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NATURE OF INHERITANCE AND HETEROSIS ESTIMATED ON SOME MORPHOLOGICAL QUANTITATIVE CHARACTERS THAT INFLUENCE THE TOBACCO YIELD

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INTRODUCTION

Inbreeding methods practiced with tobacco breeding in the latest decades have almost exhausted the variability existed in old and native cultivars. Artificial hybridization proved to be one of the most effective tools for restoring a wealth of new recombination's (4, 5, 10, 12, 13, 15).

In most type of tobacco, parallelly with cultivars, F_1 hybrids are more and more using for commercial tobacco production, especially in burley and cigar-wrapper industries type where single-cross hybrids predominates (1, 2, 3, 4, 6, 9, 10, 12).

Estimates of genetic variance, combining ability, heredity and heterosis have been determined from diallel studies conducted within and between various types of tobacco (*Nicotiana tabacum*. L.) (4, 6, 5, 10, 12, 14, 15). Determining the relative merits and feasibility of using F_1 hybrids in commercial tobacco production were the objectives of a considerable portion of that researches (5, 6, 8, 10, 11, 12, 15, 16).

The development of new hybrids permit the breeder to combine multiple characteristics of the parental forms into a single genotype in a short time (3, 4, 6, 11, 13, 15). So, the study of parental forms (or pure lines) and analysis of heterosis and inheritance etc. for the tobacco hybrid development with high yield and quality, are very important in the field of tobacco improvement (2, 4, 5, 6, 8, 10, 11, 12).

According to many studies, additive variance is the predominant type of genetic variance reported in flue-cured (3, 6), burley (10, 16) and type fire-cured (9) tobacco. However, small but significant values for heterosis have been reported that indicate the presence of non-additive genetic variance (6, 16). So, it has been observed mid parent heterosis between 2% and 14% in Virginia tobacco (8) and a small but significant amount of heterosis for yield in type fire-cured tobacco (9).

It exist small information about heterosis in type oriental tobacco (11).

The objectives of this research were to obtain estimates of inheritance effects and heterosis types for some morphological and agronomic quantitative traits that influence the tobacco yield, in oriental tobacco.

MATERIAL AND METHODS

The experimental material is represented from eight improvement oriental tobacco genotypes selected as parents. Two genotypes: R_2 and Roskovec (R_2; Rs) representing the most widely grown tobacco varieties in Albania. The other genotypes were introduced in Albania from different countries: Samsoun Conyl and Samsoun Bafra (SC; SBf) from Turky; Nevrokop (Nvr) from Bulgaria; Basma Xanthi and Katerini (BsX; Kat) from Greece and Perustitza Bega (PB) from Italy. All possible crosses, excluding reciprocals, were made between the 8 parental lines, producing a total of 28 hybrids. Parental self and F_1 hybrids, altogether **1/2 (p+1) p** = 36 genotypes, were grown in a randomized block design, in two environments, with three replications at each environment. Experiments were conducted for three years (2007, 2008, 2009) at the experimental fields of Tobacco Station Cerrik and Agricultural Technology Transfer Centre of Shkodra, respectively (in Albania). Parents and their F_1 hybrids were grown in three rows, 90 plants per plots with 12 cm between plants and 50 cm between rows. Cultural and curing practices were consistent with established farming practices of the area and with the variety used.

Characters measured were *plant height* (measured from ground level to the point at which the inflorescence was removed), *number of leaves* per plant (the number of harvested-leaves), *length and width* of middle leaves, *day to flower* (number of days from transplanting to 75% flower) and *yield* (kg/ha^{-1}).

Data were measured on ten competitive plants per plot for all characters except yield that was evaluated on the cured leaves and calculated from the plot weight.

The calculated parameters were *heterosis* and *potence ratio. Heterosis* was calculated as the difference between hybrid (**F_1**) and mid parental value and between hybrid and best parent (4, 5, 10, 11, 15). These parameters were computed, using generation means as follows:

Mid - parent heterosis (*Average heterosis*): **Avg % =(F_1 - MP)/ MP x 100**

Useful heterosis: **UH % = (F_1 - BP)/ BP x 100**; where **MP** and **BP** are mid and best parental values respectively. Inheritance nature was evaluated based on dominance parameters. Concretely, p*otence ratio* was computed by ratio of dominance parameters (**d/a)** (5, 13, 14), where **d** is the difference between F_1 means and parent means, and **a** is the half difference of two parents participators in a combination, according to the formula: **d/a = (F_1 - MP) / ½(P_1 - P_2)**.

