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Quality Parameters as Influenced by Different Integrated Nutrient Management of Rustica Tobacco (*Nicotiana rustica* L.) and Its Residual Impact on Succeeding Summer Green Gram (*Vigna radiata* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present research work entitled "Quality parameters as influenced by different integrated nutrient management of rustica tobacco (*Nicotiana rustica* L.) and its residual impact on succeeding summer green gram (*Vigna radiata* L.) " a field experiment was conducted during *rabi* and summer season of years 2020-21 and 2021-22 at Bidi Tobacco Research Station, Anand Agricultural University, Anand, Gujarat. The experimental field had an even topography with a gentle slope having good drainage and sandy loam in texture. The soil of the experimental field at 0-15 cm depth was low in organic carbon and available nitrogen, medium in available phosphorus and potassium and slightly alkaline in reaction. The ten integrated nutrient management treatments *viz.*, T_1: 100% RDF (200-00-00 kg/ha), T_2: 75% RDF + 25% N from FYM, T_3: 75% RDF + 25% N from poultry manure, T_4: 75% RDF + 25% N from castor cake, T_5: 50% RDF + 50% N from FYM, T_6: 50% RDF + 50% N from poultry manure, T_7: 50% RDF + 50% N from castor cake, T_8: 50% RDF + 25% N from FYM + Azotobacter, T_9: 50% RDF + 25% N from poultry manure + Azotobacter, T_{10}:

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50% RDF + 25% N from castor cake + Azotobacter were tested in Randomized Block Design with four replications. Rustica tobacco variety GCT 3 was considered as main *rabi* crop and green gram variety GAM 5 was considered as summer residual crop. The experiment was conducted on the same site during both the years without changing randomization of treatments. Results of the experiment showed that quality parameters *viz.* nicotine content was found significant due to various integrated nutrient management during both the years (2020-21 and 2021-22) in pooled analysis, while reducing sugar and chloride content was found non-significant during both the years (2020-21 and 2021-22) but significant result was observed in pooled analysis due different integrated nutrient management in both quality parameters under application of 75% RDF + 25% N from poultry manure (T_3). In case of residual summer green gram protein content in seed and protein yield exerted significant result due to various integrated nutrient management during the years 2021, 2022 and in pooled analysis under application of 50% RDF + 50% N from FYM (T_5). Interaction effect (Y x T) was found non-significant on all the growth parameters during the experiment.

Keywords: INM; residual; nicotine, chloride; reducing sugar; protein; quality.

1. INTRODUCTION

Tobacco, an important non-food narcotic cash crop, belongs to the night shade family (Solanaceae), is believed to be introduced in India from its native Central America by Portuguese in 1603. Tobacco has long been used in Americas, with some cultivation sites in Mexico dating back to 1400-1000 BC. Historically, people from Northeast Woodlands cultures have carried tobacco in pouches as a readily accepted trade item. Many species of tobacco are in the genus of herbs *Nicotiana.* "Most nightshades contain varying amounts of nicotine, a powerful neurotoxin to insects. However, tobacco tends to contain a much higher concentration of nicotine than the others" [1].

India is one of the principle tobacco producing countries in the world. Amongst the 66 known species of *Nicotiana,* mainly two species, *N. tabacum* and *N. rustica* are the cultivated ones. *N. tabacum* is grown all over the country while, *N. rustica* is confined mainly to the northern and north eastern areas of the country. Various types of tobacco grown in the country are mainly *Flue Cured Virginia* (FCV), *bidi, hookah, chewing, snuff, lanka, cigar-wrapper, cigar-filler*, *cheroot, oriental, pikka, natu,* Burley and HDBRG.

The crop occupies less than 0.23% of the net cultivated area and earns sizable amount of ₹21,919 crores to the nation as foreign exchange (₹5869 crores; Anon. [2]) and central excise (₹16050 crores; Anon. [3]) to the national exchequer besides providing direct and indirect employment to 36 million people including six million farmers and workers. In India, tobacco is grown mainly in Gujarat, Andhra Pradesh, Karnataka, Uttar Pradesh, West Bengal, Tamil Nadu, Orissa, Bihar and Maharashtra.

