

GENOTYPIC EVALUATION OF SOME FLUE-CURED VIRGINIA TOBACCO GENOTYPES FOR YIELD AND QUALITY TRAITS

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ABSTRACT

To identify desirable tobacco genotypes for commercial cultivation, an experiment comprising ten flue-cured Virginia tobacco genotypes, including one check cultivar, was conducted in randomized complete block design with four replications at the Tobacco Research Station, Mardan during the 2004-2005 tobacco crop growing season (December-August). Data were recorded on yield and some other important plant characteristics. Statistical analysis of the data was performed and the means were separated using the least significant difference (LSD) test. Analysis of variance revealed that the genotypes differed significantly for plant height, number of leaves plant⁻¹, cured leaf weight, cured leaf number kg⁻¹, yield ha⁻¹, nicotine percentage in the cured leaf, grade index and ratio of reducing sugars to nicotine. However, non-significant differences were observed for green leaf number kg⁻¹ and reducing sugars content in the leaves. KHG-21, KHG-23 and KHG-25 excelled in performance for yield and quality related traits and may be used in future tobacco breeding program. These three genotypes can be used as commercial cultivars in the area after multi-location test trials.

Key Words: Flue Cured Tobacco, Genotypic Evaluation, Quality Traits, Yield and Yield Associated Traits

Citation: Shah, S.M.A., A. Ahmad, F. Mohammad, Hidayat-urRahman, G. Woras, M.Y. Khan and D. Jan. 2008. Genotypic evaluation of some Virginia tobacco varieties for yield and quality traits. Sarhad J. Agric. 24(4): 607-611.

INTRODUCTION

Tobacco belongs to the family *Solanaceae* and the genus *Nicotiana*. Only two species of this genus (*Nicotiana tabacum* L. and *Nicotiana rustica* L.) are widely cultivated all over the world for tobacco production. Tobacco is one of the few crops entering the world trade entirely on leaf basis and is the most widely grown commercial non-food plant in the world. It is used in the manufacture of cigarettes, cigars, biddies among others (Taj, 1994).

In Pakistan tobacco is planted on 56.4 thousand hectares with production of 112.6 thousand tonnes (MINFAL, 2007). The tobacco industry in Pakistan makes a significant contribution in different sectors of the economy: from farming through manufacturing and to retailing the end product. The industry is also a major purchaser of supplies from other industries.

Tobacco has become an important cash crop of North West Frontier Province (NWFP) where the agro climatic conditions are highly suitable for its cultivation. In NWFP it is grown on an area of 36.5 thousand hectares with production of 87.9 thousand tonnes (MINFAL, 2007). Next to sugarcane and sugar beet, tobacco is the major source of income to farmers in the Peshawar valley. Peshawar, Mardan, Hazara and some parts of Malakand Agency are among the largest tobacco producing areas.

Evolution of high yielding tobacco varieties and improvement in leaf quality will fetch increased income to the growers and enhance exports of tobacco and its products. To improve the yield of tobacco, it is imperative to know the important plant characteristics such as plant height, total number of leaves plant⁻¹, cured leaf yield and total yield of different genotypes used in a particular study. Further, tobacco quality plays an important role in marketing of the tobacco as tobacco leaf is marketed by the physical characteristics like body, color, texture and aroma (Woras *et al.*, 1996).

Various biochemical traits like nicotine content, reducing sugars and their relative proportion influence the quality of tobacco. Genetic variation among tobacco genotypes for yield and yield related traits has been previously

reported by researchers (Belyakova *et al.*, 1997; Hanoomanjee *et al.*, 1998 and Liu *et al.*, 1999). Since the genotypes of diverse genetic make-up respond have a differential response to particular climatic conditions, the present study was conducted to evaluate different tobacco genotypes for various morphological and quality parameters. This will help in the identification of suitable tobacco genotypes for commercial cultivation in Peshawar and adjacent valleys.

