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Results of Trial Transplanting of Oriental Tobacco Varieties in Dak Lak Province, Vietnam in 2022

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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

In 2022, the Vietnam Tobacco Institute continued to test 6 tobacco oriental varieties in Dak Lak province based on the test results of tobacco varieties, cultivation techniques, curing in Ninh Thuan and Dak Lak provinces in 2021. To determine the suitable growing areas and varieties of oriental tobacco for the Dak Lak region, we experimented with six oriental tobacco varieties, including Basma 16, Kozarsko, Hanski 227, Rila 89, Dupnitsa 733 và Basma X with a fertilizer rate of 40N: 30P2O5: 50K2O kg/ha. The variety experiment was designed with a completely randomized block, repeated 3 times with 50 m^2/plot. The experimental results have determined Dak Lak region to be suitable for planting the oriental tobacco plants and have selected two of the property oriental varieties as Basma and Hanski 227. Those varieties were good growth, high yield and good quality. The quality of oriental tobacco production in Dak Lak region was quite good, equivalent to the

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imported samples which was been used by Vietnam's factories. In the coming time, the Vietnam Tobacco Institute will continue to experiment and expand the oriental tobacco area in Dak Lak to provide materials for cigarette factories and limit imported tobacco from abroad.

Keywords: Oriental tobacco; trial planting; tobacco; variety.

1. INTRODUCTION

Tobacco plants grown in the world were categorized into two groups such as yield and quality types. Virginia and Burley tobacco types had high yield, while oriental tobaccos were high in qualities. Oriental tobaccos were selected for their aroma tasting flavour [1,2]. The oriental tobaccos had a much milder flavour, contain less nicotine, and fewer carcinogens than other varieties [3-5]. The oriental tobaccos were small plants; labour intensive; many varieties; grown in hot and dry conditions; cured in the sun; harvested by hand because leaves were small; had aromatic and elastic leaves that were important to American blend cigarettes.

Oriental tobacco is popularly grown in some main countries such as Turkey, Greece, FYRO Macedonia, and Bulgaria, with yields ranging from 1,200 - 2,000 kg/ha. In Turkey, there are mainly two oriental tobaccos as Izmir and Samsun varieties; In Greece and the Balkans are Basma & Katerini varieties; in Macedonia: The Prilep variety; in Bulgaria: the Krumovgrad variety. For the Basma variety, it has broad leaf size, leaf shape, body & oil, colour, smoke, and reasonable yield kg/ha, such as a medium, elongated oval shape, medium-heavy body, high oil, good elasticity, deep yellow to orange with a reddish hue, strong dark aroma, with a sweet taste [6,7].

The planting density of Oriental tobacco is too high, ranging from 130,000 to 300,000 plants/ha, depending on the variety. Increasing planting density increases yield but reduces nicotine content [7]. In tobacco oriental plants, the nicotine and reduced sugar content increase gradually from the lower leaf to the top leaf of plant [8]. For Oriental tobacco, the soil has a significant influence on the quality. The proper soils for oriental tobacco are often stony, gravelly, thin and not very productive which makes good mild and very aromatic. Tobaccos grown in deeper soils, clayey, good soil, and more humid are stronger than poorly soil but less aromatic. The oriental tobaccos are grown on generally low fertility soils, especially at low levels of nitrogen (N) at maturing [9]. The aroma is an essential characteristic of a quality product. It largely depends on the pedological and climatic conditions where they are grown [7,9]. Harvest date is one of the most important crop management practices affecting tobacco yield, quality and usability after curing. The optimal harvest time for Oriental tobacco leaves was found to be the stage of early senescence, just after the full physiological maturity stage [10]

