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Correlation and Path Analysis Study in Cowpea [*Vigna unguiculata* (L.) Walp.] Genotypes

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A B S T R A C T

The present investigation on study of Correlation and path analysis study in cowpea *Vigna unguiculata* (L.) Walp.] genotypes was carried out during summer season in the year 2014-2015. The study was under taken on 30 genotypes of cowpea using randomized block design with three replication. The result on phenotypic and genotypic correlation coefficient revealed that pod yield per plot was significantly and positively correlated with number of branches per plant (0.7659), number of nodes (0.5523), pod length (0.3960), number of seeds per pod (0.2815), number of cluster per plant (0.550), number of pods per plant (0.547), number of pods per cluster (0.524), plant height (0.437) and protein content (0.2871). However, days for 50% flowering (-0.2081) showed significantly and negatively correlated with pod yield per plot. Other characters *viz.*, days taken for first flowering (-0.1946), pod diameter (-0.1035) showed negative non significantly correlated with pod yield per plot. Path coefficient analysis of different yield and yield contributing traits on number of branches per plant, number of nodes per plant, number of cluster per plant, number green pods per plant, number of pods per plant, number of seeds per pod, pod weight (g), pod yield per plot and percentage of protein content exhibited positive direct effects on pod yield per plot these characters play a major role in recombination breeding and suggested that direct selection based on these traits will be rewarded for crop improvement of cowpea.

Introduction

Cowpea (*Vigna unguiculata* (L.). Walp) is an important leguminous vegetable crop mainly grown both in kharif and spring summer season crop in most parts of India. It is a self pollinated crop with a chromosome no. 2n=2x= 22. Cowpea belongs to the family Leguminaseae genus *vigna*, subfamily fabaceae and tribe phaseoleae it comprises five subspecies (Verdcourt, 1970) *viz.*, *unguiculata, cylindrical, sesquipedalis, dekindtiana* and *mensensis* in phaseolae. Out of these five subspecies first three are cultivated and later two are wild. It is native to West Africa Vavilov, (1951), but Steele (1976) suggested Ethiopia as the primary and Africa as the secondary centres of diversity. The total area of beans in India is 37.54 million hectares with production of 1370.21 million tonnes (Anon., 2014).

Study of genetic variability particularly important in yield and yield contributing

characters is basic to plan out future improvement programme in any crop. Selection from quantitative characters is less efficient, if it is based on phenotypic expression, Hence, it is necessary to assess the relative extent of genetic and non genetic variability exhibited by individual characters.

The correlation co-efficient gives, an idea of the nature and intensity of association between two or more quantitative characters between yield and yield contributing characters, correlation simply measures that mutual relationship between yield and yield contributing characters. Thus, correlation helps in the selection of superior genotype from diverse genetic populations.

As there are number of factors involved in correlation studies, their indirect associations become more complex and confusing but path analysis helps to avoid this complication by measuring the direct influence of one characters on other as well as permits the partitioning of given correlation coefficients into its components of direct and indirect effects. The path coefficient analysis is an effective means of analyzing direct and causes of association and permits the critical examination of the specific that produce a given correlation. The path analysis provides information about magnitude and direction of direct and indirect effect of the yield components, which cannot provide by correlation.

Materials and Methods

The present investigation "Correlation and path coefficient analysis study in cowpea genotypes was carried out at Main Garden, University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during summer season of the year 2014-2015. The study was under taken on 30 genotypes of cowpea using randomized block design with three replications. Keeping a plot size of 3.5m x 1.16 m, the experiment on cowpea was laid out in the plot No.15. The plot was selected on the basis of suitability of the land for cultivation of cowpea.

Source of plant materials

The 30 genotypes of cowpea different region CL-14, CL-10, Arka suman, CL8,CL-3, CL-8, Divya, CL-24, Gomati, Vanita, Konkan Sadabahar, Gayatri, AKCP -20 (VN) Green selection, CL-13,C L-12, Selection – 5, CL-5, Gadchiroli local -2, CL-23, Pusa komal, Kashi Kanchan, AKCP- 31 (SAR), AKCP-99 (SAR), Gadchiroli local (RS) – 3, Akola selection, Baramasi, AKCR – 14 (Red), Arka samrudhi, CL-17, AKCP- f – 7. The data was recorded on following quantitative parameters plant height, first flower 50% flowering, Number cluster per plant, Number of green pods for cluster, Number pods per plant, Pod length, Percentage of protein content.