Gujarat occupies first place from productivity view point followed by Andhra Pradesh. 90% of tobacco grown in the state is accounted by bidi tobacco. Among the Gujarat state, Anand, Kheda, Mahesana, Banaskantha, Vadodara, Sabarkantha, Gandhinagar, Patan, Arvalli, Mahisagar and Ahemdabad are important tobacco growing districts of the state. Among all, Anand district stands first in production as well as hectrage. Tobacco is grown extensively as a commercial non-food crop throughout the world by both large and small holder farmers.

"Rustica tobacco is locally known as culcatti or vilayati tobacco. India is the only country, where mainly *tabaccum*, *rustica* and other types of tobaccos are grown under varied agro-climatic conditions throughout the country. *Rustica* types are used in chewing and snuff whereas, *tabacum* type used for all purpose. It is very potent variety of tobacco, containing up to nine times more nicotine than common species of *Nicotiana* such as *Nicotiana tabacum*. More specifically, *N. rustica* leaves have a nicotine content as high as 9% whereas, *N. tabacum* contain about 1-3%. The high concentration of nicotine in its leaves makes it useful for producing pesticides and it has a wide variety of uses specific to cultures around the world" [4].

Nicotiana rustica is often used for entheogenic purpose by South Americans shamans, because of its high nicotine content and comparitively high levels of beta-carbolines, including the harmala alkaloids, harmane and northarmane. In a

preparation known as *singado* or *singa*, *N. rustica* is allowed to soak or be infused in water and the water is then insufflated in to the stomach. The plant is also smoked in cigars, used in enemas and made into lickable product known as *ambil*.

Among the pulses, summer green gram is more cosmopolite and grown in most of the region of India, which shown very encouraging results and promises to have a far reaching significant in achieving a breakthrough in the pulse production. Summer green gram is cultivated throughout the India for its long pods and pulses as well as green manure and fodder. It is also grown for hay, silage and pasture for all types of stalk and as a source of protein, especially in lysine and tryphtophan in the staple cereal diets of the farming communities.

"Green gram (*Vigna radiata* (L.) Wilczek is one of the most ancient and extensively grown leguminous crops of India. It is a native of India and Central Asia and commonly known as mung bean. It is the third important pulse crop after chickpea and pigeon pea, cultivated throughout the India for its multipurpose uses as vegetable, pulse, fodder and green manure crop" [5]. Green gram is an important pulse crop of India as it is grown in area of 3.44 M ha with total production of 1.4 MT and productivity of 406.98 kg/ha [6].

In India, major green gram producing states are Odissa, Madhya Pradesh, Rajasthan, Maharshtra, Gujarat and Bihar. In Gujarat, it is cultivated in about 2.3 lakhs hectare with an annual production of 1.21 lakhs tonnes with average productivity of 526.09 kg/ha (Anon., 2015[c]). Its seed is more palatable, nutritive, digestible and non-flatulent than other pulses grown in the world. It is a good source of protein (20-24%), carbohydrates (60-62%), water (10%), fat (1.0%), fibre (4.0%) and ash (3.0%).

"Integrated nutrient management refers to the maintenance of soil fertility and plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all the possible sources of organic, inorganic and biological components in an integrated manner. Integrated nutrient management involving conjunctive use of organic manures like farmyard manure, poultry manure, castor cake and bio-fertilizers improves the productivity and quality of tobacco and ensures greater returns to the farmers besides improving soil health" [7].

"FYM seems to act directly for increasing crop yield by accelerating the soil microbial activities, which supplies nitrogen, phosphorus, sulphur and other nutrients in available form to the plants through biological decomposition. Indirectly, it improves the physical properties of soil such as aggregation, aeration, permeability and water holding capacity" [8]. FYM on an average contains 0.5 to 1.0 per cent N, 0.15 to 0.2 per cent P_2O_5 and 0.5 to 0.6 per cent K_2O [9]. Poultry manure contains about 3.0 per cent N, 0.63 per cent P_2O_5 and 1.40 per cent K_2O [9]. "It contains uric acid having 60.0 per cent nitrogen which change rapidly to ammonium form and hence efficiently utilized for better plant growth. Castor is one of the excellent source of organic manure. It contains about 4.4 per cent N, 2.0 per cent P_2O_5 and 1.5 per cent K_2O along with large quantity of organic matter, oil cakes are quick acting organic manure" [9].

