Genetic Variability, Character Association and Path Analysis of Oil Yield and its Component Characters in Wild Marigold (*Tagetes minuta* L.)

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Genetic variability, character association and path analysis between oil yield and its contributing traits were studied in 20 genotypes of wild marigold. Highly significant differences between genotypes were recorded for most of the characters studied except for oil content in leaves and flowers. High phenotypic and genotypic coefficients of variation coupled with high heritability and moderate to high genetic gain recorded for estimated oil yield per hectare, number of branches per plant, number of leaves per plant, leaf yield per plot, flower yield per plot, number of flower heads per plant and plant height indicate the predominance of additive gene effects in controlling these traits. Correlation and path analysis revealed that number of flower heads per plant and oil content in flowers are overriding traits among all other growth and yield parameters, there for more emphasis should be laid upon them while designing selection indices for improvement of oil yield

Key Words: ***Tagetes minuta*, Variability, Path analysis, Oil yield**

Development of high yielding cultivars requires a thorough knowledge of the existing genetic variation and also the extent of association among yield contributing characters. The observed variability is the result of genetic differences among the plants, different environment in which they are growing and interaction between genotype and the environment. Genetic variability is complex but if its magnitude and type are known, it can be manipulated to obtain good gains for some characteristics/traits in any improvement program whereas environmental variation have no significance in breeding program. Correlation and path analysis establish the extent of association between yield and its components and also bring out the relative importance of their direct and indirect effects, thus give a clear understanding of their association with yield. The present paper deals with the above genetic constants and character association in 20 genotypes of *Tagetes minuta*, the herb highly valued for its essential oil.

Materials and Methods

The material comprised of twenty collections covering Solan and Sirmour districts of Himachal Pradesh especially from the potential source of its availability. These places range between 360-1350m above mean sea level. The experiment was laid down in Randomized Block Design (RBD) with twenty treatments and three replications for each treatment, having plot size of 1.8x1.8m. Achenes were sown in lines at 30x45cm spacing. Observations were recorded for five random plants per genotype in each replication for characters including plant height, number of branches, leaves and flower heads per plant, leaf and flower yield, oil content in leaves and flowers and estimated oil yield per hectare. Standard statistical procedures were followed for estimating genetic constants-phenotypic and genotypic coefficients of variation (Burton, 1952), heritability (Hanson et al., 1956) and genetic gain (Johnson et al., 1955). Genotypic and phenotypic correlation coefficients were calculated following Searle (1961) and path analysis following the method of Dewey and Lu (1955).

Results and Discussion

The variability estimates presented in Table 1 projected wide range of variability for growth and yield parameters particularly for estimated oil yield per hectare, number of branches and leaves per plant. Phenotypic coefficients of variation for different characters were higher than the corresponding genotypic coefficients of variation, though the extent of difference between the two was relatively low. The genotypic coefficients of variation for estimated oil yield per hectare and number of branches per plant were greater than 30 percent indicating high amount of genetic variability for these characters. Whereas, the genotypic coefficients of variation ranged from 15 to 25 per cent for number of leaves per plant, number of flower heads per plant, flower yield per plot, leaf yield per plot and plant height reflecting fairly good range of variability at genotypic level. However low value of phenotypic and genotypic coefficients of variability were recorded for oil content in leaves and flowers.

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Table 1. Mean, range, coefficients of variability, heritability, genetic advance and genetic gain of growth and yield characteristics in *Tagetes minuta*

Character	Mean	Range	Coefficients of variability (%) Phenotypic	Genotypic	Heritability	Genetic advance	Genetic gain(%)
Plant height (cm)	147.31	105.20-184.20	17.39	16.81	93.42	49.31	33.47
No. of branches/plant	20.36	10.00-29.91	35.60	35.02	96.80	14.34	70.98
No. of leaves/plant	108.90	76.94-160.50	24.73	24.05	94.54	52.45	48.17
Leaf yield/Plot (g)	206.12	132.31-260.11	18.45	18.15	96.80	75.85	36.80
No. of flower heads/plant	334.98	250.50-495.41	23.51	23.19	97.33	157.93	47.14
Flower Yield/plot (g)	663.88	450.62-925.40	23.07	20.94	82.36	259.90	39.16
Oil content in leaves (%)	0.40 (0.625)	0.29-0.47	6.16	5.97	94.12	0.07	11.94
Oil content in flowers (%)	0.72 (0.847)	0.51-1.04	9.61	9.46	96.67	0.16	19.20
Estimated oil yield (l/ha)	19.41	10.26-35.51	38.40	38.12	98.52	15.15	77.94