The significance of heterosis were tested by the "t" test ± t = effect / variance of effect, where the variance of an effect is a linear function of the variance of its mean. A half- diallel analysis was performed according to Griffing (7) for a fixed effects model with parents included (Method 2, Model 1). Genotypic effects were considered fixed and parental lines comprised the population about which inferences were made.

RESULTS AND DISCUSSIONS

Mean performance of parents, F_1 hybrids, *heterosis* and *potence ratio* for all crosses are given in tables 1, 2 and 3 respectively.

***Heterosis components*:**

ANOVA analysis revealed the presence of an important variability in the experimental materials. Significant differences were observed among 28 F_1 hybrids and among the parents for all agronomic traits. Mean squares for parents vs. crosses were highly significant (at the 0,01 level of probability) for *days to flower*, *plant height*, *leaf length* and *leaf width* characters, indicating the presence of heterosis and the action of heterotic effects. Means of hybrids exceeded the means of parents for all these characters (table 1).

Table 1. Source of variation according genotypes (F - values), means of parents (MP) and hybrids (MH); average heterosis (Avg) and range of heterosis for characters measured in an oriental tobacco diallel

Characters	Plant height, cm	Leaf number	Middle leaf		Days to flower	Yield, kg. ha^{-1}
			Length, cm	Width, cm		
Genotypes	16,118**	12,91**	2,822**	5,776**	46,67**	477,038**
Means of parents	107,925	35,601	20,219	11,226	87,24	266,65
Means of hybrids.	112,275	35,665	21,015	11,752	88,39	274,075
Average heterosis %	4,03**	0, 18	3,94**	4,68**	1,32*	2,78*
Low heterosis %	-5,3	-2,2	-6,5	-6,8	-1,0	1,3
High heterosis %	13,0	1,2	14,7	19,0	3,6	7,2
No. F_1 above MP	24	13	24	25	21	18
No. F_1 above BP	10	0	16	14	3	2

(*,**) Indicates significance at the 0,05 and 0,01 level of probability, respectively

The greatest amount of heterosis was observed for *leaf width*, *leaf length* and *plant height* and the individual hybrids had the largest range in heterosis. Comparing mean values, it was found that the F_1 performance exceeded the best parent for *leaf length* and *leaf width* characters in a great number of crosses, indicating the existence of over-dominance and that was verified by the computed high value of potence ratio which exceeded unity (4, 12, 13).

So, heterosis for *plant height* of individual hybrids ranged from - 5,3% to 13% with an overall average of 4,3%. The higher value of heterosis (13%) was found in cross no. 9 (BsX x SBf). On the other hand, for this character, useful heterosis was found in 11 crosses.

Heterosis for *leaf length* of individual hybrids ranged from - 6,5% to 14,7% with an overall average of 3,94%. Useful heterosis was found in 16 crosses, with higher value 11% in cross no. 21 (SBf x Kat). Heterosis for *leaf width* of individual hybrids ranged from - 6,8% to 19% with an overall average of 4,68%. For this character, useful heterosis was found in 14 crosses.

Average heterosis values for *number of leaves* per plant were not significant, and for *days to flower* average heterosis values were low, but significant. Heterosis for *leaf yield* of individual hybrids ranged from - 1,3% to 7,2% with an overall average of 2,78%. For this character, useful heterosis was found only in 2 crosses.

As it is shown, heterosis values, observedi nour study for the oriental tobacco type, are very low than that reported by other authors (3, 6, 8, 9, 10, 16) and for other types of tobacco. Our results are similar to those reported by Marani(11).

The F_1 hybrid out-yielded the mid parental value in 18 hybrids and out-yielded the best parent only in 2 of the 28 hybrids (Tab. 1). The parent with highest yield was SC followed by PB and Nvr (table 2).