MATERIALS AND METHODS

Genotypic evaluation of ten flue-cured Virginia tobacco genotypes including one check cultivar was carried out at the Tobacco Research Station, Khan Ghari, Mardan during 2004-2005 tobacco crop growing season (December-August). The genotypes used in the study were KHG-21, KHG-22, KHG-23, KHG-24, KHG-25, K-358, RG-13, RG-17, Spt G-126 and Spt G-28 (check cultivar). Tobacco genotypes KHG-21, KHG-22, KHG-23, KHG-24 and KHG-25 are the landraces grown in different tobacco regions of North West Frontier Province of Pakistan, whereas, RG-13 and RG-17 were of United States origin. Spt G-126 and Spt G-28 (both of Scotland origin) were released by Speight Seed Company while K-358 (United States origin) was released by Northup King Seed Company. First nursery was raised and for this purpose seeding was done on 10th December, 2004. Transplantation was carried out on 11th March, 2005. The experiment was laid out in randomized complete block design (RCBD) with four replications. All ten genotypes were planted in 3 rows plot with ten plants row⁻¹. Row-to-row distance of 90 cm and plant to plant distance 60 cm was used. Nitrogenous, phosphatic and potash fertilizers (NPK) were applied in the ridges before transplantation at the rate of 70(N): 70(P₂O₅): 90(K₂O), ha⁻¹. Normal practices for inter culturing and pest control were followed during the entire growing season.

Data were recorded on ten randomly selected plants at maturity. Plant height was measured from soil surface to the tip of the buds. Total number of leaves plant⁻¹ was recorded by counting the leaves of plants from the bottom to the tip of the main stock. For leaf number kg⁻¹, one kilogram of leaves of each entry was weighed and then number of leaves was counted. Green leaves obtained from each entry were cured in a barn. One kilogram of cured leaves of each entry was weighed and then total number of cured leaves kg⁻¹ was counted. These leaves were the representative of all the three positions of the plant i.e. bottom, middle and top as per the tobacco grading guidelines. The cured leaves obtained from each plot were weighed and the yield from one plot was converted into yield hectare⁻¹. For grade index, the cured leaves were graded on the basis of the recommended classification of the Pakistan Tobacco Board. This grading was based on the color, texture, body and aroma of the leaves. The percentage of desirable grade leaves was determined for each entry. To avoid any effect of plant position, middle cured leaves (1/2 kg) of plants of each entry were selected to obtain percent values of the nicotine and reducing sugars contents. Ratio of reducing sugars (%) to nicotine content (%) was also calculated. The data after compiling was statistically analyzed using MSTATC package version 1.2 (Freed, 1990) and least significant difference (LSD) test was applied to test the significance of genotypic differences.

RESULTS AND DISCUSSION

Plant Height and Number of Leaves Plant⁻¹

Plant height is directly related to the number of leaves that are borne on a tobacco plant, hence the character may be used as an indicator for the potential number of leaves (Ali *et al.*, 1984). Analysis of variance revealed highly significant differences ($P < 0.01$) among the genotypes for plant height (Table I). Mean data displayed that plant height among the genotypes ranged from 149 to 175 cm. KHG-25 and RG-17 had maximum plant heights (175 cm) and thus displayed their superiority for this plant trait. RG-13, however, displayed a minimum value (149 cm) for this trait (Table II). Hashmi *et al.* (1985) and Butorac *et al.* (1999) also observed significant differences among tobacco genotypes for plant height.

Number of leaves plant⁻¹ is one of the major yield components of a tobacco genotype (Woras *et al.*, 1989). Usually high prices are offered for long and broad leaves. Highly significant differences ($P < 0.01$) among the tobacco genotypes were observed for number of leaves plant⁻¹ (Table I). Number of leaves plant⁻¹ among the genotypes varied between 20 and 25. Spt G-28 and Spt G-126 displayed the highest number (25) of leaves while RG-13 had the lowest number (20) of leaves (Table II). Spt G-28 and Spt G-126 excelled in performance for number of leaves plant⁻¹. Our results are in agreement with the findings of Butorac *et al.* (1999) and Liu *et al.* (1999). These researchers also reported significant genetic variation among tobacco genotypes for number of leaves.

Table I. Mean squares for plant height (PH), number of leaves plant⁻¹ (LPP), green leaf number kg⁻¹ (GL), cured leaf number kg⁻¹ (CL), yield hectare⁻¹ (YLD), grade index (GI), nicotine content (NIC), reducing sugars (RS), and ratio of reducing sugars to nicotine (RS/NIC) of 10 flue-cured Virginia tobacco genotypes during 2004-05, Mardan

SOV	DF	PH	LPP	GL	CL	YLD	GI	NIC	RS	RS/NIC
Replications	3	17.6*	5.0*	10.9	538	3035	0.89	0.08*	0.5	0.4
Genotypes	9	236**	8.8**	2.8	724**	8401**	11.1*	0.06*	0.2	0.4*
Error	27	54.7	1.6	1.8	207	2699	4.9	0.02	0.3	0.1