Every year, Vietnam usually imports about 1000 tons of oriental tobacco for producing blended cigarettes. Now, Vietnam does not have oriental tobacco growing regions to serve the demands of tobacco factories in domestic production. To develop oriental tobaccos in Vietnam, the Vietnam Tobacco Institute imported six varieties from Bulgaria for trial planting in Ninh Thuan in 2019 - 2020. But, the smoking results showed that oriental tobacco grown in Ninh Thuan burned poorly by the high chloride content in the leaves. Because irrigation water in Ninh Thuan had high chloride content. In 2021, the Tobacco Institute planted two oriental varieties Basma 16 and Hanski 227 in Dak Lak province, where the climate conditions were suitable, and the water source did not contain chlorine. The results of trial planting showed that the dry yield and grade 1 + 2 of the Basma 16 variety reached 1.57 - 1.66 tons/ha and 75.9 - 76.3%, respectively; 1.73 - 1.82 tons/ha and 85.2 - 86.5% with Hanski 227 variety. The main chemical composition of oriental tobacco was proper for oriental tobacco with nicotine content a range from 1.0 to 1.3%, reducing sugar: 9.8 - 12% and chlorine: 0.27 - 0.31%. Compared with imported oriental tobacco with nicotine at 0.9%, sugar at 7.2% and chlorine: at 0.81%. The flavour, taste and burn of oriental tobacco grown in Dak Lak were better than those imported oriental tobacco from Bulgaria, Turkey and Greece by Vietnam's factories. Oriental tobacco grown in Dak Lak had flavour points ranging from 11.9 to 12.7 points, taste: 9.1 to 9.2 points and burning: 4.4 points, while imported tobacco with flavour was 10.8 points, taste: 8.3 points and burn: 3.1 points [11].

In order to continue researching and developing the production of oriental tobacco in Vietnam, the Vietnam Tobacco Institute continued to trial plant

6 oriental varieties from Bulgaria in Dak Lak province in 2022 to select proper oriental varieties, having yield and quality for developing oriental tobacco region of Vietnam.

2. MATERIALS AND METHODS

2.1 The Study Site

The trial planting of oriental tobaccos was conducted in the Ea Sup district, Đak Lak province, from December 2021 to May 2022. This area had suitable climate and soil conditions for producing oriental tobacco, with an average temperature of every year was 24^{o}C, a max average temperature of 34^{o}C, and min average temperature of 18 - 20^{o}C. From December 2021 to May 2022 was dry, hot, and sunny, with little rain and low air humidity, with average air humidity ranging from 35 - 78% and rainfall of 1.6 - 14.8 mm, which was favourable for tobacco plant growth and curing.

The soil analysis data in Dak Lak province: Nitrogen (N): 0.49-1.09 mg/g, phosphate (P_2O_5): 0.02-0.07%, and potassium (K_2O): 0.06 - 0.52%. The available substance (mg/100 g soil) of N was 4.36-7.8, P_2O_5: 4.51-39.96 and K_2O: 3.45-15.39. The total organic was 0.52-1.41%, pH_{KCL}: 4.56-7.04, and chlorine (clo) was 7 - 33 ppm.

2.2 Material and Object

The oriental tobacco varieties experimented in the Ea Sup district, Đak Lak included Basma 16, Kozarsko, Hanski 227, Rila 89, Dupnitsa 733 và Basma X that were planted with fertilizer types: N: NH_4NO_3, P: $Ca(H_2PO_4)_2$, and K: K_2SO_4.

2.3 Experimental Field

Tobacco seeds of oriental tobacco were sown on a free pathogen nursery. The seedlings after reaching 4 - 6 leaves were transplanted in the experimental field with specified spacing distance of planting: Basma 16 and Basma X: the plant to plant spacing: 12 cm and space between lines: 30 cm, the plant population density of 280.000 plants/ha; Hanski 227, plant to plant spacing of 17 cm, lines spacing 50 cm, the plant population density of 110.000 plants/ha; Kozarsko, Dupnitsa 733, and Rila 89: plant to plant spacing of 15 cm, lines spacing 40 cm, the plant population density of 160.000 plants/ha.

