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Bio-waste from tobacco industry as tailored organic fertilizer for improving yields and nutritional values of tomato crop

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Abstract: *The dried tobacco waste was mixed in proportions of 1 %, 2 % and 3% in soil and filled in earthen pots of 6kg capacity. Three replicate pots for each soil concentration were used. Tomato saplings of cultivar Bezosheetal were transplanted age of 20 days (signifying stage before flowering), 25 days (signifying stage at the start of flowering) and 45 day (signifying just at the onset of fruiting). The morphological parameters like plant height, number of leaf, flower plant^{-1}, number of fruits and yield plant^{-1} were recorded. Nutrient parameters like moisture, total soluble solids (TSS), acidity, vitamin C, reducing sugar, proteins, pectin and lycopene were analyzed in tomato fruits. Experiments revealed that the yield of tomato fruit and critical nutritional parameters showed significant increase. For higher yield (183 g plant^{-1}) of tomato, the best option is the use of 3% tobacco waste after 45 days of transplant. Alternatively, use of 2% tobacco waste with 45 days of transplant provides a higher quality tomato. The yield obtained here would be significantly higher than control but not as high as with 3% tobacco waste.*

Key words: *Tobacco waste, Organic fertilizer, Tomato, Nutrient, Bio-waste*
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Introduction

Several types of bio-waste have shown potential of being used as fertilizers not only to improve the organic content of soil but also to act as insecticide/ fungicide. Wastes of *Nicotiana*, *Jatropha*, *Azadirachta*, *Salvadora*, *Maduca* and *Pongamia* are examples of plants whose commercial exploitation results in production of bio-waste (Kulkarni *et al.,* 2007). India is the third largest producer of tobacco in the world after China and USA. Though it occupies a mere 0.25% of the cropped area in the country, it contributed Rs 507 crores to the foreign exchange earnings and Rs 3200 crores to the exchequer by way of central excise during 1992-93 (Singh *et al.*, 2006). Tobacco waste or residues resulting from the cigarette industries could pollute the environment if they are not disposed off or used in agricultural practices as organic fertilizer (Sungur, 1978).

Tobacco waste is rich in nitrogen (2.35%), potassium (1.95%), and phosphorus (973 µgg^{-1}). Saltali and Brohi (1993) observed that the application of tobacco waste to artificially drained alkaline soils improved their physical as well as chemical properties including the availability of nutrients to the plants. The alkaline soils which received tobacco waste contained higher amount of nitrate and carbon dioxide as compared to the application of other organic materials and higher grain yield in wheat Durak *et al*. (1986); Gok *et al*. (1988). Brohi and Karaman (1998) studied the utilization of tobaccowaste and found an increase in the nitrogen content of wheat straw from 0.4% to 0.7% when tobacco waste was applied at the rate of 40 tons/ha. This was also observed by Katkat (1991), that application of tobacco-waste positively affects nitrogen content of wheat grain.

Karaman *et al*. (2004) found that tobacco waste had a positive effect on the growth and on the nitrogen uptake of maize crop. Ozguven *et al*. (1997), suggested that tobacco compost can be used as an alternative to farm yard manure for early yield and better quality.

There have been several prior researches that have confirmed improved quality of tomato crop grown on soil treated with organic fertilizer. Organic farming involves natural pesticides which are safe and does not reduce the nutrient value of tomato while a commercially grown tomato will certainly lose its nutrition because of the predominant use of chemical pesticides (Hegde *et al*., 2003). Significant differences in nutritional quality have been observed between organically and conventionally grown tomatoes and total carotenoids /antioxidant activity was found to be higher in organic tomatoes (Karaman *et al.*, 2004).

Hence, there is a need for developing tailored formulation of organic fertilizers which utilize wastes like tobacco and result in better yields and fruit quality. In the present study, tobacco-waste was applied as organic fertilizer to determine its impact on growth and quality of tomato crop.

Materials and Methods

The dried tobacco waste was obtained from a local processing unit 'Sanjay Jarda Factory' situated at chottashah Alamroad, Shahdatganj in district Lucknow, Uttar Pradesh, India. The tobacco-waste was mixed in proportions of 1% (T1), 2% (T2) and 3% (T3) in soil and filled in earthen pots of 6kg capacity. Three replicate pots for each soil concentration were used. Tomato saplings of cultivar *Bezosheetal* were transplanted with age of 20 days (signifying stage before flowering denoted as D1), 25 days (signifying stage at the start of flowering denoted by D2) and 45 day (signifying just at the onset of fruiting denoted by D3). The pots were shifted to a net house and prescribed cultural practices were followed Subrahamanyam (1982). The samples from each treatment were collected at the red ripe stage of tomato fruit.