*= Significant at 5% level of probability

**= Significant at 1% level of probability

Table II. Mean values for plant height (PH), number of leaves plant⁻¹ (LPP), green leaf number kg⁻¹ (GL), cured leaf number kg⁻¹ (CL), yield hectare⁻¹ (YLD), grade index (GI), nicotine content (NIC), reducing sugars (RS), and ratio of reducing sugars to nicotine (RS/NIC) of 10 flue-cured Virginia tobacco genotypes during 2004-05, Mardan

Tobacco Genotypes	PH (cm)	LPP	GL	CL	YLD (kg)	GI (%)	NIC (%)	RS (%)	RS/NIC
KHG-21	158	24	27	151	2579	54.2	2.3	12.2	5.2
KHG-22	159	21	25	173	2528	54.7	2.4	12.1	5.0
KHG-23	161	23	25	166	2528	54.7	2.2	12.0	5.7
KHG-24	165	23	25	172	2458	54.7	2.3	12.1	5.4
KHG-25	175	23	24	156	2557	54.2	2.3	11.7	5.1
K-358	164	24	25	152	2457	55.7	2.5	12.1	4.8
RG-13	149	20	25	186	2462	55.5	2.5	11.9	4.8
RG-17	175	23	26	182	2454	56.2	2.4	12.3	5.1
Spt G-126	168	25	26	148	2481	57.5	2.5	12.1	4.8
Spt G-28	159	25	25	157	2483	59.5	2.5	11.6	4.6
LSD(0.05)	10.7	2	-	21	75	3.2	0.22	-	0.55

Green and Cured Leaf Numbers

Green leaf yield is an important characteristic of tobacco crop which not only determines the cured leaf yield potential of a particular genotype but also affects the cost of curing green leaf (Ali *et al.*, 1984; Hashmi *et al.*, 1985). Statistical analysis, however, revealed non-significant differences ($P > 0.05$) among the genotypes for green leaf number kg⁻¹ (Table I). Mean data manifested that the green leaf number kg⁻¹ among the genotypes ranged from 24 to 27 (Table 2). KHG-21 had maximum number of green leaves (27) in one kg (Table II). These results are contrary to the findings of Dimitrova (1998) and Liu *et al.* (1999), which might be due to the variation in genetic material and changes in ecological conditions.

Cured leaf number kg⁻¹ is an important component which determines the yield potential of a genotype (Hashmi *et al.*, 1985). Mean squares revealed highly significant differences ($P < 0.01$) among the genotypes for cured leaf number kg⁻¹ (Table I). Range of cured leaves kg⁻¹ among the genotypes was from 148 to 186. RG-13 displayed maximum value (186) for the trait followed by RG-17, KHG-22 and KHG-24 with 182, 173 and 172 cured leaves in one kilogram of cured leaves, respectively. Tobacco genotype Spt G-126, however, showed the lowest number (148) of cured leaves kg⁻¹ (Table II). Hence, RG-13, KHG-22 and KHG-24 manifested their superiority for this plant characteristic. These results are compatible with the findings of Castelli *et al.* (1994) and Rao *et al.* (1998) who also reported significant genetic variation among tobacco genotypes for this trait.

Yield hectare⁻¹ and Grade Index

Cured leaf yield is one of the most important plant characteristics in tobacco crop as it is highly related to farmer's profit. It is the final product of tobacco crop after passing the green leaves through different curing procedures (Woras, 1993). Highly significant differences ($P < 0.01$) among the genotypes were observed for cured leaf yield hectare⁻¹ (Table I). The value for this trait among the genotypes varied between 2454 kg and 2579 kg in one hectare. Genotype KHG-21 had maximum yield (2579 kg ha⁻¹) followed by KHG-25 with cured leaf yield of 2557 kg ha⁻¹. Check cultivar Spt G-28 produced cured leaf yield of 2483 kg ha⁻¹ whereas, the lowest yield of 2454 kg ha⁻¹ was recorded for RG-17 (Table II). Tobacco genotypes KHG-21 and KHG-25 thus excelled in performance for cured leaf yield. Significant genetic differences among the tobacco genotypes for cured leaf yield as observed in the

present study is compatible with the findings of Butorac (1994), Subbian *et al.* (1994), Dimitrova (1998), Haomanjee *et al.* (1998) and Liu *et al.* (1999).