Correlation analysis

To determine the degree of association of characters with yield and also among the yield components, the correlation coefficients were calculated.

$$r_g(xy) = \frac{Cov_g(xy)}{\sqrt{\sigma_g^2(x) \cdot \sigma_g^2(y)}}$$

$$r_p(xy) = \frac{Cov_p(xy)}{\sqrt{\sigma_p^2(x) \cdot \sigma_p^2(y)}}$$

Where,

r_g (xy), r_p (xy) are the genotypic and phenotypic correlation coefficients respectively. Cov_g, Cov_p are the genotypic and phenotypic covariance of xy, respectively.
σ^2_g and σ^2_p are the genotypic and phenotypic variance of x and y, respectively.

The calculated value of 'r' was compared with table 'r' value with n-2 degrees of freedom at 5% and 1% level of significance, where, n refers to number of pairs of observation.

Path coefficient analysis

Standard path coefficients which are the standardized partial regression coefficients were obtained using statistical software packages called GENRES. These values were obtained by solving the following set of 'p' simultaneous equation using above package.

$P_{01}+ P_{02}\, r_{12}+$ ---------$+ P_{0P}\, r_{1P} = r_{01}$

$P_{01}+ P_{12}\, r_{02}+$ ---------$+ P_{0P}\, r_{2P} = r_{02}$

↓

$P_{01}+ r_{1P} + P_{02}\, r_{2P} +$ ---------$+ P_{0P} = r_{0P}$

Where, $P_{01,}$ $P_{02,}$ ---------- P_{0P} are the direct effects of variables 1,2,--------p on the dependent variable 0 and $r_{12,}$ $r_{13,}$ ---------- r_{1P}-------- $r_{P(P-1)}$ are the possible correlation coefficients between various independent variables and r_{01}, r_{02}, r_{03} ---- r_{0P} are the correlation between dependent and independent variables.

The indirect effects of the i^{th} variable *via* j^{th} variable is attained as (P_{oj} x r_{ij}). The contribution of remaining unknown factor is measured as the residual factor, which is calculated and given below.

$P^2ox = 1-[P^2_{01}+2P_{01}P_{02}r_{12}+2P_{01}P_{03}r_{13}+$ ---------$+ P^2_{02}+ 2P_{02}P_{03}r_{13}+$ --------$+P^2_{0P}]$

Residual factor = $\sqrt{(P^2_{ox})}$

Negligible - 0.00 to 0.09; Low - 0.10 to 0.19; Moderate 0.20 to 0.29;

High - 0.30 to 1.0; Very high - >1.00

Results and Discussion

Interrelationship study in growth and yield parameters

Correlation studies

In order to find out the association between yield and yield contributing characters, the genotypic and phenotypic correlation coefficients were estimated and presented in Table 1.

Phenotypic and genotypic correlation coefficient

The result on phenotypic and genotypic correlation coefficient revealed that pod yield per plot was significantly and positively correlated with number of branches per plant (0.7659), number of nodes (0.5523), pod length (0.3960), number of seeds per pod (0.2815), number of cluster per plant (0.550), number of pods per plant (0.547), number of pods per cluster (0.524), 100 seed weight (0.2143), plant height (0.437) and protein content (0.2871). However, days for 50% flowering (-0.2081) showed significantly and negatively correlated with pod yield per plot. Other characters *viz.,* days taken for first flower (-0.1946), first flowering (-0.1946), pod diameter (-0.1035) percentage of fiber content (-0.0816) showed negative non significantly correlated with pod yield per plot. These results are in consonance with the finding of Singh *et al.,* (2004).

Number of pods per plant showed positive significant correlation with number of cluster per plant (0.8842), green pods per cluster (0.8371), % of protein content (0.2965), negative significant correlation with number of nodes per plant (-0.0866), 50 % flowering (-0.0043), pod diameter (-0.1467), negative, significant correlation with 100 seed weight (-0.2635).

