Effect of Plant Spacing On Quantitative and Qualitative Characteristics of FCV Tobacco Hybrids

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Abstract
A field experiment was carried out on “effect of plant spacing on quantitative and qualitative characteristics of FCV tobacco hybrids” at The Tobacco Research Station, Khan Garhi, Mardan during 2014-2015, using randomized complete block design with split plot arrangement, replicated thrice. Treatments included three tobacco hybrids (CSC 4302, CSC 4704 and CSC 447) and three plant spacing (T1=R-R 120 cm and P-P 55 cm, T2=R-R 107 cm and P-P 55cm and T3=R-R 90cm and P-P 60cm). Plant height, leaf area were significantly affected by tobacco hybrids and cured leaf yield (kg ha 1) were significantly affected by spatial. Higher plant height (114.7cm) from CSC hybrid 4302, leaf area (1142cm 2) from CSC hybrid 4704 and higher cured leaf yield (3842 kg ha-1) were recorded from CSC hybrid 447 tobacco hybrids. Higher plant height (107.3 cm) and higher cured leaf yield (4109.7 kg h a-1) were recorded from spatial arrangement T3. It is due to the space for tobacco hybrids are better and the variety CSC-447 performed better. Hence spacing T3 and CSC-447 hybrid is recommended for better growth and higher yield of tobacco crop in Mardan region.

Keywords: Plant Spacing; FCV Hybrids; Tobacco yield; Tobacco Leaf Quality

Introduction
Tobacco is grown for leaf purpose and widely grown as non-food commercial plant in the world. Tobacco is also one of the major cash crops in Pakistan especially in Khyber Pakhtunkhwa. Tobacco is the only crop in Pakistan whose yield on per unit area is compare with developed countries like USA. However there is struggle for improvement in yield on per unit area Ahmed [1] Tobacco is cultivated in Pakistan on 50,000 hectares with a total leaf production of 108,000 tons. Tobacco has become an important cash crop of Khyber Pakhtunkhwa the agro climatic conditions are extremely suitable for its cultivation. Total area under cultivation in Khyber Pakhtunkhwa is 30,040 ha, which produce 100.78 million kg Pakistan Bureau Statistics [2] Tobacco contributes 4.4% to the GDP of Pakistan. Its export value was 570.2 million rupees which share in all export of Pakistan. Cigarettes and tobacco give 30.6 billion rupee indirect taxes whose share in gross are 5.4% Federal Board of Revenue, 2008. Among growing practices, plant spacing can affect agronomic and chemical traits of Tobacco Alizadeh [3] several researchers recoded high yield on maximum plant densities. However, quality of such leaves was usually lower due to decreased nicotine content Chaplin [4], Campbell [5].

Higher plant density in tobacco produce taller plants with smaller leaves, but also effect on number of leaves per plant. Closer spacing tobacco result in higher yields, increased crop returns Kozunrttx and Lurosrvrcrus., 1975. Plant spacing is required for the optimum yield. Closer spacing of plants resulted in reduction of size, body, thickness and weight per unit area of the leaf, Price of tobacco grown at higher plant densities was also lower, resulting in lower income from such production observed a decrease in total leaf area per plant with increased plant population Bukan [6] Regulate the optimal density is one of the important factors to get the maximum yield due to the climatic conditions of each region and specifications of varieties are cultivated.

The purpose is to determine the optimal density; spacing between plants, so that an appropriate combination of environmental factors provided to achieve maximum performance with possible quality. In considering an appropriate density, mutual ghosting is minimized and light thus photosynthesis is maximized. If the planting spaces are too common, certainly the number of plants per unit area reduced
and the yield will be faced with a deficit. Due to the efficiency of water use in the product increase, desirable high density is needed to achieve a high performance Kharazmi [7].

**Materials and Methods**

**Experimental site**

Tobacco research station is located in the south west of the district Mardan at 34°12’0N 72°16’0E, altitude of 283 meters (928 feet), and with an elevation of 314 meters above sea level.