Rate of fertilizers: Based on the results of soil analysis and experimental field in 2019 - 2020 in Ninh Thuan province and Dak Lak province in 2021, we built a fertilizer formula in 2022 as 40N: $30P_2O_5$: $50K_2O$ kg/ha. The variety experiments were designed with a completely randomized block, repeated 3 times with 50 m^2/plot. Other technical measures were the same, such as planting, taking care of plants, topping, harvest time (mature of leaf), curing, etc.

2.4 The Target Surveillance

The cultivation technique of oriental tobacco was based on the technical process provided by the Research Institute of Tobacco and Tobacco Products of Bulgaria. Evaluation of growth, the number of leaves, plant height, and yield parameters follows the National Technical Regulation on testing the value of cultivation and use of dried yellow tobacco varieties following QCVN 01- 85: 2012/BNN & PTNT, Vietnam. Rate of grade: National Standard 9271 - 85 of Bulgaria was used. Analysis of chemical components followed the standard of Vietnam as Nicotine: TCVN 7103: 2002 (ISO 2881:1992), total nitrogen: TCVN 7252: 2003, sugar: TCVN 7102: 2002 (CORESTA 38: 1994) and chlorine (clo): TCVN 7251: 2003. Quality assessment based on the Draft TCVN: Oriental raw tobacco - sensory assessment by the scoring method. Data collection was treated by Software of Excel and Statistics 8.2 [12].

3. RESULTS AND DISCUSSION

3.1 Experimenting 6 Tobacco Oriental Varieties in Dak Lak Province in 2022

- Growth time of 6 tobacco oriental varieties

To determine the growth and development ability of oriental tobacco varieties imported from Bulgaria in Dak Lak, the Tobacco Institute surveyed six oriental varieties in the Easup district in 2022. Results of the experiment in Table 1 showed that the growth and development time of oriental tobacco varieties depended a lot on the biological characteristics of the variety. In 6 varieties that were experimented with 50% bud appearance time of oriental tobacco ranged from 62 to 68 days. In that, the Basma 16 and Basma X varieties had the longest growth time with a bud appearance time of 68 days, the first ripe leaf was 63 days, and the last harvest was 103 days. Kozarsko variety had the shortest growth time with a 50% bud appearance time of 62 days, the first ripe leaf: 63 days, and the last harvest.

Table 1. Growth time of 6 tobacco oriental varieties in Đak Lak in 2022

Variety	Time from planting to (days)		
	50% buds of plants	First ripe leaf	Last harvesting leaf
Basma 16	68.0	63.0	103.0
Kozarsko	62.0	59.0	95.0
Hanski 227	64.0	59.0	95.0
Rila 89	66.0	59.0	95.0
Dupnitsa 733	66.0	59.0	95.0
Basma X	68.0	63.0	103.0

Table 2. Some biological characteristics impact on oriental tobacco yield in Dak Lak province in 2022

Variety	Bio-high plant (cm)	Topping high plant (cm)	Total leaves (leaf)	The leaf size in the middle of the plant		Fress weight (gr/leaf)
				Length (cm)	Width (cm)	
Basma 16	119.6^{c}	109.6^{c}	40.0^{a}	17.4^{c}	11.2^{d}	7.5
Kozarsko	128.4^{c}	115.0^{c}	31.7^{c}	30.0^{a}	13.3^{c}	9.8
Hanski 227	147.8^{b}	127.1^{b}	33.0^{bc}	32.0^{a}	21.8^{a}	12.7
Rila 89	170.7^{a}	151.4^{a}	34.6^{ab}	24.0^{b}	15.2^{bc}	9.7
Dupnitsa 733	175.3^{a}	156.6^{a}	36.5^{ab}	25.5^{b}	15.6^{b}	10.7
Basma X	119.9^{c}	109.7^{c}	40.0^{a}	16.8^{c}	10.9^{d}	7.4
CV (%)	4.4	4.62	6.17	6.61	7.79	
CVC	11.49	10.78	4.07	2.91	2.07	

