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ALLELE GENES FROM CYTOPLASMIC SOURCES CONTRIBUTING TO YIELD: A CASE STUDY IN FCV TOBACCO (*NICOTIANA TABACUM* L.)

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Unequal contribution of cytoplasmic determinants from male and female gametes to the zygote causes reciprocal differences in nature and this influences the inheritance of the traits involved. To study the existence of any such differences, five reciprocal cross combinations were synthesized (2019-20) involving four parents *viz.*, Kanchan, FCH 222, PCT 17 and A4 and were evaluated in replicated trial during 2020-21 crop season to identify the existence of any reciprocal differences. Student t test (two sample equal variances) was conducted to test the significance of reciprocal cross differences. The results of student t test (two sample equal variances) revealed significance of reciprocal cross differences for plant height, number of leaves, leaf length and width, cured leaf and bright leaf yield and TGE. There was increase in mean plant height, number of leaves, leaf length when PCT 17 was used as female parent than as a male parent. Variation with respect to cured leaf weight, bright leaf weight and TGE was also noticed in crosses involving PCT 17 as one of the parent though no definite trend was noticed in any one direction. Reciprocal cross differences were found when PCT 17 was involved as a parent indicating PCT 17 may have cytoplasmic genes/alleles contributing to yield and yield attributing traits.

INTRODUCTION

Both female and male parents contribute some amount of the genes to their offspring, but the influence of female parent often extends beyond simple genetic transmission. Reciprocal differences are caused due to cytoplasmic genes present in mitochondria/chloroplast or due to maternal effect or due to interactions between nuclear and cytoplasmic genomes or due to genomic imprinting. Reciprocal cross effect was reported in many crops such as Maize (for days to silking, plant height, husked ear length, unhusked yield and husked yield; Dermail et al., 2018), tomato (fruit quality traits; Fortuny et al., 2021), Rice (for majority of yield & yield attributing traits; Harijan et al., 2021) etc., Reciprocal cross differences influence levels of heterosis, resistance/susceptibility to diseases and also affect yield and productivity. Understanding reciprocal cross differences is crucial for optimizing crop breeding programs, improving seed quality, and enhancing crop performance. However such informationon tobacco is very scanty and hence, a pilot study was conducted during the crop season 2019-20 to ascertain the existence of any reciprocal cross differences among the Flue Cured Virginia tobacco hybrids for yield and yield related traits.

MATERIALS AND METHODS

Five reciprocal FCV hybrids were synthesized using four parents*viz.*, Kanchan, FCH 222, PCT 17 and A4 during the year (2019-20). These reciprocal hybrids were evaluated in replicated trial with three replications during 2020-21 crop season,each hybrid consisted of ten plants each with 100cm and 55cm as inter and intra- row spacing respectively. All the agronomic package of practices was followed and a healthy crop was raised. Observations were recorded on plant height, number of leaves per plant, inter-nodal length, length, and width of 5th, 7th, and 9th leaves on five randomly selected plants of each hybrid. The observations on the total green leaf and cured leaf yields were recorded by harvesting the entire row and average yield per plant computed. Total Grade Equivalent (TGE) and bright leaf was estimated using standard formula.Student t test (two sample equal variances) was conducted to test the significance of reciprocal cross differencesamong the hybrids using Microsoft excel.

Key words: Reciprocal crosses, student t -test, FCV tobacco hybrids, yield and related traits