Number of seeds per pod showed positive significant correlation with plant height, number of branches per plant, first flower, 50 % flowering, pod length (cm), pod weight (g), negative significant correlation with green pods per cluster, number pods per plant, pod diameter, negative and significant correlation with number of cluster per plant, % of fiber content, % of protein content. These results are in consonance with the finding of Hodawadekar (2002).

Number of green pods per cluster showed positive significant correlation with number of cluster per plant, number pods per plant, number of branches per plant, % of protein content, negative significant correlation with number of nodes per plant, first flower, 50% flowering, seeds per pod. These results were conformity with Vineetakumari *et al.,* (2003).

Pod weight (g) showed positive and significant correlation with characters number of branches per plant, pod length (cm), seeds per pod, It also registered significant negative correlation with % fiber content. These results were conformity with Madheshia and Pandey (2005).

% of protein content showed positive and significant correlation with characters plant height, number of nodes per plant, number of cluster per plant, number of green pods per cluster, number of pods per plant. It also registered significant negative correlation pod diameter (cm), pod length (cm) and number seeds per pod.

Path co-efficient analyses

It was analyzed for yield and yield contributing traits are presented in (Table 2). It was observed that genotypic direct and indirect effects were higher than their corresponding phenotypic values.

Direct effects

Path coefficient analysis showed that the characters plant height, number of branches per plant, number of nodes per plant, first flower, 50% flowering, number of nodes per plant, number of cluster per plant, number of green pods per cluster, number of pods per plant, number of seeds per pod, 100 seed weight, pod diameter (cm), pod length (cm), number seeds per pod, %of fiber content and % of protein content. These results were conformity with Tyagi *et al.,* (2000) and Singh *et al.,* (2004).

Indirect effects on growth and yield parameters

Plant height showed negligible positive indirect effect through number of branches per plant, number of nodes per plant, number of cluster per plant, number green pods per plants, number of pods per plant, 100 seed weight, pod weight (g) and % of protein content.

Number of cluster per plant showed negligible positive indirect effect through number of nodes per plant, pod diameter (cm), pod length (cm), 100 seed weight, number of seeds per pod.

Number green pods per cluster showed negligible positive indirect effect through number of nodes per plant, first flower, 50 % flowering, pod diameter (cm), 100 seed weight and number of seeds per pod, These results were conformity with Venkatesan (2003b).

Number pods per plant showed negligible positive indirect effect through number of nodes per plant, first flower, 50 % flowering, pod diameter (cm), 100 seed weight, number of seeds per pod.

Table.1 Phenotypic (P) and genotypic (G) correlation coefficients for different characters in 30 genotypes of cowpea