Note: The same letters have no statistical difference with confidence 95%; CVC: Critical Value for Comparison

- **Some biological characteristics impact on oriental tobacco yield**

Plant height and total leaves are important factors in determining the yield and quality of the crop. If the main stem develops well creates conditions for the leaves to develop and accumulate more nutrients. If the tree is too tall that will reduce the crop's ability to withstand environmental conditions. The results in Table 2 showed, Rila 89 and Dupnitsa 733 had the longest biology and topping-high plant, ranging from 170.7 - 175.3 cm and 151.4 - 156.6 cm, respectively. Oriental varieties had the shortest tall as Basma 16 and Basma X, with a bio-high plant of 119.6 - 119.9 cm and topping high plants: 109.6 - 109.7 cm. For total leaves, Basma 16 and Basma X had the most number of leaves, with 40 leaves/plants; Dupnitsa 733 and Rila 89: 34.6 - 36.5 leaves; Hanski 227: 33.0 leaves; and Kozarsko was the lowest, only reaching 31.7 leaves.

Leaf size and fresh weight are important yield and quality elements of tobacco and depend on the variety and cultivating methods. Basma varieties had a lot of leaves but the smallest leaf size (Length: 16.8 - 17.4 cm and Width: 10.9 - 11.2 cm) and the lowest fresh weight (7.4 - 7.5 g/leaf). The oriental varieties had the largest leaf size, and the heaviest fresh weight was Hanski 227, with a leaf length of 32.0 cm, leaf width of 21.8 cm, and fresh weight of 12.7 g/leaf.

So, Based on the number of leaves and high plant showed that Basma 16 and Basma X had shorter internode lengths of the stem than others in experiments, detailing: Internode length of the stem of the Bassma was 2.99 cm, Dupnitsa 733: 4.8 cm, and Rila 89: 4.9 cm.

- Yield and quality of oriental tobacco

Total leaves harvesting, Basma (16 and X) had the highest total leaves harvesting, reaching from 35.1 - 35.9 leaves and the lowest was Hanski 227 (27.8 leaves), Kozarsko (26.6 leaves) (Table 3).

A fresh-dry rate says the ability's dry matter accumulation of each tobacco variety and impacts on yield and quality. In the experimental varieties, Basma 16 and Basma X had the lowest rate of fresh/dry, achieving from 6.49 - 6.52, then Hanski 227: 6.95, and the variety that had the highest rate was Rila 89 (7.21).

Fig. 1. The tobacco oriental varieties in Dak Lak, from left to right was Basma X, Basma 16, and Hanski 227

Dry yield, Hanski 227 had the highest dry yield, reaching 1.954 tons/ha, then Basma 16 and X: 1.648 - 1.686 tons/ha, and the lowest yield was Rila 89 (1.392 tons/ha) and they had statistical difference with confidence 95%. For Hanski 227, total number of harvestable leaves was the lowest (27.8 leaves) but had the highest dry yield. Because leaf size of Hanski 227 was the highest (32 x 21.8 cm) and rate of fress/dry was low (6.95). With Basma variety, it had the highest total leaves harvesting but the smallest leaf size leading to yield of Basma only reaching 1.648 - 1.686 tons/ha.

Dry yield and grade 1+2 of the Hanski 227 achieved the highest with 1.954 tons/ha and 75.7%, the next Basma (16 and X): 1.648 -1.686 tons/ha and 69.8 - 70.1%, respectively. For Rila 89, the dry yield only reached 1.392 tons/ha. So, Basma 16, Basma X, and Hanski 227 are the best prospect varieties to transplant in the Dak Lak region.