**Experimental design**

The experiment was laid out in RCB design with split plot arrangement, having three tobacco varieties (Main plot) and treatment (sub plot), replicated thrice at the Tobacco Research Station, Khan Garhi, Mardan, during 2014-15. Spatial arrangement was done 120x55cm, 107x55cm and 90x60cm row to row and plant to plant distances respectively.

**Nursery management**

Nursery was raised on 20th December 2014. Seed rate of 4g ha⁻¹ was used. Bed size will be 10m². Thinning was done to get optimum and healthy plant stand. Three tobacco hybrids of CSC series i.e. CSC 4302, CSC 447, CSC 4704 were sown.

**Field preparation**

Before transplantation, land preparation was done using primary and secondary tillage implements. Good and viable seedlings were transplanted in the field and the field was irrigated to establish good root system.

**Transplantation**

Transplantation was done during the last week of March 2015. Each plot and subplot having five rows, having 10 plants in each row. The row to row distance was 3, 3.5 and 4 feet, while plant to plant distance was 2, 1.8 and 1.8 feet respectively.

**Field management**

After transplantation irrigation were applied 6-7 times. N:P:K fertilizers were applied with the rate 75:75:75 kg ha⁻¹. After transplantation one dose was applied to the two sides of plants. Topping was done at 24 leaves stage. The parameters studied were plant height, leaf area plant⁻¹, green leaves weight plot⁻¹ (kg), number of green leaves kg⁻¹, cured leaves weight plot⁻¹ (kg), number of cured leaves kg⁻¹, cured leaf yield ha⁻¹, nicotine and reducing sugar contents, using the following procedure.

**Plant height (cm)**

In each plot thirty plants were selected and measured from top to bottom and their mean was calculated.

**Leaf area (cm²)**

For leaf area, thirty plants randomly were taken then leaf length and breadth was measured. The average leaf size was computed from these plants by multiplying with a common factor of 0.644 derived by Suggs et al. 1960.

**Leaf area = Leaf length x leaf breadth x 0.644 ².**

**Number of green leaves kg⁻¹**

The number of green leaves was found by measuring the number of green leaves in each bundle of plot.

\[
\text{Number of green leaves kg}^{-1} = \frac{\text{No of leaves in the determined weight}}{\text{kg}} \times \text{Green weight determined}
\]

**Number of cured leaves kg⁻¹**

The number of cured leaves was found by measuring the number of cured leaves in each bundle plot.

\[
\text{Number of cured leaves kg}^{-1} = \frac{\text{No of leaves in the determined weight}}{\text{kg}} \times \text{Cured weight determined}
\]

**Cured leaf yield (kg ha⁻¹)**

Data concerning leaf yield, the weight of cured leaf in each treatment was taken after each picking. The total cured leaf yield was calculated by the following formula:

\[
\text{Yield (kg ha}^{-1}) = \frac{\text{Cured leaf weight plot}^{-1} \times \text{total no. of plants}}{\text{ha}^{-1}}
\]

\[
\text{No. of leaves per plot}
\]

**Nicotine Content (%)**

Nicotine was determined by the method of Cundif and Markunas 1964. The nicotine contents were calculated by the following formula:

\[
\text{Nicotine (%)} = \frac{V_1 \times N \times 32.45 \times 100}{\text{Weight of sample}}
\]

Whereas

\[
V_1 = \text{Volume of titrant for non-acetylated aliquote.}
\]

\[N = \text{Normality of perchloric acid.}\]

4.13. Reducing Sugars (%)

Reducing sugars percentage was estimated as follow:

\[
\text{Reducing sugars} = 25 \times 100 \times 0.05
\]

\[\text{Titrate x wt. of sample}\]

Data collected was analyzed according to split plot design and means were compared using least significant difference (LSD) test Steel and Torrie 1980

**Results and Discussion**

**Plant height (cm)**

Data regarding plant height of tobacco hybrids indicated that different tobacco hybrids had significant effect on plant height of different tobacco hybrids (Table 1). Taller plants (114.7) were
reported in plots of CSC-4302 as compared to CSC-4704 and CSC-447. Spatial arrangement of plant had non-significant effect and the interaction as well. The possible reason for this could be due to genetic characteristics of tobacco hybrids and each tobacco hybrid showed different response Bukan [6].

