E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(8): 526-531
Received: 09-06-2024
Accepted: 17-07-2024

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Correlation and path coefficient analysis for yield and yield attributing traits in Mulberry (*Morus spp*.)

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i8Sg.1326

Abstract
Correlation studies in mulberry aids to gain the knowledge about the association among the traits which is quite helpful for the development of superior hybrids. In the present study, fifteen genotypes were used which were obtained by crossing five lines and three testers. Results pertaining to correlation studies indicated that the magnitude of genotypic correlation was superior than their corresponding phenotypic correlation. Germination percent and survival percent had positive correlation with shoot diameter, number of leaves per branch and moisture retention capacity and negatively correlated with internodal distance and chlorophyll pigments. Plant height exhibited positive correlation with most of the studied traits and which were closely associated with growth rate and root parameters which highly influenced the shoot traits. Whereas, number of branches per plant showed highly significant and positive correlation with number of leaves per branch and number of roots per plant. Chlorophyll a, b and total chlorophyll were closely associated among themselves. Chlorophyll-a had positive correlation with chlorophyll-b and total chlorophyll. It plays a major role in transforming the unusable raw solar energy into usable chemical assimilates via photosynthesis. Research findings indicated that, all the characters included in this study were inter-related among themselves and root parameters exhibited highest positive correlation with other traits.

Keywords: Mulberry, correlation and path analysis, yield attributing traits, novel genotypes

Introduction
Correlation co-efficient and path analysis are the essential tools for development of promising mulberry hybrids (Vijayan *et al.*, 1997 and Nonthakod *et al.*, 2019) [16, 10]. Correlation analysis provides the knowledge of inter-relationship between the two traits and it revealed the variations in phenotypic and their corresponding genotypic correlations of the studied traits. Path analysis helps to determine the cause and effect relationship between the pair of traits through breakdown the correlation coefficient into direct and indirect effects (Pavan *et al*., 2011) [11].
Mulberry crop improvement programs are mainly based on increasing the quality and quantity of leaf because of the entire activities and success of the programme completely depends on the nutritive value and yield of the leaves. Yield being a crucial quantitative character, it is influenced by various genes and environmental factors. According to the authors *viz*., Vijayan *et al.* (1997) [16], Tikader and Kamble (2008) [15], Murthy *et al.* (2010) [8], Wani *et al.* (2013) [20] leaf yield is positively correlated with plant height, longest shoot length, number of branches per plant and total shoot length. Development of new hybrids of mulberry with novel traits over the existing one is a never-ending process. For improving the qualitative and quantitative characters, we should have the knowledge about the trait association (Santos *et al.*, 2014) [14]. The present study aims to determine the correlation for growth and survivability traits of eight mulberry genotypes which are used to produce new mulberry genotypes for further breeding programs.

Materials and methods
A total of 15 F1 progenies were developed by crossing five lines *viz*., MI-0543, MI-0615, MI-0651, MI-0685, MI-0718 (Procured from Central Sericulture Germplasm Resources Centre, Hosur) with three testers *viz*., V_1, G_4, MI-0663. The present study was conducted in Department

of Sericulture, Mettupalayam. These parent materials were maintained with recommended package of practices suggested by Dandin and Giridhar (2010) [2].

Line x Tester mating design was used for crossing the parental genotypes (Kempthrone, 1957) [5]. Premium quality of seeds was extracted from fully ripened fruits which was obtained from the crossed parental genotypes. Totally seeds of 15 crosses were extracted from the fruits and were placed in petri dish. The seeds were treated with 1000 ppm GA_3 overnight for better seed germination. Later the seeds were sown in separate root trainers filled with coir pith and maintained under greenhouse condition with regular watering for 15 days. Then the 15 days old seedlings were transplanted to polybags for further growth. Observations were recorded on 60, 75 and 90 days after sowing. The recorded observations were subjected to phenotypic and genotypic correlation studies among the survivability and growth traits which were estimated by using correlation and path analysis.