"Bio-fertilizers, a component of integrated nutrient management and are considered to be cost effective, eco-friendly and renewable source of non-bulky, low cost plant nutrient supplementing fertilizers in sustainable agriculture system in India. The seedlings of tobacco were dipped in the azotobacter solutions with an objective of increasing their number in the rhizosphere and substantial increase in N availability for plant growth" [7].

2. MATERIALS AND MATHODS

In order to achieve the pre-set objectives of the present exploration, a field experiment was conducted during the *rabi* and summer season of the year 2020-21 and 2021-22 on plot No. 4 A at Bidi Tobacco Research Station, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat). The experimental field had an even topography with a gentle slope having good drainage and sandy loam in texture. The soil is representative of the region and locally known as *Goradu* soil, which is alluvial in origin and very deep. The texture of the soil is loamy sand. The soil is fairly moisture retentive. The soil responds well to manure, fertilizers and irrigation. It is quite suitable for variety of crops of tropical and sub - tropical regions. The depth of ground water table is being more than 10 meter. Hence, there is no problem of high water table in this area. The physico - chemical properties of the experimental plot were determined by drawing the soil samples randomly collected from the different spots in the field at a depth of 0-15 cm before commencement of the experiment and

composite sample was prepared. After analysis physico - chemical properties of the soil. Data on initial soil analysis indicated that the experimental site was low in organic carbon (0.31%) and available nitrogen (218.6 kg/ha) while, medium in available phosphorus (42.56 kg/ha) and high in available potassium (302.53 kg/ha). The ten integrated nutrient management treatments *viz.*, T_1: 100% RDF (200-00-00 kg/ha), T_2: 75% RDF + 25% N from FYM, T_3: 75% RDF + 25% N from poultry manure, T_4: 75% RDF + 25% N from castor cake, T_5: 50% RDF + 50% N from FYM, T_6: 50% RDF + 50% N from poultry manure, T_7: 50% RDF + 50% N from castor cake, T_8: 50% RDF + 25% N from FYM + Azotobacter, T_9: 50% RDF + 25% N from poultry manure + Azotobacter, T_{10}: 50% RDF + 25% N from castor cake + Azotobacter were tested in Randomized Block Design with four replications. The simple technique of analysis of variance may not be valid under two different seasonal conditions as the error variances in the seasons and the treatments x season's interaction may be significant. Hence, pooled analysis of the preceding *rabi* tobacco and succeeding summer green gram analyzed for two years was worked out as per the method described by Panse and Sukhatme [10].

2.1 Nicotine Content

Nicotine content was calculated by following Harvey and Smith [11]. In this method, two hundred mg cured leaves of tobacco was weighed into a 125 mL Erlenmeyer flask. Two mL of carbon suspension and 98 mL of the extract solution was added, and the flask was stoppered and shaken for five minutes. The carbon and insoluble material were removed by gravity filtration through Whatman no. 1 filter paper. The filtrates were sampled by the auto-analyzer and nicotine content was determined.

The nicotine content was calculated as follows:

$$Nicotine\ alkaloids\ (\%) = \frac{mg/mL\ nicotine \times 10000}{mg\ of\ sample}$$

Reducing sugar: Reducing sugar was calculated by following Shaffer and Somogyi method [12], modified by

$$Reducing\ sugar\ (\%) = \frac{g/mL\ reducing\ sugar \times 100 \times 100}{mg\ sample}$$

Chloride content: Chloride content was calculated by following Venkataraman and Murthy [13]. In these method tobacco leaf extractant was titrated with silver nitrate.