Table 1: Plant height (cm) of different tobacco hybrids as affected by various spacing.

| Tobacco hybrids | T₁ (120 x 55 cm) | T₂ (107 x 55 cm) | T₃ (90 x 60 cm) | Mean |
|-----------------|------------------|------------------|-----------------|------|
| CSC-4302        | 110              | 119              | 115             | 114.7a |
| CSC-4704        | 101              | 107              | 107             | 103.0b |
| CSC-447         | 103              | 99               | 100             | 100.7b |
| Mean            | 104.7            | 106.3            | 107.3           |      |

Lsd value (0.05) = 9.4011

Leaf area (cm²)

Table 2: Leaf area (cm²) of different tobacco hybrids as affected by various spacing.

| Tobacco hybrids | T₁ (120 x 55 cm) | T₂ (107 x 55 cm) | T₃ (90 x 60 cm) | Mean |
|-----------------|------------------|------------------|-----------------|------|
| CSC-4302        | 937              | 942              | 958             | 946b |
| CSC-4704        | 1132             | 1166             | 1127            | 1142a |
| CSC-447         | 1046             | 1042             | 993             | 1027b |
| Mean            | 1038             | 1050             | 1026            |      |

Lsd value (0.05) = 86.410

Data regarding leaf area of tobacco hybrids indicated that different tobacco hybrids had significant effect on leaf area (Table 2). Maximum leaf area (1142 cm²) was reported in plot of CSC-4704 as compared to CSC-4302 and CSC-447. Spatial arrangement of plant had non-significant effect and the interaction as well. The possible reason for this could be due to genetic characteristics of tobacco hybrids and each tobacco hybrids showed different response Bukan [6].

Number of green leaves kg⁻¹

Table 3: Number of green leaves kg⁻¹ of different tobacco hybrids as affected by various spacing.

| Tobacco hybrids | T₁ (120 x 55 cm) | T₂ (107 x 55 cm) | T₃ (90 x 60 cm) | Mean |
|-----------------|------------------|------------------|-----------------|------|
| CSC-4302        | 18               | 18               | 16              | 17   |
| CSC-4704        | 20               | 15               | 16              | 17   |
| CSC-447         | 15               | 18               | 16              | 16   |
| Mean            | 18               | 16               | 16              |      |

Lsd value (0.05) = ns

Data regarding number of green leaves kg⁻¹ of tobacco hybrids indicated that tobacco hybrids, spatial arrangement and interaction had non-significant effect on number of green leaves kg⁻¹ (Table 3). Maximum green leaves kg⁻¹ (17) was reported in plots of CSC-4302 and CSC-4704 as compared to CSC-447. While for spatial arrangement maximum green leaves kg⁻¹ (17 cm) observed in spacing T₁ as compared to T₂ and T₃.

Cured leaf yield (kg ha⁻¹)

Table 4: Number of Cured leaves kg⁻¹ of different tobacco hybrids as affected by various spacing.

| Tobacco hybrids | T₁ (120 x 55 cm) | T₂ (107 x 55 cm) | T₃ (90 x 60 cm) | Mean |
|-----------------|------------------|------------------|-----------------|------|
| CSC-4302        | 112              | 101              | 104             | 105  |
| CSC-4704        | 129              | 102              | 114             | 115  |
| CSC-447         | 104              | 110              | 99              | 104  |
| Mean            | 115              | 104              | 105             |      |

Lsd value (0.05) = ns

Data regarding number of cured leaves kg⁻¹ of tobacco hybrids indicated that tobacco hybrids, spatial arrangement and interaction had non-significant effect on cured leaf yield kg ha⁻¹ (Table 4). Maximum number of cured leaves kg⁻¹ (115) was reported in plots of CSC-4704 as compared to CSC-4303 and CSC-447. While for spatial arrangement maximum number of cured leaves kg⁻¹ (115) observed in spacing T₁ as compared to T₂ and T₃.

