Proc. Indian Acad. Sci. (Plant Sci.), Vol. 95, No. 1, August 1985, pp. 1–5.

Impact of polyploidy on flavonoid constitution in *Narcissus tazetta* L

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MS received 26 November 1984; revised 13 May 1985

Abstract. The data reported demonstrate the impact of polyploidy on plant phenotype and flavonoid constitution in *Narcissus tazetta*. Polyploidy induces increase in flower size and intensifies flower colour. The response of flavonoid constitution is variable. In some cases, flavonoid architecture does not register any change with the imposition of polyploidy. Whenever it does, the number of flavonoids is either increased or decreased. The probable explanation for such changes has been discussed.

Keywords. *Narcissus tazetta*; flavonoids; polyploidy

1. Introduction

Flavonoids are acknowledged indicators of phylogenetic kinship because they are so stable that ordinarily they are not influenced by changes in environmental conditions. The response of flavonoid constitution to numerical chromosome changes has been studied in very few cases (Iiyama and Grant 1972; Murray and Williams 1973; Crawford *et al* 1980). During the present study the phenotype and flavonoid constitution of a diploid and three triploid clones have been explored for comparison. The results form the text of present communication.

2. Materials and methods

Foliar and floral flavonoids of four varieties of *Narcissus tazetta* (listed in table 1) were screened through thin layer chromatography. The flavonoids were extracted separately from leaf lamina, and open flower in 1 % HCl in methanol (2 g per 1 ml). The separations were achieved on TLC plates coated with 0·6 mm thick layer of cellulose, using 5 μl of test extract. The loaded plates were developed as proposed by Dass *et al* (1975). The flavonoid spots were detected under UV after spraying the plates with NH_3 and 1 % NaOH and $AlCl_3$ solutions. At least three replicates were obtained for each taxon. The spots were grouped into three size categories namely, small (24–90 mm^2), medium sized (91–159 mm^2) and large (160–225 mm^2).

3. Results and discussion

Data on some quantitative characters of plant morphology of the four taxa are illustrated in the form of polygraph (figure 1), those on foliar and floral flavonoids are also included in tables 1 and 2 respectively. Of the four varieties, Canary Bird is a diploid with $2n = 20$, whereas the remaining three varieties are triploid with $2n = 30$.

Fifty one foliar flavonoids have been detected in the four taxa constituting the

Table 1. Comparative foliar flavonoid profile of the diploid and three triploid varieties of *N. tazetta*

Taxa	Spot numbers	Total no. of spots
Canary Bird	1s, 2s, 3s, 4s, 6s, 8m, 10s, 12s, 13s, 23s, 24s, 25s, 26s, 32s, 34s, 39s, 40s, 42s, 43s, 44s, 45s, 46m, 47s, 48s.	24
Kashmir Local	3s, 4s, 6s, 7s, 9m, 10s, 14s, 17s, 18s, 23s, 29s, 31s, 33s, 36s, 39s, 40s, 41s, 43s, 46m, 48s, 50s.	21
Kashmir Local Double	1s, 3s, 4s, 5s, 9s, 10s, 11s, 19m, 23m, 24s, 26s, 27s, 28m, 30s, 34s, 35s, 36m, 38s, 39s, 40s, 42s, 44s, 45s, 46s.	24
Soleil d'or	1m, 9m, 12m, 13s, 15s, 16m, 18s, 20s, 21m, 22s, 23m, 24s, 25s, 33m, 37m, 39s, 40s, 42s, 45m, 47s, 48s, 49s, 50s, 51s.	24

s, small; m, medium-sized,

experimental material. In individual taxa the number of spots ranges between 21 (Kashmir Local) and 24 (Canary Bird, Kashmir Local Double, and Soleil d'or). Three foliar flavonoid spots bearing nos. 23, 39 and 40 are common to all the four varieties (table 1).

