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CORRELATION AND PATH ANALYSIS IN MEIOTIC CHROMOSOME BEHAVIOUR IN SOME EXOTIC *PAPAVER* SPECIES

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ABSTRACT

Correlation and path coefficient analysis of cytological characters was done in 21 entries of exotic *Papaver* species. Abnormalities at metaphase I, anaphase I, telophase I, meiotic index and pollen fertility showed highly significant correlations between them. Path analysis revealed only negative direct and indirect effects. Abnormal cells at M I, A I and T I had greater magnitude of negative direct effects on meiotic index and pollen fertility with substantial involvement of abnormal cells at A I.

Key words: *Papaver somniferum, P. setigerum,* correlation coefficient, path coefficient, meiotic abnormalities.

The *Papaver* species are partly allogamous and the extent of cross-pollination is reported to be as high as 20-30% [1]. The abnormalities in meiotic division at metaphase I, anaphase I and telophase I (MI, AI, TI) may not be uncommon in heterozygous population [2]. Shifting of growing environment may also be responsible for the occurrence of meiotic abnormalities. Meiotic index and pollen fertility exhibit the extent of operational fertility mechanism in crop species. Meiotic abnormalities have been shown to be associated with meiotic index and pollen fertility [2]. In the present investigation, correlation and path analysis have been worked out for the above parameters in *Papaver* species.

MATERIALS AND METHODS

Ninety nine lines of two *Papaver* species with unknown chromosome number and behaviour were introduced from USA and West Germany at the Medicinal and Aromatic Plant Research Project, College of Agriculture, Mandsaur. Only few entries flowered. Twenty one exotic types (19 of *Papaver somniferum* and 2 of *Papaver setigerum*) were evaluated for cytological studies. Flower buds from five plants were fixed in 1:3 aceto-alcohol between 7-11 A.M. for 24 h and then washed in distilled water and preserved in 70% ethanol. Smears

were prepared in 1% acetocarmine from young anthers. Observations were recorded on chromosome association at MI, laggards, bridges, inactivation of spindle mechanism, fragments and excluded chromosomes at AI and TI. Pollen fertility was studied by the aceto-carmine stainability test. Meiotic index was calculated as follows:

$$\text{Meiotic index} = \frac{\text{No. of normal PMCs}}{\text{Total PMCs}} \times 100$$

Taking abnormalities at M I (X_1) A I (X_2) and T I (X_3) as causal factors and meiotic index (Y_1) and pollen fertility (Y_2) as effects, correlations and different paths were worked out to estimate the extent of effects of different causal factors. Statistical analysis were done following method suggested by [3, 4].

RESULTS AND DISCUSSION

Significant and positive correlations were observed between abnormal cells at M I with abnormal cells at AI and TI and between abnormal cells at AI and TI (Table 1). Correlation between meiotic index and pollen fertility was highly significant and positive (r = 0.98), where as abnormalities at MI–AI were negatively correlated with meiotic index as well as pollen fertility.

Table 1. Correlation coefficients among different cytological characters in *Papaver* genotypes

Characters	Abnormal AI cells	Abnormal TI cells	Meiotic index	Pollen fertility
Abnormal MI cells	0.46*	0.73**	−0.87**	−0.84**
Abnormal AI cells		0.70**	−0.79**	−0.77**
Abnormal TI cells			−0.92**	−0.95**
Meiotic index				0.98**

*,**P = 0.05 and 0.01, respectively.

The association between abnormal cells at MI, AI and TI have been discussed. We now wish to study the simultaneous variation of these three abnormalities. The measures of association obtained for a pair of characters is not independent since the two characters when associated with a third, are bound to be correlated. Therefore we wanted to estimate whether a pair of characters shows any correlation when their correlation with the third is allowed for and to obtain a mathematical measure of correlation after making such allowances. Therefore, partial correlation analysis was undertaken.

Meiotic index mainly decreased due to increase of abnormal cells at TI, leading to high negative correlation (r = –0.92) between meiotic index and number of abnormal cells at TI. Next in order were the negative correlations of mitotic index with the number of abnormal cells at MI and AI (Table 2). The direct effect of abnormalities at MI, AI and TI on meiotic index were higher in comparison to indirect effects. The indirect effects of abnormal cells at

Table 2. Estimates of direct (in bold) and indirect effects of meiotic abnormalities on meiotic index

Characters	Abnormal MI cells	Abnormal AI cells	Abnormal TI cells	Correlation coefficient with meiotic index
Abnormal MI cells	**– 0.46**	– 0.15	– 0.26	– 0.87**
Abnormal AI cells	– 0.21	**– 0.34**	– 0.25	– 0.79**
Abnormal TI cells	– 0.34	– 0.23	**– 0.35**	– 0.92**

**P = 0.01. Residual factor +0.05.

MI through similar cells accumulating at TI was greater than the indirect effect through abnormal cells at AI. Similarly indirect effect of abnormal cells at AI on meiotic index through such cells at TI was greater than through abnormal cells at MI. However, abnormal cells at TI had greater indirect effect through cells at MI in comparison to cells at AI. The residual effects were negligible. The trend obtained in path analysis suggests that the three characters analyzed in this study accounted for 95% of the total variation in meiotic index.

Similar trend was observed for associations between abnormal cells at MI, AI and TI with pollen fertility. The direct effects were greater than indirect effects. Indirect effects of abnormal cells at MI and AI through abnormal cells at TI were greater than indirect effects of abnormal TI cells through similar cells at AI and MI on pollen fertility. However the indirect effect of abnormal TI cells through abnormal MI cells was greater than a similar effect through AI cells on pollen fertility. About 84% of the total variation for pollen fertility

Table 3. Estimates of direct (in bold) and indirect effects of meiotic abnormalities on pollen fertility

Characters	Abnormal MI cells	Abnormal AI cells	Abnormal TI cells	Correlation coefficient with pollen fertility
Abnormal MI cells	**– 0.35**	– 0.11	– 0.38	– 0.84**
Abnormal AI cells	– 0.16	**– 0.25**	– 0.36	– 0.77**
Abnormal TI cells	– 0.25	– 0.17	**– 0.52**	– 0.95**

**P = 0.01. Residual factor +0.16.

was due to these three characters. Residual variation was high (16%), and may be due to environmental effects and other genetic causes.

The present investigation suggests that abnormal cells at MI and TI are the major cause for reducing meiotic index and pollen fertility with substantial involvement of abnormal cells at AI.

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