Correlation analysis

Correlation analysis was performed to know the direction and magnitude of association among the various traits. Calculated value was tested against table 'r' value at (n-2) degrees of freedom for both 0.05 and 0.01 probability level. Correlation values were computed by using the following formula given by Weber and Moorthy (1952) [21].

$$r = \frac{\mathrm{Cov}\ (x\,y)}{\sigma x\ \sigma y}$$

Where,

Cov (x y) = covariance of x and y

σx = standard deviation of x

σy = standard deviation of y

Path coefficient analysis

Path coefficient analysis is first proposed by Wright (1921) [22] and it was used to determine the direct and indirect effect of the various traits on survivability and growth traits. Direct and indirect effects were estimated by using the following equations.

$$r1y = a + r12b + r13c + \cdots \ldots\ldots\ldots\ldots + r1li$$

$$r2y = a + r21a + b + r23c + \ldots\ldots\ldots\ldots\ldots + r2li$$

$$r3y = r31a + r32b + c + \cdots \ldots\ldots\ldots\ldots + r3li$$

$$r1y = r11a + r12b + r13c + \cdots \ldots\ldots\ldots\ldots + I$$

Where,

r_{1y} to 1_{1y} = coefficient of correlation between casual factors 1 to I with dependent character y.

r_{12} to r_{1I} = coefficient of correlation among casual factors

a, b, c…. i = direct effect of traits 'a' to 'I' on the dependent character 'y'

Residual effect was calculated as follows,

$$\text{Residual effect(R)} = 1 - \sqrt{a^2 + b^2 + c^2 \ldots\ldots\ldots i^2 + 2abr12 + 2acr13 + \ \ldots\ldots}$$

Results and Discussion

Correlation analysis

Phenotypic correlation among the studied traits is presented in Table 1. Germination percent exhibited positive correlation with survival percent (0.8246), shoot diameter (0.6106), number of leaves per branch (0.5182) and moisture retention capacity (0.6082). Similarly, shoot diameter (0.5174), number of leaves per branch (0.5874), leaf moisture content (0.6334) and moisture retention capacity (0.6692) were showed significant positive correlation with survival percent. Germination percent and survival percent were inter-related with each other and also had positive correlation with shoot diameter, number of leaves per branch and moisture retention capacity and negatively correlated with internodal distance and chlorophyll pigments. Plant height was closely associated with growth rate and root parameters which highly influenced the shoot traits. Similar results were obtained by Vijayan *et al.* (1997) [16], Doss *et al.* (2011) [4], Saini *et al.* (2018) [13]. Number of roots per plant was highly significant and positively correlated with plant height and growth rate. Internodal distance had negative correlation with leaf moisture content and moisture retention capacity which was in contrary with the findings of Tikader and Kamble, (2008) [15] who reported that the internodal distance exhibited close association with leaf moisture content and moisture retention capacity.

Number of branches per plant, number of leaves per branch, number of roots per plant were significantly and positively correlated with shoot diameter (0.7002, 0.7803 and 0.5735 respectively). Number of branches per plant was highly significant and positively correlated with number of leaves per plant (0.8073) and number of roots per plant (0.5102). On the contrary, internodal distance was negatively correlated with number of branches per plant (-0.1020). Growth rate was positively correlated with number of branches per plant which was contrary with earlier work done by Doss *et al.* (2011) [4], who reported that plants with less number of branches had high growth rate.

None of the traits exhibited positive correlation with number of leaves per branch while internodal distance and single leaf area were negatively correlated with number of leaves per branch (-0.2689 and -0.0563 respectively). Whereas, number of branches per plant showed highly significant and positive correlation with number of leaves per branch and number of roots per plant. This result was in congruity with the findings of Diniz and Oliveira (2019) [3], who observed 25% number of roots in the plants with more number of leaves. On the contrary, Rahman and Islam (2020) [12] reported that, number of branches per plant had no significant relation with growth and yield traits. Leaf pigments *viz.* chlorophyll-a, chlorophyll-b and total chlorophyll exhibited positive correlation with fresh leaf weight (0.5922, 0.5748 and 0.6392 respectively). Whereas, leaf moisture content showed negative correlation with fresh leaf weight (-0.1500). Chlorophyll-a showed positive correlation with chlorophyll-a and total chlorophyll (0.5110 and 0.5653 respectively) while, chlorophyll-b was positively correlated with total chlorophyll (0.7212).