- **Chemical and smoking characteristic of oriental tobacco**

Data in Table 4 showed that nicotine and reducing the content of six experimental oriental tobaccos in Dak Lak, in 2022 were low levels, ranging from 0.2 - 0.78% and 0.4 - 6.8%, respectively. The Nicotine content of Basma X was only the highest level to be 0.78%, and then Dupnitsa 733: 0.57%, Basma 16: 0.53%, and lowest Rila 89 (0.2%). For reducing sugar content, Hanski 227 was the highest reducing sugar content, but only reached 6.8%, and the lowest in Kozarsko (0.4%). The chloride content in leaf tobacco was high level from 0.92 - 1.38% which affected burning ability and aroma.

Table 3. Yield and curing leaf grade of some tobacco oriental varieties

Variety	Total leaves harvesting (leaf)	Rate of fress/dry	Dry yield (tons/ha)	Leaf grade 1+2 (%)
Basma 16	35.9^{a}	6.52	1.686^{ab}	70.1
Kozarsko	26.6^{c}	7.09	1.597^{b}	65.5
Hanski 227	27.8^{c}	6.95	1.954^{a}	75.7
Rila 89	29.2^{bc}	7.21	1.392^{c}	68.7
Dupnitsa 733	31.4^{b}	7.05	1.553^{b}	64.3
Basma X	35.1^{a}	6.49	1.648^{b}	69.8
CV (%)	5.37		9.16	
CVC	3.02		2.73	

Table 4. Chemical components of 6 oriental tobacco varieties in Dak Lak in 2022

Variety	Nicotine (%)	Reducing sugar (%)	Chloride (%)
Basma 16	0.53	5.0	1.23
Kozarsko	0.49	0.4	1.03
Hanski 227	0.49	6.8	1.03
Rila 89	0.20	1.9	1.38
Dupnitsa 733	0.57	3.7	1.17
Basma X	0.78	1.9	0.92

Compared to 2021, nicotine, reducing sugar, and chloride content of Basma 16 in Dak Lak were at 1.0 - 1.08%, 10 - 12%, and 0.27%, respectively; For Hanski 227 was 1.06 - 1.39%, 12 - 14%, and 0.26 - 0.31%, respective [11]. The cause of the decrease in nicotine and reducing sugar levels could be rainy days in 2022, especially from the period of early transplanting and curing preparation onward than years ago.

- Smoking characteristic of oriental tobacco

The aroma of oriental tobacco plays the most important role in determining the quality of the tobacco. It's called the flavouring agent in American blend cigarettes. In six oriental tobaccos, Basma (16 and X) had the highest flavour points, reaching 12.5 points, and then Hanski 227: 11.9 points and poor flavour points was Kozarsko with 10.9 points.

Total smoking points showed that Basma, Hanski 227 had the specific flavour of tobacco oriental and highest total points, reached from 33.7 - 34.5 points. Kozarsko was the lowest quality oriental type about aroma, taste, heavy smoking, burning, etc, and total points (30.4 points).

3.2 Comparing Quality of the Orientai Tobaccos in Dak Lak and Imported Oriental Tobaccos

- Chemical components of oriental tobacco

Results in Table 6 showed, nicotine content of oriental tobacco in Dak Lak in 2022 only ranged from 0.43% to 0.54%, lower than Control 1 and Control 2 (0.8 - 0.88%), but higher than Control 3 (0.29%). Nicotine content in 2022 was lower than in 2021 (ranging from 1.11 - 1.22%). Reducing sugar content in Dak Lak in 2022 was much lower than in 2021 and Controls, detailing: reducing the content of the year 2022 was from 1.3 - 1.5%, in that, in 2021 , it was from 7.5 - 10.4% and 1.3 - 1.5%, and controls: 6 - 9.5%. For chloride, in 2022, chloride content was from 0.95 - 1.01%, higher than in 2021 (0.31%) and control 1, 2 (0.45- 0.69%), but lower than control 3.

The decrease in nicotine and reducing sugars contents was due to a lot of rainy days in 2022 and it increased the plants' ability to absorb chlorine from the soil. In 2021, it was hot - sunny, with little rain, and low chloride content in the soil that increased flavour, nicotine, reducing sugar, and decreased chloride content in the soil.