Chloride (%) = Reading × 0.355

Protein content: Representative samples of the seeds were taken from each treatment and dried in oven at 65 ^{0}C temperature for 24 hours and powdered by mechanical grinder. Then nitrogen content of the seeds was determined by Micro Kjeldahl's method (Jackson, 1973).

The protein content in the seeds was calculated by multiplying nitrogen content (%) of the seeds with the conversion factor of 6.25.

Protein yield: Protein yield per plot was calculated by multiplying protein content of seed with the seed yield (kg/ha) which is divided by hundred.

3. RESULTS AND DISCUSSION

3.1 Nicotine Content (%)

Nicotine content of tobacco by virtue of its stimulatory effect on the smoker is next important constituent. It is considered that nicotine level of 3.5-8.0% in rustica tobacco is most satisfactory. High proportion of nornicotine in cigarette leaf leads to abnormal and objectionable smoke flavor due to pyrolysis of nornicotine into myosmine [11].

Data illustrated in Table 1 and graphically indicated in Fig.1 revealed that nicotine content of tobacco leaves was able to found significantly affected due to different integrated nutrient management treatments. Application of 75% RDF + 25% N from poultry manure (T_3) with values 7.058, 7.065 and 7.061% during years 2020-21, 2021-22 and on pooled basis, respectively registered significantly higher nicotine content as compared to treatment T_8. While, on pooled basis all the treatments were found at par with treatment T_3 except T_8. However, lower values (5.808, 5.853 and 5.830%) of nicotine content were examined under the treatment T_8 during both the years and on pooled basis.

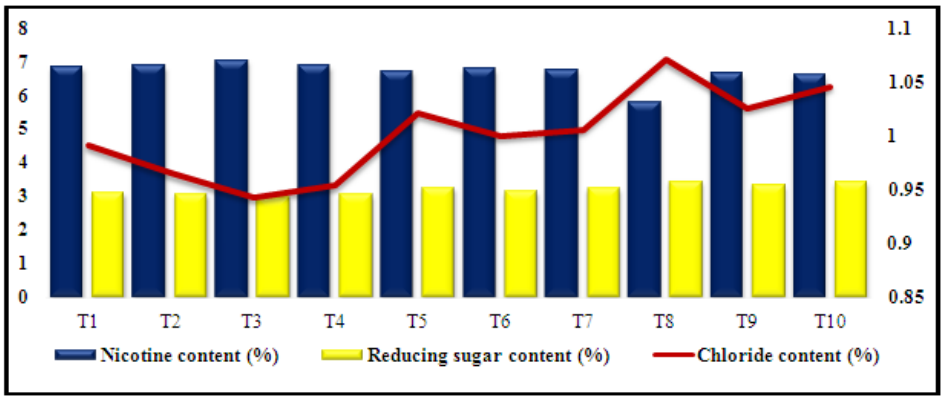

Fig. 1. Effect of INM on quality parameters of rustica tobacco on pooled basis

The result might be due to tobacco leaves contains number of closely related alkaloids of which, nicotine ($C_{10}H_{14}N_2$) is the most important. Thus, nitrogen is a constituent of nicotine, an alkaloid which, is regulated more by nitrogen supply than by any other nutrient resulting into higher nicotine content of the tobacco leaves due to nitrogen which, leads to increase in nicotine content in leaves of tobacco. These results are in conformity with Anon. [14], Anon. [15] and Anon. [16].

3.2 Reducing Sugar Content (%)

Reducing sugar is an important quality parameter which reflects the human health. Lower values of reducing sugar content seems to be safe and desirable. During smoking, sugars are burnt out as CO_2 and water, thus helping to neutralize free base and increase moisture content in smoke and so act as an emollient, if present in excessive quality [12].

The results summarized in Table 1 and graphically represented in Fig. 1 revealed that effect of integrated nutrient management on reducing sugar content of rustica tobacco leaves were failed to show their significant result during the years 2020-21 and 2021-22 but on pooled basis, it exert significant result.