With regard to the phenotypic correlation, chlorophyll pigments were genotypically correlated with each other. Chlorophyll-a showed positive correlation with chlorophyll-b (0.6894) and total chlorophyll (0.6751, whereas, chlorophyll-b was positively correlated with total chlorophyll (0.8678). Similarly, number of roots per plant had significant positive correlation with fresh root weight (0.6292). The study results inferred that the genotypes with high chlorophyll contents are photosynthetically efficient. Reports of the present study was in conformity with the results made by Kumar *et al.* (2012) [6], who reported that the leaves with high chlorophyll pigments had more photosynthetic efficiency. Number of roots per plant was positively correlated with fresh root weight. Findings of the study was strengthened by the reports made by Wang *et al.* (2009) [19] and Nassir *et al.* (2017) [9].

Path coefficient analysis

Correlation between the traits should be either positive or negative, but it is the net result produced by direct effect of the trait or indirect effect via other characters. Path analysis divided the correlation coefficient into direct and indirect effects and it enhanced the accuracy of the correlation among the studied traits. Survival percent had positive indirect effects were exhibited with germination percent, internodal distance, single leaf area and chlorophyll-a. Similarly, plant height showed direct negative effect and its indirect positive effects were expressed by germination percent and total chlorophyll. Similar results were found in rice, by Babu *et al.* (2012) [1] and contrary findings were observed by Doss *et al.* (2011) [4]. Pavan *et al.* (2011) [11] and Vinoth *et al.* (2018) [18] reported that plant height showed positive direct effect on growth traits.
Number of branches per plant showed low positive direct effect, besides germination percent and total chlorophyll had positive indirect effects to number of branches per plant. Similar findings were reported by Doss *et al.* (2011) [4] and Saini *et al.* (2018) [13]. Apart from that, less positive direct effect was noticed for number of leaves per branch and it had positive indirect effects via germination percent, internodal distance, single leaf area and total chlorophyll. Internodal distance had negative direct effect and its indirect effects were positive through survival percent, leaf moisture content, moisture retention capacity and total chlorophyll. Among the twenty traits number of roots per plant (1.1634) had highest positive direct effect followed by germination percent (1.0077), fresh root weight (0.8950), total chlorophyll (0.6455), number of branches per plant (0.1194) and number of leaves per branch (0.0350). These results were in corroboration with the findings of Doss *et al.* (2011) [4], Saini *et al.* (2018) [13] and were in contrary with the reports of Banerjee *et al.* (2011). Chlorophyll-a and chlorophyll-b showed negative direct effect while total chlorophyll exhibited positive direct effect on growth traits. And chlorophyll pigments had positive indirect effects via leaf moisture content and moisture retention capacity which was supported by Lenis *et al.* (2006) [7] who stated that genotypes with high leaf pigments and greater leaf retention have the ability to produce more photo assimilates.

Conclusion

Single leaf area, number of leaves per plant, number of branches per plant and internodal distance are the principal traits which predominantly contributed to leaf yield. number of branches per plant showed highly significant and positive correlation with number of leaves per branch and number of roots per plant, whereas, negatively associated with internodal distance. Internodal distance was positively correlated with single leaf area. It denotes that shoots with more nodal distance should produce larger leaves. Findings of path analysis denoted that number of branches per plant and number of leaves per branch also exhibited positive indirect effect for the studied traits except internodal distance. For this study, all the values of the variables which produce direct effect were greater than the residual effect except number of leaves per branch. Residual effect was very less, it indicates that the studied characters of this research were sufficient to describe the variability in the dependent trait and the traits contributed more to the survivability and growth of mulberry. From this study, we concluded that crucial parameters which were associated with leaf yield are number of leaves per branch, number of branches per plant, single leaf area, internodal distance and number of roots per plant. Hence, genotypes with high positive correlation with these above traits should be utilized for further development of mulberry hybrids.