Values in parentheses are transformed values

Since broad sense heritability includes both additive and epistatic effects, it will be useful in predicting effectiveness of selection only when accompanied by high genetic gain. High values of heritability were recorded for all characters ranging from 82.36 per cent for flower yield per plot to 98.52 per cent for estimated oil yield per hectare. The characters viz., estimated oil yield per hectare and number of branches per plant recorded high genetic gain whereas number of leaves per plant, number of flower heads per plant, flower yield per plot, leaf yield per plot and plant height registered moderate genetic gain. Selection for these characters is likely to accumulate more additive genes leading to scope for potential improvement in their performance. Oil content in leaves and flowers recorded high heritability but did not show expected genetic gain, suggesting presence of non-additive gene action, thus selection will not be efficient for improvement of these traits. Expression of such traits can be modified through hybridization followed by selection. Pandey (1992) in *Solanum khasianum*, Harne (1993) in *Valeriana jatamansi*, Devagiri (1994) in *Heracleum candicans* and Rampal (1996) in *Gentiana kurroo* reported similar observations.

Inheritance of most of the traits is complex in nature and is influenced by wide range of associate characters. Presence of significant correlation among characters which have high heritability and are less affected by environmental variables permit better use of indirect selection i.e. selection applied for the contributory or associated traits would bring simultaneous improvement of the desired trait. Based on the estimation of phenotypic and genotypic correlations, the breeder decides the breeding methodology to be followed so that the useful correlations can be exploited and undesirable ones can be modified by generating fresh variability to obtain new recombinants. In the present investigation, it was reported that all growth and yield parameters were strongly correlated at phenotypic and genotypic level. In general, the genotypic correlations were higher than the corresponding phenotypic ones, which could be either due to modifying effect of the environment or the strong inherent association of these characters at genetic level. Plant height number of branches, leaves and flower heads per plant, leaf and flower yield per plot and oil content in leaves and flowers with high heritability and moderate to high genetic gain were significantly and positively correlated to oil yield per hectare. Thus, oil yield per hectare can be improved significantly through indirect selection for any of these traits. Biswas (1982) in *Rauwolfia serpentina*, Singh and Mahey (1991) in *Anethum graveolens* and Rampal in (1996) in *Gentiana kurroo* observed similar results.

Rapid improvement in the principal character is expected to result if selection is practiced for component characters. The component characters are quite often interrelated which affect their direct relation with principal character thereby, making correlation coefficients not much reliable as selection indices. So much so, when more variables are included in the correlation studies, the indirect association becomes more complex and it becomes imperative to separate them out. In such a situation, path coefficient analysis helps to dissociate the direct and indirect effects by partitioning and distributing the correlation coefficients over different contributing traits. The results of present investigation on path coefficient analysis revealed direct positive effect of number of flower heads per plant, oil content in flowers, oil content in leaves, number of leaves per plant

Table 2. Estimates of phenotypic and genotypic correlation coefficients among different growth and oil yield contributing parameters in *Tagetes minuta*

Character	Plant height (cm)	No. of branches/ plant	No. of leaves/plant	Leaf yield/ plot (g)	No. of flower heads/ plant	Flower Yield/ plot (g)	Oil content in leaves (%)	Oil content in flowers (%)	Oil yield (l/ha)
Plant height (cm)	1.0000	0.936	0.880	0.872	0.918	0.765	0.894	0.901	0.907*
	1.0000	0.954	0.885	0.911	0.923	0.973	0.899	0.904	0.913**
No. of branches/plant		1.000	0.936	0.905	0.938	0.751	0.926	0.899	0.939
		1.000	0.951	0.963	0.958	0.957	0.948	0.915	0.958
No. of leaves/plant			1.000	0.970	0.902	0.675	0.919	0.857	0.915
			1.000	0.978	0.905	0.851	0.923	0.860	0.923
Leaf yield/plot (g)				1.000	0.882	0.665	0.894	0.816	0.875
				1.000	0.914	0.860	0.928	0.845	0.916
No. of flower heads /plant					1.000	0.793	0.960	0.921	0.972
					1.000	0.891	0.963	0.923	0.978
Flower Yield/plot (g)						1.000	0.777	0.756	0.779
						1.000	0.992	0.949	0.985
Oil content in leaves (%)							1.000	0.928	0.969
							1.000	0.931	0.974
Oil content in flowers (%)								1.000	0.963
								1.000	0.966
Estimated oil yield(l/ha)									1.000
									1.000

All the *phenotypic and **genotypic correlations are significant at 5% level of significance

Table 3. Estimates of direct and indirect effects of various growth and oil yield contributing parameters on oil yield