Table 2 shows that the generalized chromatogram has 45 spots. The chromatograms of the four taxa were superimposed to obtain the generalized chromatogram. In individual varieties the number ranges from 15 (Kashmir Local) to 27 (Soleil d'or). Four flavonoids, represented by spot nos. 4, 10, 17 and 33, are common to the flowers of all the four varieties.

The influence of polyploidy on plant morphology was earlier studied in a variety of plants including narcissi (Stebbins 1971; Bose and Flory 1965; Smolskiy and Mankevich 1968; Raghuvanshi and Pathak 1975; Karihaloo 1977). In the taxa now studied, polyploidy has influenced vegetative as well as floral organs. Comparison of var Canary Bird (diploid) with Kashmir Local and Soleil d'or (both triploid) reveals that, while on the one hand, polyploidy has reduced plant height and scape length, on the other, it has boosted the flower size. Comparison between diploid Canary Bird and triploid Kashmir Local Double reveals a reverse trend. In this triploid, vegetative characters registered an increase in size but the floral features underwent dimunition (figure 1).

Apart from the size changes, polyploidy also affects the colour of the flower. The colour deepens from light to deep yellow. In triploid vars Soleil d'or, Kashmir Local and Kashmir Local Double flowers are bicoloured. Development of novel colours has been observed in many other polyploids also (Smol'skiy and Mankevich 1968).

The impact of polyploidy on flavonoid pattern has been worked out in members of Poaceae and Rosaceae (Iiyama and Grant 1972; Kohli and Denford 1977). The polyploid varieties of *N. tazetta* have either only as many flavonoids as the diploid or fewer. The chromatograms of Canary Bird ($2x$) and Kashmir Local ($3x$) bear ten common spots. The triploid Soleil d'or shares twelve spots with the diploid and