F_1 generation means for *yield* exceeded the mid parent for all hybrids except SC, PB and Nvr. Hybrid means of these latter three parents were higher than the overall average of hybrids observed in this study (=274,07 kg ha^{-1}). (table 1; 2).

Nature of inheritance:

The analysis of data, showed in tab. 3, indicated that the nature of inheritance for *plant height* character was over-dominance in 10 hybrids and partial dominance with positive direction towards higher parent in other 16 of the 28 hybrids.

Inheritance for*number of leaves* per plant was partial dominance in 20 hybrids with direction towards higher or low parent.

Table 2. Parental and hybrid means for agronomic traits of 8 oriental tobacco genotypes crossed in a diallel design

Cv.	Plant height		Leaf number		Mid leaf length		Mid leaf width		Days to flower		Yield,kg ha^{-1}	
	Parent	Hybrid	Parent	Hybr.	Parent	Hybr.	Parent	Hybr.	Parent	Hybr.	Parent	Hybr.
R_2	116,8	116,3	33,4	34,7	18,7	21,3	10,0	12,0	90,9	89,9	194,2	246,3
Bsx	93,3	107,2	34,3	35,1	19,2	20,6	10,3	11,6	84,2	86,7	225,0	260,1
SC	110,9	112,6	38,4	36,9	20,9	21,3	12,3	11,8	91,8	90,3	331,0	305,0
SBf	97,3	112,6	31,0	33,8	19,8	21,0	10,7	11,8	81,0	85,4	245,2	264,3
Nvr	106,2	107,1	37,7	36,4	22,2	20,9	10,9	11,1	96,4	92,7	300,2	289,6
Ros	123,2	116,7	36,4	36,0	19,7	21,0	12,1	12,0	91,9	90,6	259,6	258,9
Kat	112,4	115,3	37,5	36,5	20,0	21,1	11,3	11,9	76,8	84,2	270,8	275,8
PB	103,3	110,4	36,1	35,9	21,2	20,8	12,1	11,8	84,9	87,3	307,2	292,6

Table 3. Inheritance for agronomic characters of eight oriental tobacco genotypes crossed in a diallel design

No.	Hybrids	Potence ratio values (d/a)					
		Plant height	Leaf number	Mid leaf length	Mid leaf width	Days to flower	Yield, kg ha^{-1}
1	R2 x BsX	+0,47	0,00	+7,20	+9,00	+0,65	+0,40
2	R2 x SC	+2,05	+0,12	+1,07	+0,96	+0,50	+0,25
3	R2 x SBf	+1,17	+0,11	+4,77	+5,00	+0,30	+0,34
4	R2 x Nvr	- 0,11	+0,05	+1,43	+2,60	+0,54	+0,22
5	R2 x Rs	- 0,27	0,00	+4,60	+0,91	0,00	+0,13
6	R2 x Kat	+3,38	- 0,05	+3,38	+1,86	+0,28	+0,24
7	R2 x PB	+0,56	0,00	+0,72	+1,00	+0,26	+0,32
8	BsX x SC	+1,28	+0,15	+0,86	+0,79	+0,35	+0,35
9	BsX x SBf	+6,20	0,00	+3,14	+6,00	+0,12	+0,85
10	BsX x Nvr	+0,81	-0,41	-1,37	-1,33	+0,20	+0,42
11	BsX x Rs	+0,68	+0,30	+8,40	+1,11	+0,36	+0,46
12	BsX xKat	+0,87	-0,12	+4,00	+2,20	+0,22	+0,35
13	BsX x PB	+0,46	+0,33	-0,50	+0,02	+1,60	+0,35
14	SC x SBf	+0,69	0,00	+1,28	+0,33	+0,15	+0,13
15	SC x Nvr	+0,59	+0,57	+0,05	-1,15	+1,40	+0,28
16	Sc x Rs	+0,07	-0,09	+1,62	+1,00	+5,00	+0,33
17	SC x Kat	+2,47	+0,22	-0,15	+0,55	+0,29	+0,37
18	SC x PB	+0,67	+0,26	-10,00	-11,00	+0,23	+0,52
19	SBf x Nvr	+1,95	0,00	+0,60	+8,00	+0,09	+0,33
20	SBf x Rs	+0,58	+0,06	+2,00	+0,14	+0,76	+0,50
21	SBf x Kat	+1,18	-0,04	+17,00	+1,67	+0,93	+0,54
22	SBf x PB	+4,03	-0,25	+0,61	+0,71	+0,10	+0,17
23	Nvr x Rs	+0,56	+0,14	-0,58	0,00	+0,13	+0,42
24	Nvr x Kat	+1,52	0,00	0,00	-0,50	+0,32	+0,36
25	Nvr x PB	+0,07	+0,12	+0,41	-0,25	+0,56	+1,43
26	Rs x Kat	+0,80	+0,17	+0,85	+3,25	+0,30	+1,32
27	Rs x PB	+0,36	0,00	+0,93	0,00	+0,54	+0,33
28	Kat x PB	+0,96	+0,57	+1,17	+1,75	+0,17	+0,21
d/a		**+1,21**	**+0,07**	**+1,90**	**+1,33**	**+0,58**	**+0,42**
σ		1,36	0,21	4,26	3,37	0,92	0,30