Tobacco leaf is marketed by its physical characteristics like body, color, texture, size and aroma etc. These traits when grouped together, represent grade index (Woras, 1996). Statistical analysis manifested significant differences ($P < 0.05$) among the genotypes for percent grade index (Table I). Spt G-28 and Spt G-126 were topping the list of tobacco genotypes used in the study with the grade indices of 59.5 and 57.5%, respectively. These were followed by RG-17, K-358 and RG-13 with quality grade values of 56.2, 55.7 and 55.5%, respectively (Table II). These results are supported by the findings of Triplat *et al.* (1994), Rao (1998), and Spirov and Lukipudis (1999) who also reported significant differences among tobacco genotypes for this important commercial plant trait.

Chemical Characteristics

Nicotine content, reducing sugars and proportion of reducing sugars to nicotine content are the important chemical characteristics of a particular tobacco genotype determining its quality. Hence a thorough assessment of these traits is imperative while studying tobacco genotypes of differential genetic backgrounds.

Nicotine is the principal alkaloid in tobacco defining tobacco quality (Shmuk and Nauk, 1953a). Higher contents of nicotine negatively affect different physiological functions of the smoker while very low contents offer no satisfaction to the smoker (Hashmi *et al.*, 1990). The genotypes exhibited significant differences ($P < 0.05$) for the nicotine content of their leaves (Table I). Nicotine content among the genotypes varied from 2.2 to 2.5%. Spt G-28, K-358 and Spt G-126 had the leaves of maximum nicotine content of 2.5% whereas KHG-23 leaves showed minimum nicotine of 2.2% in its leaves (Table II). Genotypic differences among cured tobacco leaves for nicotine percentage have also previously been reported by Triplat *et al.* (1994), Pathak *et al.* (1996) and Liu *et al.* (1999). Nicotine content was low in all the genotypes used in the present study.

Reducing sugars exercise the most favorable influence on the tobacco taste and aroma during smoking and are one of the most important quality parameters of flue-cured tobacco. Its higher contents impart sweetness to aroma (Hashmi *et al.*, 1990). Non-significant differences ($P > 0.05$) among the genotypes were observed for reducing sugars percentage in the leaves (Table I). The reducing sugars content in the leaves of tobacco genotypes used in the study ranged between 11.6 to 12.2%. Tobacco genotype KHG-21, however, had the maximum reducing sugars content (Table II). Our results are contrary to the findings of Triplat *et al.* (1994). They reported significant differences among tobacco genotypes for this trait. The possible reason for non-significant genetic differences among tobacco genotypes observed in the present study could be their narrow genetic make up for this plant parameter.

For the evaluation of tobacco quality it is important to know not only the absolute content of one element of its composition, but also its relation to other elements. With an increase in sugars content, the tobacco taste improves, whereas with an increase in nicotine content, the tobacco taste deteriorates (Shmuk and Nauk, 1953b). Thus the ratio of reducing sugars to nicotine content is an important characteristic determining tobacco quality. Mean squares revealed significant differences ($P < 0.05$) among the genotypes for ratio of reducing sugars (%) to nicotine content (%) in the leaves (Table I). The value for this trait among the genotypes ranged between 4.6 and 5.7. KHG-23 had the maximum ratio of reducing sugars to nicotine of 5.7, followed by KHG-24, KHG-21 and KHG-25 with the ratios of 5.4, 5.2 and 5.1, respectively. Of all the genotypes used in the study, KHG-23 thus manifested its superiority for ratio of reducing sugars to nicotine content. Check cultivar Spt G-28, however, displayed the lowest ratio of reducing sugars to nicotine of 4.6 (Table II). These results are compatible with the findings of Triplat *et al.* (1994), Pathak *et al.* (1996) and Liu *et al.* (1999) who also observed significant genetic variation among tobacco genotypes for ratio of reducing sugars to nicotine. The differences in the above mentioned morphological traits, yield potential and chemical characteristics of the tobacco genotypes used in the present study could be attributed to their genetic constitution.

CONCLUSION

In the present study, different tobacco genotypes displayed potential for selection of desired traits. However, tobacco genotypes KHG-21, KHG-23 and KHG-25 exhibited superiority for various yield and quality associated characteristics of this crop. The genetic potential of these genotypes can be exploited in future tobacco breeding programs. These genotypes displayed immense potential to replace Spt G-28, the existing commercial

cultivar of tobacco in NWFP and are recommended for multi location test trials for onward release as commercial tobacco cultivars.

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