Characters		Plant height (cm)	Number of branches / plant	Number of nodes on main branch	Days taken for first flowering	Days to 50% flowering	Number of cluster per	Number of green pods per cluster	No. of pods per plant	Pod diameter (cm)	Pod length (cm)	100 seed weight	No. of seeds per pod	Average pod weight (g)	Pod yield per plot(kg)	Fiber content	Protein content
Plant height (cm)	**P**	**1.0000**	07659***	0.5523***	-0.1946	-02081*	0.0652	0.0316	0.0366	-0.103	0.3960***	0.2143*	0.2815**	0.1979	0.2421	-0.0816	0.2871**
	G	**1.0000**	0.7723***	0.5800**	-0.1958	-0.2116*	0.0659	0.0321	0.361	-0.107	0.4003***	0.2145*	0.2824**	0.4302	0.2538	-0.0867	0.2955**
No. of branches per plant	**P**		**1.0000**	0.3916***	-0.1826	-0.1788	0.2106*	0.2170*	0.2401*	0.0595	0.3979***	0.695	0.2406*	0.3309	0.5123	0.0481	0.0905
	G		**1.0000**	0.4187***	-0.1863	-0.1845	0.2126*	0.2235*	0.2431*	0.0598	0.4052***	0.722	0.2431*	0.7490	0.5290	0.0416 5	0.093
Number of nodes on main branch	**P**			**1.0000**	-0.0984	0.1235	-0.0728	-0.0345	-0.0868	0.2030	0.0312	0.209*	0.1582	0.1585	0.1280	-0.0660	0.2652*
	G			**1.0000**	-0.1082	-0.1351	0.0793	-0.0380	-0.0984	0.2099	0.0351	0.2333*	0.1706	0.4035	0.1384	-0.0673	0.2851*
Days taken for first flowering	**P**				**1.0000**	0.9934***	0.0163	-0.0714	-0.0339	-0.309**	0.421***	-0.137	0.2612*	0.1704	0.0342	-0.287**	0.529
	G				**1.0000**	0.9964***	0.0161	-0.0768	-0.0338	-0.3197**	0.4272***	0.1381	-0.2640*	0.3899	0.0350	-0.2971**	0.0574
Days to 50% flowering	**P**					**1.0000**	0.0604	-0.0706	-0.0043	-0.3046*	-0.401**	-0.229*	-0.2266	0.0881	0.0529**	-02755**	0.0335
	G					**1.0000**	0.0592	-0.0785	-0.058	-0.3182*	0.4067	-0.148	0.2288	0.3964	0.0534**	-2870**	0.0341
Number of cluster per plant	**P**						**1.0000**	0.5038***	0.8842***	0.2040	-0.062	-0.298**	- 0.2266**	0.0881	0.7079	0.1603	0.2755**
	G						**1.0000**	0.5246**	0.8913***	-0.2184	-0.064	-0.237	-0.2303	0.2173	0.7268	0.1648	0.2870
Number of green pods per cluster	**P**							**1.0000**	0.8371***	-0.0413	0.0937	-0..228*	-0.1151	0.1053	0.6790	0.2119*	0.2881**
	G							**1.0000**	0.8495	-0.0641	0.1012	-0.258*	-0.1178	0.1556	0.7113	0.2175*	0.2990**
No. of pods per plant	**P**								**1.0000**	-0.1467	0.0171	-0.262*	-0.1945	0.1008	0.8008*	0.2009	0.296**
	G								**1.0000**	0.1672	0.0182	-02802*	-01976	0.2152	0.8200*	0.2062	0.3043**
Pod diameter (cm)	**P**									**1.0000**	-0.280*	0.402	-0.1005	0.0015	-0.0163	0.2503*	-0.140
	G									**1.0000**	-02971*	0.445	-0.1067	0.0651	-0.0219	0.2448	-0.1507
Pod length (cm)	**P**										**1.0000**	0.858	0.7071***	0.3029**	0.2431*	-03111**	-0.0143
	G										**1.0000**	0.883	0.7102***	0.7166**	0.2469*	0.3181	-0.0093
100 seed weight	**P**											**1.0000**	0.2452*	0.2065	0.0279	0.0455	0.1693
	G											**1.0000**	0.2479	0.4692	0.0247	0.0427	0.1752

No. of seeds per pod	**P**												**1.0000**	0.3261**	0.1156**	-0.4026**	-0.0108
	G												**1.0000**	0.7347**	0.1194**	-0.4103	-0.0107
Average pod weight (g)	**P**													**1.0000**	0.3411	-0.169	0.1011
	G													**1.0000**	0.8059	-0.3798	0.2400
Pod yield per plot (kg)	**P**														**1.0000**	0.0359	0.2328*
	G														**1.0000**	0.0348	0.3011*
Fiber content	**P**															**1.0000**	0.2817
	G															**1.0000**	0.2418
Protein content	**P**																**1.0000**
	G																**1.000**

*Significant at 5 per cent level; ** Significant at 1 per cent level

Table.2 Phenotypic (P) and genotypic (G) path coefficient analysis indicating direct and indirect effects of components characters on green pod yield per plant in cowpea genotypes of cowpea

