Irradiated pollen selfs in cultivars of *Hordeum vulgare*

W. Powell and
P. D. S. Caligari

Scottish Crop Research Institute, Pentlandsfield, Roslin,
Midlothian, EH25 9RF, U.K.

Pollen of two spring barley cultivars, Golden Promise and Magnum, was irradiated before being used in self pollinations. Golden Promise was subjected to 500 and 1500 rads while Magnum was exposed to 500 and 1000 rads of gamma radiation. No variation was detected in the major gene characters, mildew resistance and growth habit, when the second generation following the irradiated self was examined. Four continuously varying characters were also investigated and gave means and variances indistinguishable from the unirradiated selfs. Thus the results gave no evidence to support the suggestion that the inheritance of damaged DNA could explain the predominance of maternal characters in irradiated pollen crosses.

INTRODUCTION

Experiments with several different plant genera have demonstrated that irradiation of pollen prior to fertilisation gives plants (M_1 generation) whose progenies (M_2) differ from normal crosses (F_2) by expressing only a portion of the paternal genome (e.g., Pandey, 1975 and 1980; Caligari, Ingram and Jinks, 1981; Powell, Caligari and Hayter, 1983; Snape, *et al.*, 1983 and Daskalov, 1984). Various mechanisms have been proposed to explain the observed results and these are discussed by Caligari, Powell and Hayter, 1984. Cytological investigations by Werner, Dunkin, Cornish and Jones, 1984 and Borrino, Caligari, Powell, McNaughton and Hayter, 1985, have shown that the mechanism proposed by Pandey, 1978, for the transfer and incorporation of small pieces of pulverised paternal DNA, followed by parthenogenetic doubling was not applicable to the cases studied. Werner, *et al.* went on to postulate that the results in *Nicotiana rustica* could be explained, in the main, by the inheritance of radiation induced damage. Thus the paternal DNA was largely inactivated and any maternal trends observed were purely co-incidental. Caligari, *et al.*, 1984, demonstrated that the results in barley were consistent with the preferential elimination of much of the paternal DNA between the M_1 and M_2 generation.

In this paper, pollen from the same highly inbred cultivars of spring barley as described by Powell, *et al.*, 1983, was irradiated and used to self

pollinate the respective parents. If an explanation similar to that postulated by Werner, *et al.*, 1984, is appropriate it would be expected that variation would be apparent when the second selfed generation from the irradiated selfs was examined. Indeed, it would be further expected that when dominant major alleles were irradiated they would be inactivated in such a way as to behave like their recessive counterparts.

MATERIALS AND METHODS

The materials and methods used were the same as those described by Powell *et al.*, 1983, and involved the true-breeding cultivars “Golden Promise” and “Magnum”. Golden Promise is mildew susceptible while Magnum contains a single, effective, dominant mildew resistance gene. Golden Promise also contains a recessive dwarfing gene which produces an erect juvenile growth habit while Magnum has a non-allelic dwarfing gene which gives a prostrate juvenile growth habit.

Ears of Golden Promise and Magnum were emasculated by the “egg-topping” method of Pope, 1944. Golden Promise ears were exposed to 500 and 1500 rads and were used to pollinate previously emasculated Golden Promise. Magnum ears were exposed to 500 and 1000 rads and again used to produce irradiated selfs. At the same time unexposed ears were used to produce the unirradiated, control selfs. The plants produced from the irradiated and unirradiated selfs were raised in the

glasshouse and allowed to self pollinate to produce the second generation. In this way 10 families were produced from both Golden Promise and Magnum using unirradiated pollen. Golden Promise pollen treated with 500 rads gave 4 families while at 1500 rads 2 were produced. For magnum, five families were obtained from the 500 rad treatment and two from 1000 rads.

The second generation material was grown in a four replicate, randomised complete block design at the Murrays Farm, East Lothian. Within each block the material was sown as dibbed rows which contained up to 10 plants sown at 5 cm spacing, between rows the spacing was 22.5 cm. The major gene characters mildew resistance and growth habit were scored in the field while after harvest a random sample of 5 plants from each row was scored for four characters displaying continuous variation, namely:

HT = Final plant height in cm.

GN = Number of grains on the main stem.

TN = Number of fertile tillers.

EL = Length of the ear in cm.

RESULTS

The results for the major gene characters, mildew resistance and growth habit, are given in table 1

for the normal selfs and the irradiated equivalents. As can clearly be seen the irradiation of pollen prior to selfing has had no detectable effects in the second generation with regard to producing any segregation. The results for the continuously varying characters are presented in table 2 as the means and between plant variances for the different groups of material. Analyses of variance showed there were no significant differences for any of the characters and Bartlett's tests provided no indication of significant heterogeneity for the variances. Thus there was no significant effect detected in the second generation for any of the four characters due to irradiating the pollen prior to selfing.