For this character positive partial dominance was observed in 14 crosses, negative partial dominance in 6 crosses and absence of dominance in 8 of the 28 crosses, since the F_1 mean value was equal to the mid-parent value and this was verified by computed values of potence ratio which in this 8 crosses were equal to zero and very small in the other crosses.

For *leaf length* and *leaf width* the nature of inheritance was over-dominance and partial dominance. Over-dominance was found for *leaf length* in 16 hybrids and for *leaf width* in 14 of the 28 hybrids with direction (in a great number of hybrids) towards higher parent and partial dominance was found in 11 and 10 crosses respectively. For the latter character complete dominance was found in 2 crosses and none-dominance in other 2 crosses. Inheritance for *day to flower* character was in great portion of hybrids (in 24 crosses) partial dominance with direction towards low (early) parent and over-dominance only in 3 crosses.

For *yield* character the inheritance was partial dominance with direction towards higher parent in all hybrids observed and over-dominance in two crosses with direction towards best parent and this was verified by the computed low values of potence ratio which not exceeded the half unity in all crosses except 2 crosses where the **d/a** values were higher than unity (table 3).The low values of *heterosis* and of *potence ratio* for such characters as: *number of leaves* per plant and *yield* proved that additive genetic variance was more important in the inheritance of these characters. The nature of inheritance for these two characters was partial dominance or non-dominance and this was verified by the computed low values of *potence ratio* which not exceeded the half unity in all crosses for *yield*, and was very small or equal to zero for *number of leaves* per plant.

The average values of **d/a** ratio of overall crosses for *leaf number* and *yield* were very small (+0,07 and +0,42 respectively). This proved that the inheritance of these characters is controlled especially by the additive gene action. Both non-additive and additive genetic variance appeared to play a significant role in the inheritance of *leaf size* and *plant height*.

It is showed that in particular crosses the components of non-additive variance (dominance etc, play an evident role in genetic control of *leaf size* and *plant height* characters and this was verified by the computed higher values of potence ratio of overall crosses which exceeded the unity (+1,9; +1,33 and +1,21) for mid *leaf length*, mid *leaf width* and *plant height* respectively.

According to (3, 5, 6, 8, 9, 10, 11, 15, 16) the accumulated evidence in tobacco suggests that additive genetic variance with partial to complete dominance of favorable alleles is the predominant type of gene action in the expression of *yield* and other quantitatively inherited traits. Our results were in concordance with these suggestions.

The presence of additive genetic variance for all agronomic traits measured would suggest that the development of pure line would be more useful and more productive in commercial production of oriental tobacco.

However, because both additive and non-additive genes action play a significant role in the inheritance of all characters and above all for *yield* and for *number of leaves* per plant (as an important *yield* component), high yielding hybrids could be rapidly developed to meet new problem such as drought or disease resistance. So, F_1 hybrids development, in oriental tobacco, would be effective in specific regions and would be recommended for particular or temporary situations.