Application of 75% RDF + 25% N from poultry manure (T_3) obtained numerically lower values (3.000 and 3.013%) of reducing sugar content during both the years 2020-21 and 2021-22. Similarly, pooled data on reducing sugar content showed significant value (3.006%) and closely related to treatments T_1, T_2 and T_4.

Reducing sugar is an important quality parameter which reflects the human health. High reducing sugar content is undesirable and impart acidic character to smoke, while low reducing sugar content impart alkalinity to smoke due to high nitrogenous constituents. The result was in close agreement with that of Anon. [14], Anon. [15] and Anon [16].

3.3 Chloride Content (%)

Chloride content act as a negative combustion catalyst to tobacco and hence, lower level of chloride content is good and safe. High level of chlorine in leaf inhibits leaf burn or combustibility. The chlorine content of leaf must be preferably less than 1.5% but should never exceeds 2%. Chlorine content is positively correlated with deterioration of colour. High chloride content in leaf leads to dull muddy orange colour with sour or linoleum smell of leaves of tobacco [13].

The data regarding to the effect of nutrient management on chloride content (%) of rustica tobacco are presented in Table 1 and graphically represented in Fig.1. Results revealed that different integrated nutrient management treatments did not exert any significant effect on chloride content of tobacco leaves during both the years (2020-21 and 2021-22) of experimentation.

Numerically lower values of chloride content (0.945 & 0.940%) was obtained under application of 75% RDF + 25% N from poultry manure (T_3) during both the years 20220-21 and 2021-22. However, on pooled basis it showed significant result regarding chloride content of rustica tobacco with value 0.943% and treatment T_1, T_2, T_4 and T_6 were found at par with T_3.

The result obtained might be due to less chlorine content leaves of rustica tobacco which impart

good colour of leaves. The results are in accordance with the results reported by Anonymous [14], Anon. [15] and Anon. [16].

4. RESIDUAL SUMMER GREEN GRAM

4.1 Protein Content (%)

Proteins are large biomolecules and macromolecules that comprises one or more long chains of amino acid residues. They perform a vast array of functions within organisms, including catalyzing metabolic reactions, DNA replication, responding to stimuli, providing structure to cells etc. (Jackson, 1973).

The result on protein content of residual summer green gram seed as influenced by integrated nutrient management treatments during years 2021, 2022 as well as on pooled analysis are presented in Table 1 and graphically depicted in Fig. 2. The result indicated that significant influence was observed on protein content of residual summer green gram due to integrated nutrient management treatments during years 2021, 2022 and in pooled analysis.

Protein content (21.08, 21.10 and 21.09%) of residual summer green gram grain was found significantly higher under an application of 50% RDF + 50% N from FYM (T_5) during years 2021, 2022 as well as in pooled analysis as compared to other treatments. However, it was closely comparable with treatments T_8, T_9 and T_{10} for the years 2021 and 2022 while, in pooled analysis it was closely related to treatments T_9 and T_{10}.

On the other hand, significantly lower values (18.83, 18.90 and 18.86%) of protein content was noticed under an application of 100% RDF 200-00-00 kg/ha (T_1) during the years 2021, 2022 and in pooled analysis, respectively.

The above mentioned result might be due to increased nutrient content in seeds of green gram especially N and P in organic manures that increased the mineralization synthesis in turn increased protein content and it was supported by Manjhi et al. [17].

4.2 Protein Yield (kg/ha)

The result on protein yield after harvest of residual summer green gram crop as influenced by integrated nutrient management treatments during the years 2021, 2022 as well as on pooled analysis are presented in Table 1 and graphically displayed in Fig. 2.

It is evident from Table 1 and Fig. 2 that integrated nutrient management treatments significantly influenced protein yield after harvest of residual summer green gram crop in both the years as well as on pooled analysis.

A critical examination of data indicated that application of 50% RDF + 50% N from FYM (T_5) recorded significantly higher protein yield (218.97 and 221.91 kg/ha). However, it was statistically at par with treatment T_8, T_9 and T_{10} during the year 2021 and 2022.