The morphological parameters like plant height, number of leaf, flower plant^{-1}, number of fruits and yield plant^{-1} were recorded.

Nutrient of tomato fruits were analyzed. TSS content of the fruit was measured by Hand refractometer (Erma, Japan) by putting small quantity of pulp between the prisms and reading was expressed in terms of ^{o}Brix. Titratable acidity was estimated by titrating the pulp extract with 0.1N sodium hydroxide using phenolphthalein as indicator (Ranganna, 1986). Moisture in tomato fruits was estimated by drying the samples to a constant weight in an oven at 60^{o}C. Lycopene, vitamin C and pectin were analyzed as per the methods described by Ranganna (1986). The reducing sugars were estimated by the method of Folin and Wu (AOAC, 1975).

The data was subjected to statistical analysis by using Two-Way ANOVA. The significance of impacts of treatments was determined using F-test with 5% level of significance.

Results and Discussion

Growth parameters: Growth parameters like height achieved, leaf plant^{-1}, numbers of flowers and fruit yield are presented in Table 1.

For D1, there was an improvement in number of leaves plant^{-1} as compared to control. Average number of leaves was 8 for T2 and T3, which was higher as compared to 6 for control. Number of flowers was as high as 8 for T2 which was higher than control. These results are similar to Hunt and McNeil (1998) who had observed significant increase in leaf number and thickness due to increased nitrogen supply on cucumis sativas. The higher number of leafs and flowers can be attributed to the presence of higher quantities of nitrogen in tobacco-waste. There was however, no significant difference for other morphological parameters.

For D2, the plant height was 30 cm for T3, which was higher as compared to 26 cm for control. Similarly, number of leaves plant^{-1} for T3 was 12 as compared to 7 for control and number of fruits plant^{-1} was 7 as compared to 4 for control. The results for T1 and T2 were similar to that of control.

Similarly, for D3, The plant height recorded was 32 cm in T2, 30 cm in T3, which was higher than 20 cm recorded in control. Average number of leaves plant^{-1} was 11 in T3, which was higher than control. Average number of flower was 10 in T2, which was high as compared to 5 in control and average number of fruits plant^{-1} was 6 in T2 and T3, which was higher than control. The better plant growth may be due to the presence of utilizable plant nutrient in tobacco-waste.

Agrawal *et al.* (2006) in their study have found beneficial effect of nutrients like nitrogen and phosphorus on plant growth and yield of moong bean. Levizou and Manetas (2000) had observed that a high nutrient level of N, P and K improve the growth in phlomis fruticosa. Thus the improved morphological parameters in plants produced on treated soil are due to enhanced nitrogen and phosphorus levels resulting from application of tobacco-waste.

The yield results for various treatments are displayed in Table 2. The two-way ANOVA results are displayed in Table 3. The results show that the F-values obtained for treatment factor percentage organic fertilizer and treatment factor days of transplant were higher than the F-values corresponding to 5% significance, thus rejecting the hypothesis that the varying treatments do not result in change in values of average yield parameter. The results of the One-Way ANOVA tests of comparison of average yield values are displayed in Table 2.

For D1, as compared to the yield in control soil (91 g), the yield plant^{-1} was highest in T3 (125 g), an increase of 43%. The yield plant^{-1} for T2 was 101 g, an increase of 11%, while for T1 it was 96 g an increase of just 5%. The yield corresponding to T2 and T3 was significantly higher than control at 95% confidence level (Table 2).

For D2, the yield plant^{-1} recorded was higher than control (123 g) only for T3 (150 g), which was an increase of 22%. However, this increase was not significant at 95 % confidence level.

For D3, the increase in yield plant^{-1} as compared to control was 45% corresponding to T3. The increase in yield for T2 was 16% and just 10% for T1. The yield corresponding to T3 was significantly higher than yield corresponding to control at 95% confidence level.

Khan and Khan (1996) had studied the effect of fly ash on the plant growth and yield of tomato. They had concluded that improved growth and yield was apparently due to presence of utilizable plant nutrients like sulphate, P, K, Ca, B, Mg, and Mn in fly ash. We are observing a similar phenomenon in the present research, where the utilizable plant in nutrient available in soil treated with tobacco-waste is causing improved yields and growth.