Our results, similar to those reported by Matzinger and others (12, 3, 5), confirmed this suggestion. In general, according our investigation, there are interested in F_1 hybrid development the SC, PB and Nvr cultivars that showed a high productivity and they would be useful to improve the *yield* of oriental tobacco. Also the local cultivar Rs presented interest for improvement of *leaf size* and *leaf width* especially.

ABSTRACT

An eight-parental half-diallel study of oriental tobacco cultivars was conducted to estimate inheritance effects and heterosis types for some morphological quantitative characters that influence the tobacco yield in a genetically diverse oriental tobacco population.

The trials were carried out in a randomized block design with three replications, in two different environments, during three years.

Plant height, *leaf number*, *leaf length*, *leaf width*, *days to flower* and *yield* (kg ha $^{-1}$) were determined.ANOVA analysis revealed the presence of an important variability in the experimental materials.

Additive genetic variance appeared to be more important in the inheritance of *yield*, *leaf number* and *days to flower*; while non-additive genetic variance appeared to play a greater role in the inheritance of *leaf size* and *plant height*.

The nature of inheritance was: partial dominance with direction towards best parent for *yield*, early parent for *days to flower*, higher or low parent for *leaf number*; and: over-dominance, complete dominance and partial dominance with positive and negative direction towards higher or low parent for *leaf size* and *plant height*. Average heterosis values were significant for *yield*, *plant height* and *leaf size*, that indicate the presence of non-additive genetic variance.

Average heterosis ranged from 2,8% for *yield* to 4,7% for middle *leaf width*.

REFERENCES

1. AKERHURST, B. C., 1982 - "Tobacco". 3-42,114-265
2. BEUCHAT, A; G. COVARELI,1990 - "Il tabacco virginia e burley". 5-37
3. CHAPLIN, J. F, 1966 - "Comparative performance of F1 flu-cured tobacco hybrids and their parents. I.Agronomie and quality characteristics". Tob. Scien. 10: 126-130.
4. CUNUNGHAM, P. E., 1983 - "The genetic basis of heterosis". 190-204
5. DEAN, C.E., 1974 - "Heterosis, inbreeding depression, and combining ability in diallel crosses of cigar-wrapper tobacco." Crop Sci. 14:482-484
6. FAN, C. J. AND M. K. AYCOCK, JR., 1974 - "Diallel crosses among Maryland cultivars of tobacco". Crop Sci. 14:679-682
7. GRIFFING, B., 1956 - "Concept of general and specific combining ability in relation to diallel crossing systems." Aust. Biol. Sci. 9:463-493
8. JONES, J.L., AND R.G.HENDERSON, 1978 - "Performance of Virginia dark-fired tobaco hybrids."Tob. Sci. 22: 109-111
9. LEGG, P. D., 1991 - "Genetic variability in broadleaf dark tobacco." Tob. Sci. 35:32-34
10. LEGG, P. D., G.B. COLLINS, AND C.C. LITTON, 1970 - "Heterosis and combining ability in diallel crosses of burley tobacco, Nicotiana tabacum L." Crop Sci. 10;705-707
11. MARANI, A. AND Y. SACHS, 1966 - "Heterosis and combining ability in a diallel cross among nine varieties of oriental tobacco". Crop Sci. 6:19-22
12. MATZINGER, D.F., T.J. MANN, and C.C. COCKERHAM, 1962 - "Diallel crosses in Nicotiana tabacum." Crop Sci. 2:383-386.
13. PEDERSON, D. G.., 1971 - "The estimation of heritability and degree of dominance from a diallel cross". Heredity 27: 247-264
14. TOUNKARA, F.; PALAKARCHEVA, M., 1991 - "Etude genetique de la resistance de la variete Pmr Burley 21 a *Erysiphe cichoracearum* D.C. et de quelques caracteres morphologiques lies åu rendement". Ann. du Tab. Seita-BERGERAC, Sect. 2-23:81-87
15. VANDENBERG, P.AND D.F.MATZINGER, 1970 - "Genetic diversity and heterosis in *Nicotiana.*III.Crosses among tobacco introduction and flu-cured varieties". Crop Sci. 10:437-440
16. WILKINSON, C.A., and R.C. RUFTY., 1990 - "Diallel analysis of crosses among United States and European burley tobacco cultivars." Tob. Sci. 34:15-18

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