Character	Plant height (cm)	No. of branches/ plant	No. of leaves/plant	Leaf yield/ plot (g)	No. of flower heads/ plant	Flower Yield/ plot (g)	Oil content in leaves (%)	Oil content in flowers (%)	Oil yield (l/ha)
Plant height (cm)	**-0.413**	0.064	0.080	0.013	0.440	-0.034	0.123	0.370	0.913
No. of branches/plant	-0.136	**0.067**	0.086	0.014	0.456	-0.033	0.130	0.374	0.958
No. of leaves/plant	-0.126	0.064	**0.090**	0.014	0.431	-0.029	0.127	0.352	0.923
Leaf yield/Plot (g)	-0.130	0.064	0.090	**0.014**	0.435	-0.030	0.127	0.346	0.916
No. of flower heads/plant	-0.132	0.064	0.082	0.013	**0.476**	-0.035	0.132	0.378	0.978
Flower Yield/plot (g)	-0.139	0.064	0.077	0.012	0.482	-0.035	0.136	0.388	0.985
Oil content in leaves (%)	-0.128	0.063	0.083	0.013	0.459	-0.034	**0.137**	0.381	0.974
Oil content in flowers (%)	-0.129	0.061	0.078	0.012	0.440	-0.033	0.128	**0.409**	0.966

Note: Bold values indicate direct effect
Residual effect = 0.0096

number of branches per plant and leaf yield per plot on oil yield per hectare, whereas plant height and flower yield had direct negative effects.

The direct negative effect caused by plant height and flower yield per plot on oil yield per hectare was supposed to be counterbalanced by high positive indirect effects via number of flower heads per plant and oil content in flowers. Further it can be concluded that, among all growth and yield parameters, number of flower heads per plant and oil content in flowers are overriding traits, therefor more emphasis should be laid upon them while designing selection indices for improvement of oil yield. These traits not only exhibited strong direct positive effects on oil yield per hectare but also all other associated traits have high and positive indirect effect via them. Very low magnitude of residual effect (0.0096) signifies that almost all the characters which have strong bearing on oil yield per hectare are included in the analysis. Similar work on path analysis was reported by Xiques *et al.* (1984) in *Datura candida*, Khanna and Singh (1987) in *Solanum elaegnifolium*, Singh *et al.* (1995) in scented geranium and Rampal (1996) in *Gentiana kurroo*.

References

Biswas PK (1982) Correlation studies in two populations of *Rauwolfia serpentina* Benth. *Indian Agric.* **26(3):** 175-177

Burton GW (1952) Quantitative inheritance in grasses. Proc. 6th Int. Grassland Congr. **1:** 227-283

Devagiri GM (1994) Studies on genetic evaluation, correlation and path analysis in some *Heracleum candicans* Wall. Collections from Himachal Pradesh. M.Sc.

Thesis, Dr YS Parmar University of Horticulture and Forestry. Solan (HP).

Dewey DR and KH Lu (1959) A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.* **51:** 515-518

Hanson CH, HF Robinson and RE Comstock (1956) Biometrical studies of yield in segregating population of Korean lespedza. *Agron. J.* **48:** 268-272

Harne S (1993) Identification of morphotypes in *Valeriana jatamansi* Jones in relation to their morphological characters and valepotriates component. M.Sc. Thesis, Dr YS Parmar University of Horticulture and Forestry, Solan (HP).

Johnson, HF Robinson and RE Comstock (1955) Estimates of genetic and environmental ability in soybean. *Agron. J.* **47:** 314-318.

Khanna KR and Singh SP (1987) Studies on variability and association of yield and its components in *Solanum elaeagnifolium. Indian Forester.* **113:** 629-633.

Rampal M (1996) Studies on genetic variability for bitter content and associated yield parameters in *Gentiana kurroo* Royle. M.Sc. Thesis, Dr. YS Parmar University of Horticulture and Forestry, Solan (HP)

Pandey BK (1992) Variability in solasodine content in *Solanum khasianum* Clarke. as affected by soil pH and available NPK under natural conditions. M.Sc. Thesis, Dr YS Parmar University of Horticulture and Forestry, Solan (HP).

Searle SR (1961) Phenotypic, genotypic and environmental correlations. *Biometrics.* **57:** 474-480.

Singh A and RK Mahey (1991) Character association studies in dill (*Anethum graveolens* L.). *Indian Perfumer* **35(3):**181-185.

Singh HP, NK Patra and S Sharma (1995) Contribution of different plant traits to herbage yield in scented geranium. *Current Research on Medicinal and Aromatic Plants.* **17(3&4):** 328-331.

Xiques XM, Alvarez and V Torres (1984) Correlation and path coefficient of characters of economic importance in *Datura candida. Cultivos Tropicales* **6(2):** 469-476.