Pooled analysis result revealed that significantly higher protein yield (220.44 kg/ha) recorded under application of 50% RDF + 50% N from FYM (T_5). However, treatments T_8 and T_{10} shows at par relation. In contrast to it, significantly lower protein yield (165.20, 166.46 and 165.83 kg/ha) was recorded under application of 100% RDF 200-00-00 kg/ha (T_1) during the years 2021, 2022 and in pooled analysis.

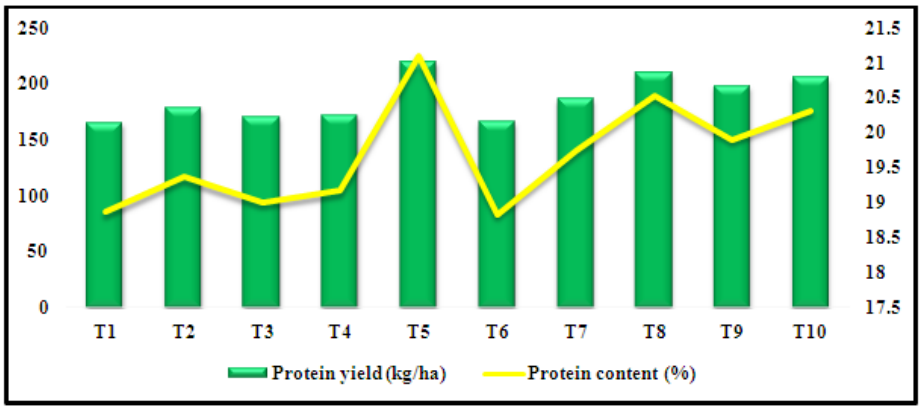

Fig. 2. Effect of INM on quality parameters of residual summer green gram on pooled basis

Table 1. Quality parameters of rustica tobacco and residual summer green gram as influenced by different integrated nutrient management on pooled basis

Sr. No.	Treatments	Rustica tobacco			Residual summer green gram	
		Nicotine content (%)	Reducing sugar content (%)	Chloride content (%)	Protein content (%)	Protein yield (kg/ha)
T_1	100% RDF (200-00-00 kg/ha)	6.863	3.123	0.991	18.86	165.83
T_2	75% RDF + 25% N from FYM	6.885	3.088	0.965	19.36	178.89
T_3	75% RDF + 25% N from poultry manure	7.061	3.006	0.943	19.00	170.32
T_4	75% RDF + 25% N from castor cake	6.910	3.063	0.954	19.16	172.85
T_5	50% RDF + 50% N from FYM	6.736	3.279	1.021	21.09	220.44
T_6	50% RDF + 50% N from poultry manure	6.801	3.171	1.000	18.84	166.32
T_7	50% RDF + 50% N from castor cake	6.770	3.263	1.006	19.73	186.75
T_8	50% RDF + 25% N from FYM + Azotobacter	5.830	3.463	1.071	20.53	210.51
T_9	50% RDF + 25% N from poultry manure + Azotobacter	6.656	3.338	1.026	19.90	198.52
T_{10}	50% RDF + 25% N from castor cake + Azotobacter	6.623	3.438	1.046	20.31	205.73
	SEm ±	0.156	0.078	0.021	0.32	6.17
	CD (P=0.05)	0.444	0.220	0.058	0.91	17.50
	CV%	6.59	6.81	5.82	4.63	9.31
	Y	NS	NS	NS	NS	NS
	Y x T	NS	NS	NS	NS	NS

The above mentioned result might be due to higher protein content in the seed of green gram. Similar results were reported earlier by Manjhi et al. [17].

5. CONCLUSION

The concept of quality has attained a new dimension in the present days because of higher mobility in international market [18], ever growing sophistication among smoker taste, increasing automation in cigarette industry, overall good monetary returns in rustica tobacco as well as good protein content in green gram. Looking at the above facts, an experiment was conducted on quality parameters of rustica tobacco and its impact on residual summer green gram. The above results were catalogued higher under combined application of organic and inorganic fertilizers (75% RDF + 25% N from poultry manure) and residual impact was checked.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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