DISCUSSION AND CONCLUSIONS

The results presented here show no significant differences between the unirradiated and irradiated selfs for either of the cultivars used. These two cultivars were the ones described by Powell *et al.*, 1983, and Caligari *et al.*, 1984, where the pollen of Magnum was irradiated and then used to pollinate Golden Promise. The results showed the second generation (M_2) progenies to have a preponderance of maternal Golden Promise characters. For these observations to be due to a phenomenon such as suggested by Werner *et al.*,

Table 1 Numbers of plants in the various phenotypic classes produced by the major gene characters in the second generation after selfing

		Mildew resistance		Growth habit	
		Resist.	Susc.	Erect.	Prostrate
G. Promise	0 rad self	0	282	282	0
	500 rad self	0	127	127	0
	1500 rad self	0	31	31	0
Magnum	0 rad self	358	0	0	358
	500 rad self	160	0	0	160
	1000 rad self	64	0	0	64

Table 2 Means and between plant variances in the second generation material

		Ht		GN		TN		EL	
		Mean	Var. (df)	Mean	Var. (df)	Mean	Var. (df)	Mean	Var. (df)
G. Promise	0 rad self	45.2	15.7 (137)	28.4	18.8 (137)	8.0	11.9 (137)	9.9	0.8 (137)
	500 rad self	44.4	17.9 (59)	29.4	14.6 (59)	9.6	14.8 (59)	9.8	0.8 (59)
	1500 rad self	45.0	15.4 (23)	30.2	10.0 (23)	7.6	11.9 (23)	9.9	1.1 (23)
Magnum	0 rad self	52.6	22.3 (149)	26.1	7.5 (149)	9.7	14.3 (149)	9.8	0.8 (149)
	500 rad self	51.0	26.8 (76)	26.3	9.1 (76)	8.8	12.8 (76)	10.1	1.1 (76)
	1000 rad self	52.3	16.7 (26)	28.1	4.4 (26)	8.9	11.3 (26)	10.4	0.7 (26)

1984, it would require the Magnum characters to be largely inactivated by irradiation and give an expression similar to that of the counterpart alleles in Golden Promise. Thus in the irradiated selfs studied here, it would be anticipated that such induced variation would be exposed in the second generation. Clearly Magnum does not show any particular shift towards an expression of recessive characters mimicing Golden Promise. Similarly Golden Promise did not display any detectable changes.

Thus the data presented here provide further evidence that in barley, damage induced by irradiating the pollen cannot adequately account for the observed maternal trend.

Acknowledgements We would like to thank Professor W. Duncan and Dr J. Law of the Western General Hospital, Edinburgh, for providing radiation facilities. The expert assistance of W. Wood and G. R. Drabble is also gratefully acknowledged.

REFERENCES

- BORRINO, E., CALIGARI, P. D. S., POWELL, W., MCNAUGHTON, I. H. AND HAYTER, A. M. 1985. Cytological observations on the effect of pollen irradiation in diploid and polyploid crops. *Heredity*, **54**, 165-170.
- CALIGARI, P. D. S., INGRAM, N. R. AND JINKS, J. L. 1981. Gene transfer in *Nicotiana rustica* by means of irradiated pollen. I. Unselected progenies. *Heredity*, **47**, 17-26.
- CALIGARI, P. D. S., POWELL, W. AND HAYTER, A. M. 1984. Quantitatively varying characters in the second generation from an irradiated pollen cross in barley. *Heredity*, **52**, 347-353.
- DASKALOV, S. 1984. Pollen irradiation and gene transfer in *Capsicum*. *Theor. Appl. Genet.*, **68**, 135-138.
- PANDEY, K. K. 1975. Transformation, incompatibility and plant improvement. *Incompatibility Newsletter*, **6**, 91-121.
- PANDEY, K. K. 1978. Gametic gene transfer in *Nicotiana* by means of irradiated pollen. *Genetica*, **49**, 53-69.
- PANDEY, K. K. 1980. Further evidence for egg transformation in *Nicotiana*. *Heredity*, **45**, 15-29.
- POPE, M. N. 1944. Some notes on techniques in barley breeding. *J. Hered.*, **35**, 99-111.
- POWELL, W., CALIGARI, P. D. S. AND HAYTER, A. M. 1983. The use of pollen irradiation in barley breeding. *Theor. Appl. Genet.*, **65**, 73-76.
- SNAPE, J. W., PARKER, B. B., SIMPSON, W., AINSWORTH, C. C., PAYNE, P. I. AND LAW, C. N. 1983. The use of irradiated pollen for differential gene transfer in wheat (*Triticum aestivum*). *Theor. Appl. Genet.*, **65**, 103-111.
- WERNER, C. P., DUNKIN, I. M., CORNISH, M. A. AND JONES, G. H. 1984. Gene transfer in *Nicotiana rustica* by means of irradiated pollen. II Cytogenetical consequences. *Heredity*, **52**, 113-119.