Table 1: Estimation of phenotypic correlation among survivability and growth traits in mulberry

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X_1	1.0000	0.8246**	0.2004	0.3343	0.1457	0.3579	0.0137	0.6106*	0.3565	0.5182*	-0.1620	0.0839	-0.0786	0.4958
X_2		1.0000	0.2252	0.3928	0.2682	0.4171	0.1654	0.5874*	0.2860	0.5683*	-0.2679	-0.1133	0.0011	0.6334*
X_3			1.0000	0.6860**	0.5951*	0.7009**	0.5046*	0.4166	0.4716	0.3609	0.4216	0.3800	0.3278	0.1928
X_4				1.0000	0.7919**	0.9159**	0.6405**	0.6342*	0.5502*	0.5305*	0.4347	0.4999	0.4302	0.4181
X_5					1.0000	0.7922**	0.8949**	0.5474*	0.4579	0.4269	0.4371	0.4028	0.4902	0.1670
X_6						1.0000	0.6608**	0.6560**	0.5543*	0.5653*	0.3902	0.5036*	0.4278	0.4736
X_7							1.0000	0.4395	0.3473	0.3461	0.3661	0.3339	0.5050*	0.0259
X_8								1.0000	0.7002**	0.7803**	0.0591	0.2314	0.2176	0.3446
X_9									1.0000	0.8073**	-0.1020	0.1454	0.2266	0.2147
X_{10}										1.0000	-0.2689	-0.0563	0.1648	0.4587
X_{11}											1.0000	0.5621*	0.3258	-0.1413
X_{12}												1.0000	0.2382	-0.0470
X_{13}													1.0000	-0.1500
X_{14}														1.0000

*,** Significant at 5% and 1% respectively

Traits	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}
X_1	0.6082*	-0.3179	-0.0413	-0.2413	0.2250	0.2110
X_2	0.6692**	-0.2366	0.0189	-0.0909	0.3273	0.0610
X_3	0.2054	0.1635	0.2283	0.0835	0.7248**	0.4624
X_4	0.3998	0.2323	0.2460	0.1502	0.8809**	0.5642*
X_5	0.3058	0.4376	0.3843	0.2656	0.8822**	0.4816
X_6	0.4733	0.2226	0.2793	0.1846	0.8794**	0.5857*
X_7	0.1551	0.5071*	0.4170	0.3082	0.7899**	0.4007
X_8	0.3963	0.1315	0.2418	0.1192	0.5735*	0.4692
X_9	0.3095	0.2584	0.1870	0.0683	0.5102*	0.2368
X_{10}	0.4804	0.1153	0.0048	0.0994	0.4629	0.2004

X_{11}	-0.2004	0.2246	0.1817	0.0063	0.5381*	0.5891*
X_{12}	-0.0584	0.3277	0.3961	0.2180	0.4570	0.6088*
X_{13}	0.0572	0.5922*	0.5748*	0.6392*	0.4318	0.2247
X_{14}	0.6347*	-0.2711	-0.2109	-0.1655	0.3264	0.1504
X_{15}	**1.0000**	-0.0593	0.0443	-0.0239	0.3557	0.1542
X_{16}		**1.0000**	0.5710*	0.5653*	0.3142	0.1323
X_{17}			**1.0000**	0.7212**	0.3259	0.3895
X_{18}				**1.0000**	0.1437	0.1712
X_{19}					**1.0000**	0.5736*
X_{20}						**1.0000**
***,** Significant at 5% and 1% respectively**						

Table 2: Estimation of Genotypic correlation among survivability and growth traits in mulberry

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X_1	1.0000	0.8923**	0.4859	0.3763	0.1499	0.3841	0.0086	0.7260**	0.4114	0.5807*	-0.1566	0.0604	-0.0880	0.6111*
X_2		1.0000	0.4527	0.4144	0.2851	0.4403	0.1801	0.6348*	0.2921	0.5860*	-0.2860	-0.1190	0.0045	0.7816**
X_3			1.0000	1.3281**	1.2152**	1.2722**	0.9899**	1.0829**	0.7757**	0.6803**	0.7924**	0.7583**	0.5750*	0.5607*
X_4				1.0000	0.9193**	1.0416**	0.7399**	0.7859**	0.6111*	0.5815*	0.4940	0.5520*	0.4439	0.5374*
X_5					1.0000	0.9179**	0.9990**	0.6343*	0.4928	0.4993	0.4712	0.4811	0.5748*	0.3037
X_6						1.0000	0.7315**	0.7800**	0.5859*	0.5869*	0.4620	0.5336*	0.4572	0.5550*
X_7							1.0000	0.4827	0.3660	0.3804	0.4222	0.3684	0.5584*	0.1261
X_8								1.0000	0.7688**	0.8669**	0.0536	0.2777	0.2705	0.4313
X_9									1.0000	0.8531**	-0.1107	0.1786	0.2383	0.2826
X_{10}										1.0000	-0.2997	-0.0791	0.1607	0.5417*
X_{11}											1.0000	0.6583**	0.3498	-0.2319
X_{12}												1.0000	0.2776	-0.1088
X_{13}													1.0000	-0.2258
X_{14}														1.0000
*,** Significant at 5% and 1% respectively														