Characters		Plant height (cm)	Number of branches/	Number of nodes on main	Days taken for first	Days to 50% flowering	Number of cluster per plant	Number of green pods per cluster	No. of pods per plant	Pod diameter (cm)	Pod length (cm)	100 seed weight	No. of seeds per pod	Average pod weight (g)	Pod yield per plot(kg)	Fiber content	Protein content
Plant height (cm)	**P**	**-0.1763**	-0.1350	-0.0974	0.0343	0.0367	-0.0115	-0.0056	-0.0064	0.0183	-0.0698	-0.0378	-0.0496	-0.0349	0.2421	0.0144	-0.0506
	G	**-0.2969**	-0.2293	-0.1722	0.0581	0.0628	-0.0196	0.0095	-0.0107	0.0320	0.1188	-0.0637	-0.0838	-0.1277	-0.297	0.0257	-0.0877
No. of branches per plant	**P**	0.2926	**0.3821**	0.1496	-0.0698	-0.0683	0.0805	0.0829	0.0918	0.0227	0.1520	0.0648	0.0919	0.1264	0.5123	0.0184	0.0346
	G	0.4103	**0.5313**	0.2224	-0.0990	-0.0980	0.1130	0.1187	0.1292	0.0318	0.2153	0.0915	0.1292	0.3979	0.531	0.0221	0.0497
Number of nodes on main branch	**P**	0.0239	0.0169	**0.0432**	-0.0042	-0.0053	-0.0031	-0.0015	-0.0037	0.0088	0.0013	0.0090	0.0068	0.0068	0.1280	-0.0029	0.0115
	G	0.0051	0.0037	**0.0088**	-0.0009	-0.0012	-0.0007	-0.0003	-0.0009	0.0018	0.0003	0.0020	0.0015	0.0035	0.009	-0.0006	0.0025
Days taken for first flowering	**P**	-0.0181	-0.0169	-0.0091	**0.0928**	0.0922	0.0015	-0.0066	-0.0031	-0.0287	0.0391	-0.0128	0.0242	0.0158	0.0342	-0.0267	0.0049
	G	0.5286	0.5029	0.2920	**-2.6991**	-2.6893	-0.0435	0.2074	0.0913	0.8630	-1.1530	0.3728	-0.7126	-1.0525	--2.699	0.8020	0.1549
Days to 50% flowering	**P**	0.0013	0.0011	0.0008	-0.0062	**-0.0063**	-0.0004	0.0004	0.0000	0.0019	-0.0025	0.0009	-0.0014	-0.0011	0.0529	0.0017	-0.0002
	G	-0.5951	-0.5188	-0.3799	2.801	**2.8120**	0.1665	-0.2207	-0.0164	-0.8947	1.1438	0.4167	0.6435	1.1146	2.812	-0.8071	0.0960