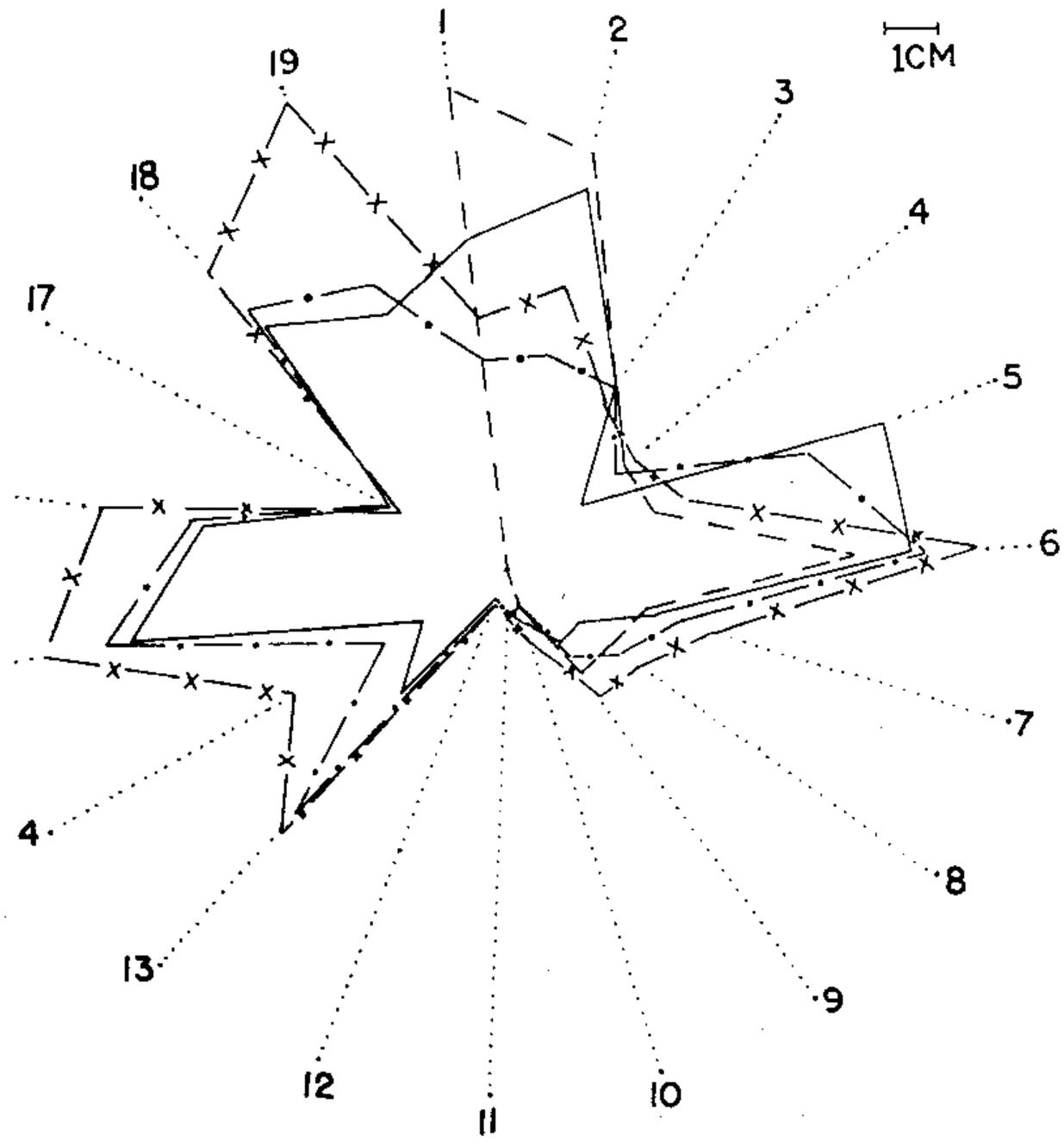

Figure 1. Polygraph illustrating variation in nineteen quantitative characters among four varieties of *N. tazetta* namely, Canary Bird (———), Kashmir Local (——×——), Kashmir Local Double (- - - - -), and Soleil d'or (——o——). 1. Plant height (1 cm = 7 cm), 2. Scape length (1 cm = 5 cm), 3. Number of leaves per plant (1 cm = 1 no.), 4. Breadth of leaf (1 cm = 0.5 cm), 5. Number of flowers, per inflorescence (1 cm = 1 no.), 6. Spread of flower, (1 cm = 0·5 cm), 7. Perianth lobe length (1 cm = 0·5 cm), 8. Perianth lobe breadth (1 cm = 0·5 cm), 9. Corona spread (1 cm = 0·5 cm), 10. Corona depth (1 cm = 0·5 cm), 11. Stamen length (1 cm = 0·5 cm), 12. Anther length (1 cm = 0·5 cm), 13. Pistil length (1 cm = 0·5 cm), 14. Style length (1 cm = 0·5 cm), 15. Polar axis of pollen (1 cm = 6 μ), 16. Equitorial axis of pollen (1 cm = 6μ), 17. P/E ration (1 cm = 0·5), 18. Pollen size index (1 cm = 5), 19. Pollen volume (1 cm = 2400 μ^3).

therefore appears closer to it. The flavonoids, which are common, exhibit quantitative differences as is reflected by the size of the spot they form on the chromatograms. For instance, spots 1, 12, 23 and 45 are small in chromatograms of Canary Bird but medium-sized in those of Soleil d'or. The increase in quantity can be attributed to the increased synthesis of these compounds in the polyploid taxa caused by the increase in number of genes coding for their synthesis.

Another effect of polyploidy is the synthesis of some novel flavonoids, the likes of which do not exist in the diploid. Appearance of novel flavonoids has been reported by Murray and Willams (1973) in polyploids of *Briza media*, and by Mangotra (1981) and

Table 2. Comparative floral flavonoid profiles of the diploid and three triploid varieties of *N. tazetta*.