Traits	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}
X_1	0.6761**	-0.3271	-0.0367	-0.2937	0.2663	0.2444
X_2	0.8129**	-0.2562	0.0160	-0.0951	0.3388	0.0546
X_3	0.5664*	0.3677	0.4314	0.1549	1.2503**	0.9160**
X_4	0.5815*	0.2686	0.3194	0.1674	0.9759**	0.6363**
X_5	0.3044	0.4690	0.4446	0.2962	0.9893**	0.5534*
X_6	0.6112*	0.3047	0.3203	0.1883	0.9625**	0.6138*
X_7	0.1541	0.5335*	0.4760	0.3383	0.8834**	0.4418
X_8	0.5387*	0.1407	0.2807	0.1584	0.6625**	0.5171*
X_9	0.3596	0.2702	0.1817	0.0781	0.5230*	0.2479
X_{10}	0.6623**	0.1326	0.0634	0.0943	0.5001	0.1971
X_{11}	-0.2198	0.2026	0.2195	0.0153	0.5567*	0.6470**
X_{12}	-0.0545	0.3952	0.4864	0.1958	0.5262*	0.6711**
X_{13}	0.1402	0.6677**	0.6726**	0.7213**	0.4399	0.2527
X_{14}	1.1073**	-0.2789	-0.1842	-0.2648	0.4260	0.1885
X_{15}	1.0000	-0.0761	-0.0443	-0.0744	0.4128	0.2240
X_{16}		1.0000	0.6894**	0.6751**	0.3535	0.1418
X_{17}			1.0000	0.8678**	0.3605	0.4540
X_{18}				1.0000	0.1749	0.2025
X_{19}					1.0000	0.6292*
X_{20}						1.0000
*,** Significant at 5% and 1% respectively						

Table 3: Estimates of direct and indirect effects between survivability and growth traits in mulberry

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
X_1	1.0077	-0.6257	-0.0494	-0.0545	-0.0286	-0.0290	-0.0004	-0.2952	0.0491	0.0203	0.0264	-0.0248	0.0217
X_2	0.8992	-0.7012	-0.0460	-0.0600	-0.0545	-0.0332	-0.0079	-0.2581	00349	00205	0.0483	0.0487	-0.0011
X_3	0.4896	-0.3174	-0.1017	-0.1923	-0.2322	-0.0961	-0.0435	-0.4403	0.0926	0.0238	-0.1338	-0.3106	-0.1418
X_4	0.3792	-0.2906	-0.1350	-0.1448	-0.1757	-0.0786	-0.0325	-0.3196	0.0730	0.0204	-0.0834	-0.2261	-0.1095
X_5	0.1510	-0.1999	-0.1236	-0.1331	-0.1911	-0.0693	-0.0439	-0.2579	0.0588	0.0175	-0.0796	-0.1970	-0.1417
X_6	0.3871	-0.3088	-0.1293	-0.1508	-0.1754	-0.0755	-0.0321	-0.3172	0.0700	0.0205	-0.0780	-0.2185	-0.1127
X_7	0.0087	-0.1263	-0.1006	-0.1072	-0.1909	-0.0552	-0.0439	-01963	0.0437	0.0133	-0.0713	-0.1509	-0.1377
X_8	0.7316	-0.4451	-0.1101	-0.1138	-0.1212	-0.0589	-0.0212	-0.4066	0.0918	0.0303	-0.0090	-0.1137	-0.0667
X_9	0.4146	-0.2048	-0.0789	-0.0885	-0.0942	-0.0442	-0.0161	-0.3126	0.1194	0.0299	0.0187	-0.0731	-0.0588
X_{10}	05852	-0.4109	-0.0692	-0.0842	-0.0954	-0.0443	-0.0167	-0.3525	0.1019	0.0350	0.0506	0.0324	-0.0396
X_{11}	-0.1578	0.2005	-0.0806	-0.0715	-0.0900	-0.0349	-0.0185	-0.0218	-0.0132	-0.0105	-0.1689	-0.2696	-0.0863