From the above analysis, we can conclude that the best results, as far as tomato fruit yield is concerned, were obtained by using T3 this could be due to adding of tobacco-waste which increase soil porosity and water holding capacity which may be beneficial for plant yield.

Nutrition parameters: The Two-Way ANOVA test results for various nutritional parameters are displayed in Table 3. The results show that for nutrients like lycopene, pectin, protein, reducing sugar, TSS, acidity and moisture the F values are higher than corresponding value for 5% significance, which rejects the hypothesis that the varying treatments do not result in change in

Table - 1: Morphological characters of tomato plants under various treatments

	D1				D2				D3			
Parameters	**Control**	**T1**	**T2**	**T3**	**Control**	**T1**	**T2**	**T3**	**Control**	**T1**	**T2**	**T3**
Plant height (cm)	23 (22-24)	19.5 (19-20)	21 (16-26)	20 (19-22)	26 (20-30)	28 (26-30)	22 (21-25)	30 (26-40)	27 (26-31)	28 (25-30)	32 (20-45)	30 (27-32)
Number of leaves plant^{-1}	6 (5-7)	7.5 (5-9)	8 (7-9)	8 (7-9)	7.5 (4-13)	9.5 (8-11)	7 (6-8)	12 (8-15)	9.5 (4-13)	7.5 (7-8)	8 (6-10)	11 (8-12)
Number of flowers	3 (1-7)	3.5 (2-5)	8 (1-15)	3.5 (1-6)	4.5 (1-7)	4 (3-5)	3 (1-5)	4 (3-5)	5 (2-12)	6 (4-7)	10 (7-13)	6 (3-10)
Number of fruits	3 (2-4)	2.5 (1-3)	1.5 (1-2)	2.5 (2-3)	4 (2-5)	2 (1-3)	4 (3-5)	7 (3-9)	4 (1-9)	3 (2-4)	5 (2-8)	6 (4-7)

T1 = 1% tobacco-waste in soil, T2 = 2% tobacco-waste in soil, T3 = 3% tobacco-waste in soil, D1 = Transplant on 20 days, D2 = Transplant on 25 days, D3 = Transplant on 45 days, Note = Range is given in parenthesis

Table - 2: Yield and Nutritional composition of tomato fruit under various treatments of tobacco-waste

	D1				D2				D3			
Parameters	**Control**	**T1**	**T2**	**T3**	**Control**	**T1**	**T2**	**T3**	**Control**	**T1**	**T2**	**T3**
Yield (g)	91.25	96.67	101.67	125.00*	123.75	116.67	108.33	150.00	124.00	136.67	143.33*	183.33*
Moisture (%)	92.37	92.50	93.30*	93.06*	92.49	93.57*	92.85	92.08	92.47	93.34*	93.08	93.43*
Acidity (%)	0.70	0.68	0.64**	0.74*	0.70	0.81*	0.66	0.74	0.69	0.69	0.64**	0.64**
TSS (^{0}B)	5.20	5.21	5.3	4.7	5.20	5**	5.23	5.5*	5.2	5.03**	5.4*	4.9**
Vitamin C (mg 100 g^{-1})	29.40	30.40	34.80*	23.20**	29.40	33.30*	37.70*	21.70**	29.6	27.5	44.9*	23.2**
Reducing sugars (%)	1.27	1.1**	1.62*	2.13*	1.27	1.13**	1.63*	1.55*	1.27	1.45**	1.64*	2.2*
Protein (mg 100 g^{-1})	557.04	664.82*	711.4*	1354.4*	557.04	624*	812.4*	665.98*	544.7	532.8	692.9*	589.48*
Lycopene (mg 100 g^{-1})	3.45	4.1*	2.17**	4.13*	3.45	2.99**	4.89*	3.49*	3.43	2.74**	3.86*	3.07**
Pectin (mg 100 g^{-1})	253	290.33*	384.6*	190.6	253	256.38	438.6*	246.6	260	300.6*	398*	158**

* = Indicates that the average value of the nutrient is significantly higher than the average value corresponding to control,
** = Indicates that the average value of the nutrient is significantly lower than the average value corresponding to control Significance level is 5%

average nutrient values. The results for comparison of means are also displayed in Table 2.

