

SIMILARITIES IN THE RESPONSE TO CHROMOSOME DOUBLING AND GIBBERELLIN APPLICATION IN SOME PLANTS

M. S. SWAMINATHAN, R. S. RANA AND A. K. GUPTA*

Division of Genetics, Indian Agricultural Research Institute, New Delhi

THERE is greater scope for polyploidy breeding in plants grown for fodder and ornamental purposes since seed fertility, which is usually reduced in autopolyploids, is not of primary importance in such plants.¹⁻⁴ Tetraploids were hence produced by colchicine treatment in the fodder plants, Berseem (*Trifolium alexandrinum*) and Senji (*Melilotus indica*) in 1954 and in the ornamental plants, Snapdragon (*Antirrhinum majus*), Larkspur (*Delphinium ajacis*) and *Acroclinium* (*Helip-terum roseum*) in 1957 at the Indian Agricultural Research Institute, New Delhi.⁵⁻⁶ Induced tetraploids of Snapdragon and Larkspur showed a striking improvement in flower size over their respective diploids, whereas those of *Acroclinium* did not differ markedly from the diploid parent.⁶ Such a differential response to chromosome doubling was also observed in the induced tetraploids of Berseem and Senji.⁵ Autotetraploid Berseem was consistently superior to the diploid in fodder yield and has been released for general cultivation under the name "Pusa Giant Berseem"⁷ while tetraploid Senji did not show any improvement over the diploid parent.⁸

A comparative study revealed that Berseem and Senji differ prominently in initial cell size, the cells of diploid Senji being nearly double in size than that of diploid Berseem.⁵ Stebbins⁴ has postulated that the optimum cell volume may be reached in many plants in the diploid state itself and that if in such plants the cell volume is further increased through colchicine treatment, the consequent

effect on physiologic efficiency is deleterious and hence is of negative selection value. Since cell enlargement is also a characteristic response to exogenous application of gibberellin,^{9,10} a study was undertaken to ascertain whether there is a parallelism in the favourable response of plants to the application of colchicine and gibberellin.

Observations were made on plants grown in pots under comparable growth conditions. There were three sets for every species—one set of diploids to serve as control, another set of diploids for gibberellin treatment and one set of induced tetraploids. Each set consisted of 15 plants in the ornamentals and 25 plants in Berseem and Senji. Leaves of eight week-old plants of ornamental and nine week-old fodder plants were sprayed with 100 p.p.m. gibberellic acid (GA) through an atomiser applying 1 mg. of GA per plant. Observations on cell size were taken 7 to 10 days after spraying. Leaf samples from the three sets of each species were taken from comparable growth regions and the peelings from the lower epidermis were used for observing cell size. For measuring area, cells were traced on a centimeter square graph paper at bench level with the help of a camera lucida. Observations on 20 cells were recorded for each plant and the data were statistically analysed (Table I).

The data reveal that response in terms of increased cell size is significant, for both GA and chromosome doubling, only in those species whose tetraploid forms are promising. Thus,

TABLE I
Effects of exogenous gibberellic acid (GA) and induced polyploidy on cell size

Material	Somatic chromosome number	Mean cell size (expressed as percentage of the controls)		T. values for comparing means treatments vs. controls		Commercial value of induced tetraploids
		G. A. effect	Polyploidy effect	G. A. effect	Polyploidy effect	
Snapdragon	.. 16	142.72	164.61	4.61*	4.89*	Good
Larkspur	.. 16	135.46	150.18	3.18*	4.06*	Good
<i>Acroclinium</i>	.. 14	108.27	117.54	1.47	1.52	Poor
Senji	.. 16	112.24	119.32	1.22	1.45	Poor
Berseem	.. 16	139.13	156.25	3.43*	4.51*	Good

* T value at 5% level = 2.045.

* Present address: Plant Breeding Department, Punjab Agricultural University, Ludhiana.

the present study supports the views of Schwanitz¹¹ and Stebbins⁴ that an optimum cell size exists for each species and that this size may be attained through natural selection at the diploid level in some species and at higher ploidy levels in others. The favourable response to induced polyploidy will then depend upon whether or not the optimum cell size has already been attained in the initial population chosen for colchicine treatment.