X_{12}	0.0609	0.0835	-0.0771	-0.0799	-0.0919	-0.0403	-0.0162	-0.1129	0.0213	-0.0028	-0.1112	-0.4096	-0.0684
X_{13}	-0.0887	-0.0031	-0.0585	-0.0643	-0.1098	-0.0345	-0.0245	-0.1100	0.0285	0.0056	-0.0591	-0.1137	-0.2465
X_{14}	0.6158	-0.5480	-0.0570	-0.0778	-0.0580	-0.0419	-0.0055	-0.1754	0.0337	0.0190	0.0392	0.0445	0.0557
X_{15}	0.6813	-0.5700	-0.0576	-0.0842	-0.0582	-0.0461	-0.0068	-0.2190	0.0429	0.0232	0.0371	0.0223	-0.0346
X_{16}	-0.3296	-0.1797	-0.0374	-0.0389	-0.0896	-0.0230	-0.0234	-0.0572	0.0323	0.0046	-0.0342	-0.1619	-0.1646
X_{17}	-0.0370	-0.0112	-0.0439	-0.0463	-0.0850	-0.0242	-0.0209	-0.1141	0.0217	0.0022	-0.0371	-0.1992	-0.1658
X_{18}	-0.2959	-0.0667	-0.0157	-0.0243	-0.0566	-0.0142	-0.0149	-0.0644	0.0093	0.0033	-0.0026	-0.0802	-0.1778
X_{19}	0.2684	-0.2375	-0.1271	-0.1413	-0.1890	-0.0727	-0.0388	-0.2694	0.0625	0.0175	-0.0940	-0.2155	-0.1084
X_{20}	0.2463	-0.0383	-0.0931	-0.0921	-0.1057	-0.0463	-0.0194	-0.2103	0.0296	0.0069	-0.1093	-0.2749	-0.0623

Traits	**X_{14}**	**X_{15}**	**X_{16}**	**X_{17}**	**X_{18}**	**X_{19}**	**X_{20}**
X_1	-0.0100	-0.1014	0.0740	0.0014	-0.0896	0.3099	0.2188
X_2	-0.0128	-0.1219	0.0580	-0.0006	-0.0614	0.3941	0.0489
X_3	-0.0092	-0.0849	-0.0832	-0.0169	0.1000	1.4545	0.8198
X_4	-0.0088	-0.0872	-0.0608	-0.0125	0.1080	1.1353	0.5695
X_5	-0.0050	-0.0456	-0.1061	-0.0174	0.1912	1.1509	0.4953
X_6	-0.0091	-0.0916	-0.0689	-0.0125	0.1215	1.1198	0.5493
X_7	-0.0021	-0.0231	-0.1207	-0.0186	0.2184	1.0277	0.3954
X_8	-0.0071	-0.0807	-0.0318	-0.0110	0.1023	0.7708	0.4628
X_9	-0.0046	-0.0539	-0.0611	-0.0071	0.0504	0.6085	0.2218
X_{10}	-0.0089	-0.0993	-0.0300	-0.0025	0.0609	0.5818	0.1764
X_{11}	0.0038	0.0330	-0.0458	-0.0086	0.0099	0.6477	0.5791
X_{12}	0.0018	-0.0082	-0.0894	-0.0190	0.1264	0.6122	0.6007
X_{13}	0.0037	-0.0210	-0.1510	-0.0263	0.4656	0.5117	0.2261
X_{14}	-0.0164	-0.1660	0.0631	0.0072	-0.1710	0.4956	0.1687
X_{15}	-0.0181	-0.1499	0.0172	0.0017	-0.0480	0.4803	0.2005
X_{16}	0.0046	0.0114	-0.2262	-0.0270	0.4358	0.4112	0.1269
X_{17}	0.0030	0.0066	-0.1560	-0.0391	0.5601	0.4194	0.4064
X_{18}	0.0043	0.0112	-0.1527	-0.0340	0.6455	0.2035	0.1813
X_{19}	-0.0070	0.0619	-0.0800	-0.0141	0.1129	1.1634	0.5631
X_{20}	-0.0031	-0.0336	-0.0321	-0.0178	0.1307	0.7320	0.8950
Residual effect = 0.2333; Figures in bold - direct effects							

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