- Smoking characteristic of oriental tobaccos

Table 7 showed that the flavour of Basma 16 and Hanski 227 that were transplanted in Dak Lak was similar to control 1 and 2, but better than control 3. Taste, heavy smoking, and burning in 2022 ranged from 9.4 - 9.5 points, 4,1 - 4.2 points, and 3 points, respectively and lower than in 2021.

Table 5. Smoking characteristic of six oriental tobaccos in Dak Lak in 2022

Variety	Smoking points (points)					
	Aroma	Taste	Heavy smoke	Burning	Colour fiber	Total points
Basma 16	12.5	9.3	4.5	3.2	4.2	33.7
Kozarsko	10.9	9.0	4.2	2.8	3.5	30.4
Hanski 227	11.9	10.6	4.5	3.0	4.5	34.5
Rila 89	11.0	9.5	4.2	3.2	4.2	32.1
Dupnitsa 733	11.0	10.0	4.2	3.2	4.2	32.6
Basma X	12.5	9.5	4.3	3.2	4.2	33.7

Table 6. Chemical components of oriental tobacco in Dak Lak and imported oriental tobacco

Samples	Nicotine (%)	Total nitrogen (%)	Reducing sugar (%)	Chloride (%)
Basma 16 - 2021	1.22	1.95	7.5	0.31
Hanski 227 - 2021	1.11	1.91	10.4	0.31
Basma 16 - 2022	0.43	1.93	1.5	1.01
Hanski 227 - 2022	0.54	1.83	1.3	0.95
Control 1 (Bungaria)	0.88	2.77	9.5	0.69
Control 2 (Turkey)	0.80	2.51	6.0	0.45
Control 3 (Greece)	0.29	2.27	9.8	1.68

Table 7. Smoking characteristic of oriental tobaccos in Dak Lak and imported oriental tobaccos

Samples	Smoking points (points)					
	Aroma	Taste	Heavy smoking	Burning	Colour fiber	Total points
Basma 16-2021	12.3	9.8	4.2	3.2	3.8	33.3
Hanski 227-2021	12.3	10.0	4.4	3.4	4.3	34.3
Basma 16-2022	12.3	9.5	4.1	3.0	4.0	32.9
Hanski 227-2022	12.3	9.4	4.2	3.0	4.2	33.1
Control 1 (Bungaria)	12.1	9.3	4.3	3.2	5.0	33.9
Control 2 (Turkey)	12.4	9.5	4.2	3.2	4.0	33.3
Control 3 (Greece)	10.5	8.4	4.0	3.0	4.0	29.9

For imported samples, the quality of oriental tobacco in Dak Lak was the same as control 1 and 2, but higher than control 3. Total smoking points of tobacco in Dak Lak region reached 33.1 - 34.3 points, similar to tobacco of Bulgaria and Greece (33.3 - 33.9 points), and higher than Greece (29.9 points). Through two experiments of oriental tobacco varieties, Vietnam Tobacco Institute has chosen Basma and Hanski 227 as suitable to transplant tobacco production in the Ea Sup district, Dak Lak province.

4. CONCLUSION

After 4 years of trial planting of oriental tobacco in Ninh Thuan and Dak Lak provinces, the Vietnam Tobacco Institute had determined Dak Lak region that was suitable for plating the oriental tobacco plants and had selected two varieties of the oriental as Basma and Hanski 227. Those varieties were good growth, high yield and good quality. The quality of oriental tobacco production in Dak Lak was quite good, equivalent to the imported samples which were been used by Vietnam's factories.

The Institute of Tobacco initially completed the fertilizer formula, the process of growing, harvesting, curing and preserving the oriental tobacco to make high-quality tobacco production.

5. RECOMMENDATIONS

In the coming time, the Tobacco Institute will continue to experiment and expand the oriental tobacco area in 2023 in Dak Lak to provide materials for cigarette factories and limit imported tobacco from abroad.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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