Cured leaf yield (kg ha⁻¹)

Table 5: Cured leaf yield (kg ha⁻¹) of different tobacco hybrids as affected by various spacing.

| Tobacco hybrids | T₁ (120 x 55 cm) | T₂ (107 x 55 cm) | T₃ (90 x 60 cm) | Mean |
|-----------------|------------------|------------------|-----------------|------|
| CSC-4302        | 3222             | 3958             | 4140            | 3773 |
| CSC-4704        | 2793             | 3868             | 3797            | 3486 |
| CSC-447         | 3504             | 3632             | 4392            | 3842 |
| Mean            | 3173b            | 3819a            | 4109a           |      |

Lsd value (0.05) = 484.48

Data regarding cured leaf yield kg ha⁻¹ of tobacco hybrids indicated that different tobacco hybrids and interaction had non-significant on cured leaf yield kg ha⁻¹ of different tobacco hybrids (Table 5). Spatial arrangement had significant effect on cured leaf yield kg ha⁻¹ of different tobacco hybrids. Maximum cured leaf yield kg ha⁻¹ (4109) were reported in plot of spatial T₁ arrangement as compared to spatial T₂ and T₃. The possible reason for this could be due to the genetic adoptability of tobacco hybrids to T₁ spatial arrangement Kharazmi [7] and also similar results were reported by Bukan [6-10].
Data regarding nicotine contents percentage of tobacco hybrids indicated that tobacco hybrids, spatial arrangement and interaction had non-significant effect on nicotine contents percentage (Table 6). Maximum nicotine contents percentage (2.40) were reported in plots of CSC-4302 as compared to CSC-4704 and CSC-447. While for spatial arrangement maximum nicotine contents percentage (2.46) observed in spacing T3 as compared to T2 and T1.

Reducing sugar contents percentage

**Table 7:** Reducing sugar content of different tobacco hybrids as affected by various spacing.

| Tobacco hybrids | T₁ (120x55 cm) | T₂ (107x55 cm) | T₃ (90x60 cm) | Mean |
|-----------------|----------------|----------------|----------------|------|
| CSC-4302        | 2.4            | 2.11           | 2.68           | 2.40 |
| CSC-4704        | 2.11           | 2.28           | 2.64           | 2.34 |
| CSC-447         | 1.99           | 2.64           | 2.07           | 2.23 |
| Mean            | 2.17           | 2.34           | 2.46           |      |

Data regarding reducing sugar contents percentage of tobacco hybrids indicated that tobacco hybrids, spatial arrangement and interaction had non-significant effect on nicotine contents percentage (Table 7). Maximum reducing sugar contents percentage (18.07) were reported in plots of CSC-4302 as compared to CSC-4704 and CSC-447. While for spatial arrangement maximum reducing sugar contents percentage (19.38) observed in spacing T₃, as compared to T₂ and T₁.

**Conclusion**

It was concluded from the results of experiment that variety CSC-447 showed better results from the other two varieties. the variety CSC-447 have tremendous potential to improve various traits such as yield and yield related components and therefore variety CSC-447 are recommended to obtain higher yield and the Row to Row 90 cm and plant-plant 60 cm distance are sufficient for tobacco crop and increasing further spacing in tobacco crop were not significant effect on yield and yield related traits. Hence 90x60cm spacing are good to obtain higher FCV leaf yield and of good quality.

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