The analysis of average nutrient values on various treatments reveals that for D1, nutrients like moisture, acidity, reducing sugars, proteins and lycopene were found to be highest in fruits produced on T3 and they were significantly more than corresponding values for control. As the table reveal, the increase recorded for acidity was 5.71%, reducing sugars were 67.71%, protein was 143% and lycopene was 19.71% over their corresponding control values. There was a significant decrease of 21.09% recorded for vitamin C as compared to control. However, the differences in values for other nutrients like pectin and TSS were insignificant.

For D2, the average values of TSS, reducing sugars, protein and lycopene were significantly higher than the corresponding control values in treatment T3. The increase in TSS value recorded was 5.77%, reducing sugars were 22.04%, protein was 19.56% and lycopene was 2% as compared to their corresponding control values. The differences in values for Acidity, and pectin were insignificant; however, there was a significant decrease of 26.2% for vitamin C as compared to control.

TAble - 3: Analysis of variance (Two-Way ANOVA) for yield and nutrition values

Source of variation (treatments)	Degrees of freedom (DF)	F at 5% level of significance	F Values of key parameters								
			Yield	Lycopene	Pectin	Protein	Vit C	R. sugar	TSS	Acidity	Moisture
Treatment factor: Percentage of organic fertilizer	3	3.01	12.26	3320.35	7.43	82.75	28.88	17.36	48.32	5.80	136.48
Treatment factor: Plant age when applied	2	3.40	17.23	3215.92	6.04	15.07	47.45	14.11	11.64	2.34	47.45
Interaction	6	2.51	2.56	1243.89	14.04	14.65	20.06	9.06	23.26	1.11	38.83
Error	24										
Total	35										

Similarly, for D2 and treatment T2, vitamin C, reducing sugars, proteins, lycopene and pectin values was significantly higher as compared to control. The increase in vitamin C content was recorded as 29.23%, reducing sugars were 28.35%, protein was 45.84%, lycopene was 41.74% and pectin was 73.36%. The differences in other parameters like acidity and TSS were insignificant.

For D3, moisture, reducing sugars, TSS, vitamin C, proteins, lycopene and pectin values for treatment T2 were significantly higher than control. The increase recorded in TSS was 3.77%, vitamin C was 51.69%, reducing sugars was 29.13%, protein was 27.20%, lycopene was 12.54% and pectin was 53.08% over the corresponding control values. There was a significant decrease of 7.8% only in case of acidity as compared to control values

Similarly, for D3 and treatment T3, the only significant increase was recorded for reducing sugar (73.22%) and protein (8.22%).However, there was significant decrease in values for acidity-7.8 %, TSS - 5.77%, vitamin C -21.62%, lycopene -10.43% and pectin - 39.23%.

Bryant *et al.* (1983) had proposed that the availability of carbon and nutrient resources in local environment greatly influenced the amount of carbon based secondary plant compounds found in plants. In the present study the tobacco-waste treated soil is providing carbon and nutrient resources which is probably the cause of increased levels of nutrients like lycopene.

It has been established that application of tobacco waste improve the alkaline soils in arid and semi arid regions (Saltali and Brohi, 1993), increase the soil organic matter, nitrate content of the soil (Durak *et al.,* 1986). The plants also utilize the different macronutrients available in tobacco-waste. Tobacco-waste increased N-content in wheat straw (Brohi and Karaman, 1998; Korkmaz *et al.,* 1991).

Similar to the above mentioned research findings, in the present study, the tomato fruits also exhibit increased level of protein from 557.04 mg/100 g (control) to 1354.4 mg/100 g. There have been improvements in other key nutrients also.

Thus we find that fruits produced on D3 on one side significantly exhibit higher yield on T3 concentration but the key nutritional contents like lycopene, pectin and vitamin C were being compromised. Alternatively, for T2, significantly high values for key nutrients like vitamin C, proteins, lycopene and pectin are being obtained. However, the yield though significantly higher than control is not as high as that obtained on T3.

From the above discussions we can conclude that adding tobacco waste in soil has definite positive influence on yield for D1 and D3 transplants. Best results were obtained for D3 transplant and T3 composition. While the nutritional values improved for D3 transplants and T2 compositions, the results for D3 with T3 were not that encouraging as key nutrients recorded inferior values than control.

If one desires a higher yield of tomato, then the best option is to use T3 along with D3. Alternatively, we go for higher quality tomatoes best option is to use. T2 with D3 transplant. The yield obtained here would be significantly higher than control but not as high as yield with T3.

A Third alterative is to use D1 with T3. In this formulation, one is getting moderately but significantly higher yield as compared to control and also getting comparable or higher nutritional values.

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