Taxa	Spot number	Total no. of spots
Canary Bird	1s, 2s, 4s, 6m, 9s, 10s, 12s, 14s, 15s, 16s, 17s, 20s, 21s, 22m, 28s, 30s, 32s, 33s, 34s, 35s, 39s.	21
Kashmir Local	2s, 4s, 10m, 15s, 17s, 23s, 24s, 27s, 28s, 31s, 33s, 34s, 38s, 44s, 45s.	15
Kashmir Local Double	1s, 3s, 4s, 5s, 7s, 8s, 10s, 13s, 17s, 20s, 21s, 22s, 25s, 29s, 30s, 32s, 33s, 36s, 40s, 42s, 43s.	21
Soleil d'or	1s, 2s, 4s, 6s, 10*l*, 11s, 14m, 15m, 16s, 17s, 18m, 19m, 20s, 22s, 23m, 24s, 26s, 28s, 31s, 33s, 34s, 36s, 37s, 38s, 39s, 41s, 42s.	27

s, small; m, medium-sized; l, large

Gupta (1983) in polyploids of *Crotalaria*. Their synthesis has been explained on the basis of the interactions among genes brought together in the polyploid taxa.

Like foliar, floral flavonoids also show three major trends; they increase, decrease or remains unaltered with the numerical increase in chromosome. The increase in number of flavonoids may be an outcome of recombination or presence of new gene combinations within the polyploids. The reduction in number of flavonoids can be explained on the grounds of simple dominance.

Comparison between the profiles of Canary Bird and Kashmir Local reveals that only eight floral flavonoid spots are common between the two. From among these, only one (represented by spot no. 10) shows increase in size. Similarly, Soleil d'or shares fifteen flavonoids with the diploid. Three of these (represented by spot nos. 10, 14 and 15) are produced in large quantity within the polyploids, but two others (represented by spot nos. 6 and 22) diminishes in quantity within the polyploids.

On the whole, flavonoid profiles of polyploid narcissi do not strictly match those of their diploid ally indicating their alloploid nature. The alloploid status is also borne out by the formation of some novel flavonoids. This conclusion is in line with that drawn on the basis of studies on their chromosome complement and the course of meiosis (Karihaloo 1977).

Acknowledgements

One of the authors (RB) thanks CSIR, New Delhi, for financial assistance.

References

Bose S and Flory W S 1965 A cytological study of *Sprekelia formosissima*. Herbert; *The Nucleus* **8** 115–128

Crawford D J, Smith E B and Mueller A M 1980 Leaf flavonoid chemistry of *Coreopsis* (Compositae) section *Palmatae*: *Brittonia* **32** 452–463

Dass H C, Randhawa G S and Kour M 1975 Variation in flavonoid patterns and species relationship in the genus *Annona; Indian J. Hortic.* **32** 111–116

Gupta M 1983 *Chemosystematics of some species of the genus Crotalaria* L; Ph.D. thesis, Jammu University

Iiyama K and Grant W F 1972 A correlation of nuclear DNA content and the thin layer chromatographic pattern in resolving genome relationships in *Avena; Can. J. Bot.* **50** 1529–1545

Karihaloo J L 1977 Cytogenetic studies in some members of Amaryllidaceae Ph.D. thesis, Jammu University

Kohli B L and Denford K E 1977 A study of the flavonoids of the *Potentilla pensylvanica* complex in North America; *Can. J. Bot.* **55** 476–479

Mangotra R 1981 *Cytomorphological and chemotaxonomical studies of some species of genus Crotalaria* L; Ph.D. thesis, Jammu University.

Murray B G and Williams C A 1973 Polyploidy and flavonoid synthesis in *Briza media* L; *Nature (London)* **243** 87–88

Raghuvanshi S S and Pathak C S 1975 Polyploid breeding and possibility of raising double varieties in *Phlox drummondii* Hook; *Cytologia* **40** 355–363

Smol'skiy N V and Mankevich O I 1968 Variation in flowers and inflorescence in experimental polyploids of decorative plants,: *Vest. Akad. Navuk. BSSR, Ser. Biyal, Navuk* **4** 25–31

Stebbins G L 1971 *Chromosome evolution in higher plants* (London: Addison-Wesley)