Number of cluster per plant	**P**	0.0185	0.0596	-0.0206	0.0046	0.0171	**0.2831**	0.1426	0.2503	-0.0577	-0.0175	--0.0650	-0.0642	0.0249	0.7079	0.0454	0.0780
	G	0.1542	0.4971	-0.1853	0.0376	0.1384	**2.3381**	1.2266	2.0841	-0.5106	-0.150	-0.5563	-0.5385	0.5082	2.338	0.3854	0.6711
Number of green pods per cluster	**P**	0.0068	0.0468	-0.0074	-0.0154	-0.0152	0.1087	**0.2158**	0.1806	-0.0089	0.0202	-0.0493	-0.0248	0.0227	0.6790	0.0457	0.0622
	G	0.0715	0.4970	-0.0845	-0.1709	-0.1745	1.1667	**2.2240**	1.8893	-0.1425	0.2250	-0.5737	-0.2620	0.3460	2.224	0.4836	0.6649
No. of pods per plant	**P**	0.0142	0.0934	-0.0337	-0.0132	-0.0017	0.3438	0.3254	**0.3888**	-0.0570	0.0067	-0.1025	-0.0756	0.0392	0.8008	0.0781	0.1153
	G	-0.1133	-0.7638	0.3092	0.1062	0.0183	-2.8002	-2.6688	**-3.1416**	0.5253	-0.0573	0.8802	0.6206	-0.6762	-3.142	-0.6478	-0.9559
Pod diameter (cm)	**P**	-0.0104	0.0060	0.0203	-0.0310	-0.0305	-0.0204	-0.0041	-0.0147	**0.1001**	-0.0280	0.0140	-0.0101	0.0001	-0.0163	0.0251	-0.0141
	G	-0.0119	0.0066	0.0232	-0.0353	-0.0351	-0.0241	-0.0071	-0.0185	**0.1104**	-0.0328	0.0159	-0.0118	0.0072	0.11	0.0270	-0.0166
Pod length (cm)	**P**	-0.0170	-0.0171	-0.0013	-0.0181	-0.0172	0.0027	-0.0040	-0.0007	0.0120	**-0.0429**	-0.0080	-0.0303	-0.0130	0.2431	0.0133	0.0006
	G	-0.0412	-0.0417	-0.0036	-0.0439	-0.0418	0.0066	-0.0104	-0.0019	0.0306	**-0.1029**	-0.0194	-0.0731	-0.0737	-0.103	0.0327	0.0010
100 seed weight	**P**	0.0364	0.0288	0.0356	-0.0234	-0.0249	-0.0390	-0.0388	-0.0447	0.0238	0.0315	**0.1698**	0.0416	0.0351	0.0279	0.0077	0.0287
	G	0.0550	0.0441	0.0598	-0.0354	-0.0380	-0.0610	-0.0661	-0.0718	0.0370	0.0483	**0.2563**	0.0635	0.1203	0.256	0.0109	0.0449
No. of seeds per pod	**P**	0.0394	0.0337	0.0222	0.0366	0.0316	-0.0317	-0.0161	-0.0272	-0.0141	0.0990	0.0343	**0.1401**	0.0457	0.1156	-0.0564	-0.0015
	G	0.0931	0.0801	0.0562	0.0870	0.0754	-0.0759	-0.0388	-0.0651	-0.0352	0.2340	0.0817	**0.3295**	0.2421	0.33	-0.1352	-0.0035
Average pod weight (g)	**P**	0.0094	0.0158	0.0076	0.0081	0.0081	0.0042	0.0050	0.0048	0.0001	0.0144	0.0098	0.0155	**0.0476**	0.3411	-0.0081	0.0048
	G	-0.0445	-0.0775	-0.0417	-0.0403	-0.0410	-0.0225	-0.0161	-0.0223	-0.0067	-0.0741	-0.0485	-0.0760	**-0.1035**	0.103	0.0393	-0.0248
Pod yield per plot (kg)	**P**	-0.176	0.382	0.043	0.093	-0.006	0.283	0.216	0.389	0.1	-0.043	0.17	0.14	0.048	**-0.129**	0.038	0.152
	G	0.2538	0.5290	0.1384	0.0350	0.0534	0.7268	0.7113	0.8200	-0.0219	0.2469	0.0247	0.1194	0.8059	**-0.22**	0.0348	0.3011
Fiber content	**P**	0.0105	-0.0062	0.0085	0.0370	0.0354	-0.0206	-0.0273	-0.0258	-0.0322	0.0400	-0.0058	0.0518	0.0218	0.0359	**-0.1287**	-0.0300
	G	0.0190	-0.0091	0.0148	0.0653	0.0631	-0.0362	-0.0478	-0.0453	-0.0538	0.0699	-0.0094	0.0901	0.0834	0.0348	**-0.2197**	-0.0531
Protein content	**P**	0.0108	0.0034	0.0100	0.0020	0.0013	0.0013	0.0108	0.0111	-0.0053	-0.0005	0.0064	-0.0004	0.0038	0.2817	0.0087	**0.0375**
	G	0.0200	0.0063	0.0193	0.0039	0.0023	0.0194	0.0202	0.0206	-0.0102	-0.0006	0.0119	-0.0007	0.0163	0.3011	0.0164	**0.0677**

Phenotypic Residual effect = 0.3864; Genotypic Residual effect= 0.2920; Diagonal (under lined) values indicate direct effects

Number of seeds per pod showed negligible positive indirect effect through Number of cluster per plant, number green pods per cluster, number pods per plant, pod diameter (cm).

Pod weight (g) showed negligible positive indirect effect through % of fiber content reported that Nigude *et al.*, (2004b).

100 seed weight showed negligible positive indirect effect through first flower, 50 % flowering, number of cluster per plant, number green pods per cluster and number pods per plant.

% fiber content showed negligible positive indirect effect through number of branches per plant, number of cluster per plant, number green pods per plants, number of pods per plant, Pod diameter (cm). % of protein content showed negligible positive indirect effect through pod diameter (cm), pod length (cm), number of seeds per pod and pod yield per plot. These results are in consonance with the finding of Girish (2000) and Kapoor *et al.*, (2000).

In conclusion, pod yield per plot (Kg) had a positive and highly significant association with number of pods per plant, number of green pods per cluster, pod length (cm) average pod weight (g), number of seeds per pod, and % of protein content strong association of these traits revealed that the selection based on these traits would ultimately improve the fruit yield were positive and significant correlated with fruit yield plant per plant.

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