RESULTS AND DISCUSSION

Results of theStudent- t- test analysis presented in Table 1 & 2indicated significant differences among the reciprocal hybrids forboth morphological and yield related traits. Among the morphological traits, plant height, number of leaves, leaf length and width exhibited significant reciprocal cross differences,while for yield traits cured leaf, bright leaf yield and TGE showed significant reciprocal cross differences. These present results are in concurrence with results of Lamprecht & van Wyk (1969) on air-cured tobacco. Van Heerden *et al.*, (1988) also reported significant reciprocal differences for number of leaves and average weight of leaves.It is interesting to note that, there was an increase in mean plant height, number of leaves, leaf length when PCT 17 was used as female parent than as a male parent indicating that PCT 17 cytoplasm may be contributing positive alleles for these traits. Reciprocal cross differences werewas also noticed in crosses involving PCT 17 as one of the parent though no definite trend was noticed in any one direction with respect to cured leaf weight, bright leaf weight and TGE (Table 3&4). Maternal effect and reciprocal differences in reciprocal hybrids of FCV tobacco for various traits including yield and quality were earlier reported by Kumar, *et al.*,(2015); Patel*et al.*, (2017)and Zhang *et al.*, (2019).Further, increase in means of traits can also be due to favourable nuclear-cytoplasm interaction. Such nuclear-cytoplasm interactions often have favourable effect on yield and quality of tobacco (Kumar, *et al.*, 2015 and Liu, *et al.*, 2017).Thus, this study indicates existence of reciprocal differences which can have a bearing on breeding procedures (Meredith, 1984) especiallywith regards to development of F_1 hybrids.

CONCLUSION

Reciprocal crosses play an important role in the selection of any breeding programme for population improvement and development of new hybrids in a crop. The student test indicated significant differences among the reciprocal hybrids for plant height, number of leaves, leaf length and width, cured leaf and bright leaf yield and TGE.Higher mean plant height, number of leaves and leaf length when PCT 17 was used as

Table 1: t values for the morphological characters in the Reciprocal crosses (F_1s).

Reciprocal Crosses	df	Plant height	No. of leaves	5th Leaf Length	5th Leaf Width	7th Leaf Length	7th Leaf Width	9th Leaf Length	9th Leaf Width
A4 × PCT17 vs PCT17 × A4	28	-1.163	0.968	-0.564	-2.158*	0.419	-0.847	0.123	0.648
Kanchan × PCT17 vs PCT17 × Kanchan	28	-4.11**	-0.874	-2.962**	0.206	-1.556	-2.977**	-1.019	-0.938
FCH222 × PCT17 vs PCT17 × FCH222	28	-7.729**	-3.85**	-0.129	-2.824**	-0.756	0.721	0.603	-0.759
FCH222 × A4 vs A4 × FCH222	28	0.103	-1.186	0	-0.938	-1.038	-1.446	-0.223	-1.74
Kanchan × A4 vs A4 × Kanchan	28	-1.347	-1.767	0.644	1.813	1.82	-0.074	0.445	1.281

Table 2: t values of yield per plot in different Reciprocal crosses (F_1s)

Reciprocal Crosses	df	Green leaf yield	Cured leaf yield	Bright leaf yield	TGE
A4 × PCT17 vs PCT17 × A4	4	0.021	1.566	2.2	2.94**
Kanchan × PCT17 vs PCT17 × Kanchan	4	-0.411	4.419**	2.18	2.889**
FCH222 × PCT17 vs PCT17 × FCH222	4	-1.002	-2.225	-3.21**	-4.282**
FCH222 × A4 vs A4 × FCH222	4	0.414	-2.56	-0.781	-1.781
Kanchan × A4 vs A4 × Kanchan	4	-0.886	-0.704	0.157	-0.289

female parent indicates that PCT 17 may have cytoplasmic genes/alleles contributing to yield and yield attributing traits. The present investigation was preliminary involving few reciprocal FCV hybrids and the findings needs further investigating by increasing the number of reciprocal hybrids so as to identify the probable lines with positive cytoplasmic allele genes on yield that can be utilized in hybrid development in FCV Tobacco.

REFERENCES

Kumar,P., A.Kumar, V. Gupta and N.K.Singh. 2015. Nuclear –Cytoplasmic interaction affecting leaf yield and quality in tobacco. **J. of Plant Growth Regulation** 34(2): 257-265.

Lamprecht, M.P. andR.I.Van Wyk. 1969. Improved yield,quality and disease resistance in air-cured tobacco. **Agroplantae** 1:99-100.

Liu, Y., X.Wang, Z. Li and Y. Zhang. 2017. Nuclear- Cytoplasmic Interactions Regulates Leaf growth and development in tobacco. **Plant Mol. Biol**. 93(4) 347-358.

Meredith, W.R., 1984. *Cotton*. In R.I. Kohel&e.F. Lewis(eds), pp. 132-147, Soil Sci. Soc. of Amer., Amer. Soc. of Agron,and Crop Sci. Soc. of Amer.

