{-1} would be an optimum level for obtaining maximum cane girth in variety Thatta-10. The results of the present study coincides those achieved by Rana *et al.* (2003) who found that cane girth is positively influenced by the mulching, because mulching conserve moisture and nutrients and suppresses weeds. Similarly, Rita *et al.* (2003) reported that although higher N levels improve cane girth but if N is applied at excessive rate, the cane length may increase, but cane girth will follow adverse trend.

Table-1 Effect of trash mulch + nitrogen levels on germination, cane length and cane girth of sugarcane variety Thatta-10

Sr. No.	Treatments (Mulch + N)	Germination %	Cane length (cm)	Cane girth (cm)
1.	Control (No much: 225 kg ha^{-1} N)	59.00 b	232.33 b	2.26 c
2.	Mulch+225 kg N	51.00 d	236.33 b	2.38 b
3.	Mulch+250 kg N	64.00 a	246.00 a	2.67 a
4.	Mulch+275 kg N	54.00 c	248.00 a	2.36 b
5.	Mulch+300 kg N	48.00 e	248.33 a	2.31 b
S.E.±		1.082	2.002	0.024
LSD 0.05		3.491	5.746	0.106
LSD 0.01		5.038	7.544	0.162

Number of internodes cane^{-1}

Number of internodes cane^{-1} is directly proportional to cane length. The data regarding the number of internodes cane^{-1} for sugarcane variety Thatta-10 as affected by trash mulch + different levels of N fertilizer are shown in Table-2. The maximum number of internodes (22.20) was recorded in crop with trash mulch + 250 kg N ha^{-1}, while the number of internodes decreased to 20.43 and 20.28 when the crop was mulched with trash and fertilized with 275 kg N ha^{-1} and 300 kg N ha^{-1}, respectively. The crop treated with trash mulch + 225 kg N ha^{-1} resulted in 19.00 internodes cane^{-1}, while the lowest number of internodes (18.80) cane^{-1} was achieved from the plots given N @ 225 kg ha^{-1} and no mulching (control). The results clearly showed that trash mulch was effective to increase number of internodes significantly ($P<0.05$), while with increasing N level beyond 250 kg N ha^{-1} the number of internodes gradually reduced under N application at the rates of 275 and 300 kg ha^{-1}. Regardless the mulching practice, 250 kg N ha^{-1} showed superb performance and further increase in N rate would be uneconomical for sugarcane. Most of the studies are in concurrence with the present findings. Hussain and Afghan (2001) reported that number of internodes generally is associated with genetic factors, but the internodes can be associated with cane length. In another study, Chatta (2007) found that under mulching and higher N levels, the number of internodes were increased, but this trait was generally associated with cane length.

Cane yield ha^{-1}

The results in regards to cane yield ha^{-1} of sugarcane variety Thatta-10 as affected by trash mulch + different levels of N fertilizer are presented in Table-2. The data showed that the higher cane yield of 117.67 tons ha^{-1} was achieved in crop treated with trash mulch + 250 kg N ha^{-1}, while the cane yield showed adverse trend i.e. decreased to 110.33 tons ha^{-1} and 105.33 tons ha^{-1} when the crop was trash mulched and fertilized with higher N levels of 275 kg and 300 kg ha^{-1}, respectively. The crop treated with trash mulch + 225 kg N ha^{-1} resulted cane yield of 109.33 kg ha^{-1}, while the lowest cane yield of 92.80 kg ha^{-1} was achieved from the plots given N @ 225 kg ha^{-1} without mulching (control). The trash mulch showed significant and positive effect on cane yield ($P<0.05$), while increasing N levels beyond 250 kg N ha^{-1} did not show economic effects and yield decreased under N application of 275 and 300 kg ha^{-1} over 250 kg ha^{-1}. Irrespective of trash mulch, 250 kg N ha^{-1} maximized the cane yield, while differences in cane yield under 275 kg and 300 kg N ha^{-1} were non-significant. These results are further supported by those of Mui *et al.* (1996), Yadav *et al.* (2009), Hussain and Afghan (2001), Chatta (2007) and Kanchann (2009) who found that due to mulching in sugarcane, the crop yield was increased, because mulching conserve the moisture and nutrients and check the weed growth. Moreover, higher N levels obviously results in increased cane yield, but excessive N application may decrease the yield.

Sugar recovery

The data pertaining to sugar recovery of variety Thatta-10 as influenced by trash mulch + different levels of N fertilizer are shown in Table-2. The results showed that the highest sugar recovery of 10.90 percent was noted in crop treated with trash mulch + 250 kg N ha^{-1}, while the sugar recovery followed a negative direction i.e. 10.58 and 10.43 percent when the crop fertilized with higher N levels of 275 and 300 kg ha^{-1}, respectively. The crop treated with trash mulch + 225 kg N ha^{-1} resulted sugar recovery of 10.78 percent, while the sugar recovery under control treatment was 10.51 percent. This indicated that increasing N levels although improved the plant growth slightly, but due to excessiveness of N, the recovery started decreasing when applied beyond 250 kg ha^{-1}. Statistically, the differences in recovery between N levels of 275 and 300 kg ha^{-1} was non-significant ($P>0.05$) and significant

($P<0.05$) when compared with rest of the treatments. The present findings are in accordance with those of Mui *et al.* (1996), Yadav *et al.* (2009), Hussain and Afghan (2001), Chatta (2007) and Kanchann (2009) who reported that higher N levels results in increased sugar content, but its application beyond optimum level, will result in loss of sugar content. Moreover, the findings also suggested that organic mulches are economical and effective to improve sugar recovery.

Table-2 Effect of trash mulch + nitrogen levels on number of internodes, cane yield and CCS of sugarcane variety Thatta-10

Sr. No.	Treatments (Mulch + N)	No. of internodes cane^{-1}	Cane yield (tons ha^{-1})	C.C.S. (%)
1.	Control (No much: 225 kg ha^{-1} N)	18.80 c	92.33 c	10.51 b
2.	Mulch+225 kg N	19.00 b	109.33 b	10.78 a
3.	Mulch+250 kg N	22.20 a	117.67 a	10.90 a
4.	Mulch+275 kg N	20.43 b	110.33 b	10.58 b
5.	Mulch+300 kg N	18.28 c	105.33 b	10.43 b
S.E.±		0.719	2.002	0.024
LSD 0.05		1.578	6.692	0.203
LSD 0.01		2.244	9.519	0.452

CONCLUSIONS

It was concluded that systematically applied trash mulch showed positive impact on all the studied traits of sugarcane variety Thatta-10 including cane yield and recovery. Moreover, higher N levels of 300 and 275 kg ha^{-1} slightly increases cane length, but cane girth, internodes, cane yield and recovery decreased over 250 kg ha^{-1} N level. This indicates that for obtaining economically maximum crop performance for sugarcane variety Thatta-10, the sugarcane may be trash-mulched and N may be applied at the rate of 250 kg ha^{-1}.

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