If this correlation between GA and polyploidy effects is generally operative, an interesting application of the present observation will be that positive response to GA can be used as a sieve for selecting plants for the induction of polyploidy. This technique may be particularly useful in ornamental and fodder plants but not in crops where the economic part is the seed, since in such plants increased grain size is not the only component

of increased yield and the seed sterility associated with autopolyploidy also reduces the utility of the polyploid.

1. Emsweller, S. L. and Ruttle, N. L., *Amer. Nat.*, 1941, **75**, 310.
2. Levan, A., *Hereditas*, 1942, **28**, 245.
3. Emsweller, S. L., *Proc. Amer. Soc. Hort. Sci.*, 1948, **51**, 565.
4. Stebbins, G. L., *Brookhaven Symp. Biol.*, 1956, **9**, 37.
5. Sikka, S. M., Swaminathan, M. S. and Mehta, R. K., *Nature* (London), 1958, **181**, 32.
6. Rana, R. S., *Assoc. I.A.R.I., Dissertation*, 1959.
7. Mehta, R. K. and Swaminathan, M. S., *Indian Fmg.*, 1965, **15** (6), 4.
8. —, Subramanyam, K. N. and Swaminathan, M. S., *Indian J. Genet.*, 1963, **23**, 67.
9. Stowe B. B. and Yamaki, T., *Ann. Rev. Plant Physiol.*, 1957, **8**, 181.
10. Haber, A. H. and Luippold, H. J., *Amer. J. Bot.*, 1960, **47**, 140.
11. Schwant, F., *The Origin of Cultivated Plants*, Harvard University Press, Cambridge, 1966.

DRY MATTER PRODUCTION IN SUN AND SHADE LEAVES AND A SIMPLE METHOD FOR THE MEASUREMENT OF PRIMARY PRODUCTIVITY

R. MISRA, J. S. SINGH AND K. P. SINGH

Department of Botany, Banaras Hindu University, Varanasi-5

WITH increasing emphasis in recent years on the evaluation of primary productivity the role of sun and shade leaves in production has drawn considerable attention. Although some amount of work is available on the differential behaviour of sun and shade leaves (often referred to as upper and lower leaves) with regard to their dry weight per unit area,¹⁻³ a direct evaluation of their capacity for dry matter production is lacking in ecological literature. In order to investigate, therefore, the gross productivity of these two types of leaves when exposed to their normal as well as reciprocal light conditions, a few experiments were conducted with *Bougainvillea spectabilis* during April 1968. The same are discussed briefly here.

Gross production was measured through the increase in the dry weight of leaf discs of one square centimeter area obtained with the help of a cork borer. Twigs of current growth with equal number of nodes were selected from the permanently shaded (10% of full daylight) and upper exposed areas from shrubs growing in the botanical garden of the Banaras Hindu University at 8 a.m. The leaves obtained from shaded and exposed areas are termed

shade and sun leaves respectively. In order to avoid the error due to changes in the area of the leaves⁴ they were immersed in water till fully turgid before cutting out the discs. The discs were then placed over cotton pads kept constantly wet in uncovered Petri dishes. Cotton pads were necessary to check excessive heat which otherwise would kill the discs within a short period when kept in full sunlight. Twenty discs were placed in each Petri dish and three such Petri dishes were used for each of the following treatments: sun leaves in full daylight, sun leaves in shade, shade leaves in full daylight, shade leaves in shade, and sun and shade leaves in a dark chamber with 40% KOH placed in another Petri dish. Presence of KOH solution was necessary as we have gathered some evidence of substantial dark fixation of CO₂ in this plant which will be published elsewhere.

At the start of the experiment an equal number of discs, both from sun and shade leaves, were oven-dried at 80° C. for recording the initial dry weight. Increase in the dry weight of the discs at the end of six hours treatment is taken as the apparent photosynthesis or net production and the decrease in