Patel, R.K., S.K. Singh, A.K. Sharma, R.C. Agarwal and P.K. Singh. 2017. Reciprocal cross effects on yield and quality traits in Flue-Cured Virginia Tobacco. **J. of Tob. Res.** 9(2): 123-133

van Heerden, H. G., M. P. Lamprecht and H. van Ark.1988. Reciprocal differences inintraspecies crosses of tobacco (*Nicotiana tabacum* L.).**S. African J. of Plant and Soil**, 5:3, 117-119.

Zhang, Y., X. Liu, Wang, X and Y. Li. 2019. Cytoplasmic and maternal effects on cured leaf yield in FCV tobacco reciprocal hybrids. **Plant Mol. Biol.** 99(4) 347-358.

DermailA., B.Suriharn, , K. Lertrat , S. Chankaew and J. Sanitchon(2018) Reciprocal cross effects on agronomic traits and heterosis in sweet and waxy corn Sabrao J. Breed. Genet. 50 (4) 444-460.

Agustina P Fortuny, Rodrigo A Bueno, Javier H Pereira da Costa, María Inés Zanor, Gustavo R Rodríguez, (2021) Tomato fruit quality traits and metabolite content are affected by reciprocal crosses and heterosis. J. of Exp. Bot., 72(15):5407–5425.

Harijan Y., AshvinkumarKatral, Mahadevaiah C, Hanamareddy Biradar, Jagadeesh Hadimani and Shailaja Hittalmani (2021) Genetic analysis of reciprocal differences for yield and yield attributing traits in segregating populations of rice (*Oryza sativa* L.) J. of Pharmacognosy and Phytochem., 10(2): 614-621.

Table :Mean values of yield per plot in different Reciprocal crosses (F_1s)

Cross	Green leaf yield		Cured leaf yield		Bright leaf yield		TGE	
	P1 P2	P2 P1	P1 P2	P2 P1	P1 P2	P2 P1	P1 P2	P2 P1
A4 × PCT17 vs PCT17 × A4	14495	14474	2402	2113	1339	1205	1744	1537
Kanchan × PCT17 vs PCT17 × Kanchan	11126	11298	1836	1507	1110	769	1335	1067
FCH222 × PCT17 vs PCT17 × FCH222	11637	12155	1441	1666	665	1061	906	1232
A4 × FCH222 vs FCH222 × A4	15156	14886	1586	2156	987	1095	1109	1389
Kanchan × A4 vs A4 × Kanchan	13459	14377	1786	1982	1265	1233	1365	1424

Table :Mean values for the morphological characters in the Reciprocal crosses (F_1s).

Cross	Plant height		No. of leaves		5th Leaf Length		5th Leaf Width		7th Leaf Length		7th Leaf Width		9th Leaf Length		9th Leaf Width	
	P1×P2	P2×P1	P1×P2	P2×P1	P1×P2	P2×P1	P1×P2	P2×P1	P1×P2	P2×P1	P1×P2	P2×P1	P1×P2	P2×P1	P1×P2	P2×P1
A4 × PCT17 vs PCT17 × A4	118.40	123.07	25.00	24.47	58.80	59.60	29.13	32.40	62.60	61.80	30.13	31.00	60.27	60.07	28.33	27.60
Kanchan × PCT17 vs PCT17 × Kanchan	121.67	140.07	25.40	25.80	53.07	60.00	30.27	29.93	58.67	61.27	28.00	31.27	59.13	60.67	26.53	27.93
FCH222 × PCT17 vs PCT17 × FCH222	106.40	145.53	24.20	26.07	55.53	55.73	28.07	31.40	59.33	60.93	31.00	29.73	58.13	56.20	27.93	29.20
A4 × FCH222 vs FCH222 × A4	125.40	124.87	24.93	25.40	59.40	59.40	30.93	32.27	58.20	59.80	30.07	31.40	59.60	60.00	28.13	30.47
Kanchan × A4 vs A4 × Kanchan	112.27	119.80	24.87	25.67	58.90	57.60	30.45	27.93	60.70	58.40	27.78	27.87	57.15	55.80	27.79	25.73