

New Mutants of Perennial *Portulaca grandiflora* Through Gamma Radiation

Arunee Wongpiyasatid¹ and Praparat Hormchan²

ABSTRACT

Stem cuttings of two perennial *Portulaca grandiflora* varieties, “Double Orange” and “Double Pink” were gamma irradiated with the doses of 0, 10, 20 and 40 gray. Variations in phenotypic characters of flower color, form and size were noticed. Three characters could be maintained by vegetative propagation and developed into new mutant varieties. The first mutant, “Chompoo Praparat”, was obtained from irradiated treatments of both Double Orange and Double Pink varieties. The second mutant, “Pattik”, was obtained from all gamma irradiation treatments of Double Orange variety only. The third mutant, “Som Arunee”, was obtained from 40 gray treatment of Double Orange variety. The flower colors of Chompoo Praparat and Pattik are pink (Red Purple Group # 73 A–B) and Orange (Red Group # 40 B–C) as classified by the Royal Horticulture Society color chart respectively. Both have single form of petal (five petals). Som Arunee has double form of petals with deep orange flower color (Red Group # 41 A–B). These mutants do not differ in other characters from the original varieties except the flower color and form.

Key words : portulaca, gamma radiation, mutant

INTRODUCTION

Portulaca grandiflora Hook, is known by several different names : sunplant, rose moss, moss rose as well as portulaca. It is extensively cultivated in tropical and subtropical regions and grows well in sunny and dry locations, rock gardens, as an edging plant and when interplanted in bulk beds. Belonging to the family Portulacaceae, order Caryophyllales, *P. grandiflora* is grouped into 2 types, annual and perennial. The annual *P. grandiflora*, a succulent herb, has a large number of single and double flowered varieties in various colors but the perennial type, a hardy herbaceous

plant, produces only double flowered varieties and likely to have limited color shade in contrast to the annual. At present, perennial portulaca in Thailand has 5 colors of white, pink, orange, purple and pink with white margin. The flower of this type does not set seeds. (Lata and Gupta, 1971)

With the limitation in color and having no seed setting, many researchers have tried to use mutation breeding to improve the flower characters (Gupta, 1970; Desai, 1974; Wongpiyasatid and Roongtanakiat, 1992). *Portulaca* improvement by gamma irradiation and chemicals resulted in several new commercial varieties (Gupta, 1970; Abraham and Desai, 1977) whose flowers had changes in

¹ Department of Applied Radiation and Isotopes, Faculty of Science, Kasetsart University, Bangkok 10900, Thailand.

² Department of Entomology, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand.

color and form.

The objective of the study was to obtain new portulaca varieties through induced mutation by using gamma rays.

MATERIALS AND METHODS

One hundred and sixty freshly unbranched cutting of 2 double flower (multipetals) varieties of perennial *P. grandiflora*: “Double Orange”, orange flower color (Red Group # 40 B–C classified by The Royal Horticultural Society color chart) and “Double Pink”, pink flower color (Red Purple Group # 73 A–B), of 3–4 inches long were divided into 4 groups, 40 cuttings to each one. Acute gamma rays at 0, 10, 20 and 40 gray were applied to cuttings of each group by Gamma Irradiator Model Mark I-30 (4500 Ci of Cs-137) at Gamma Irradiation Service and Nuclear Technology Research Center, Kasetsart University.

The irradiated cuttings (M_1V_0) and control were then planted in 12 inch diameter clay-pot, 5 cuttings per pot. The cuttings were allowed to grow till flowering. Cutting back technique was employed to increase branching. During flowering, the branches (M_1V_1 , M_1V_2 or M_1V_3) which produced desirable mutant flowers were selected and individually planted in pots.

The characters of mutant flowers compared with the control were visually recorded as follows: flower color, flower form, flower diameter, number of petal, petal length and petal width. Pollen fertility was also determined after staining the pollen grains with aceto-carmin and keeping them for at least one hour before counting was made. The empty and shrunken pollen grains were treated as sterile while the only filled ones fertile. Pollen fertility percentage was calculated as follows:

% pollen fertility =

$$\frac{\text{No. of fertile pollen}}{\text{Total no. of pollen observed}} \times 100$$

RESULTS AND DISCUSSION

Radiation effects on cutting survival

Cutting of perennial *P. grandiflora* has quite low radiosensitivity compared to the cuttings of many other ornamentals. Survival percentage of every treatment of both varieties were found to be 100. Radiation doses administered in this experiment did not affect the survival but the growth of the cuttings. It was observed that the first few growth stages would reduce with increasing doses resulting in late blooming. However, when the plants were allowed to grow in the next 1 – 1 1/2 months, the different in growth were not expected to be encountered later as every treatment could resume normal growth.

Radiation effects on vegetative parts

Vegetative parts, stem and leaf, did not seem to be much affected by radiation. Abnormal leaf forms were noticed at a short period after planting but later resumed normal.

Radiation effects on flower color

Original variety : Double Orange

Every irradiated treatment of Double Orange variety was shown to have rate of color change greater with increasing doses. The color change of flowers on all primary branches (M_1V_1) were found to be sectorial chimera. That was orange and pink color would be observed in the same flower with variation in sector size. When primary branches bearing sectorial chimera were separately planted for 2–3 generations (M_1V_2 , M_1V_3 , M_1V_4), the flowers on new branches would give flowers of 3 color shades which were solid pink, solid orange and sectorial chimera of pink and orange (Figure 1). Solid colors were found to increase with the increasing generation while sectorial chimera decreased. Moreover, deep orange flower color was isolated from the treatment of 40 gray. Flowers

with sectorial chimera of orange and white colors were also observed but the white sector was quite small and always associated with abnormal petals. At present, white flower has not been able to be isolated yet.

Original variety : Double Pink

Only chimera of pink with small sector of white flowers were observed from the treatment of Double Pink variety. The white sector also associated with abnormal petals as occurred in Double Orange Variety. Solid white flower has not been able to be isolated from the mentioned sectorial flower. The little darker or lighter color shades might be present where the difference could not be pointed out if not closely noticed.

For flower color, Ootani and Hagiwara (1969) summarized that flower colors of *P. grandiflora* chiefly manifested by nitrogenous pigments called betacyanin and betaxanthin. The betacyanins of orange-yellow and red flowers always accompany the betaxanthins. The survey of betacyanin and betaxanthin in qualitative and quantitative manner by using a large number of color forms of *P. grandiflora* and F_1 hybrids was also carried out by Ootani and Hagiwara (1969). Paper-chromatography analyses showed that purple and yellow pigments of various flower color forms were composed of five betacyanins (Bc_1 to Bc_5) and five betaxanthins (Bx_1 to Bx_5), respectively. The constitutions and the contents of both pigments, betacyanin and betaxanthin were arranged. In general, orange forms of *P. grandiflora* have four to five betaxanthins together with a small amount of four betacyanins, while pink forms contain two to four betacyanins with two traces of betaxanthins. Besides, there are many other intermediate color forms in accordance with different combinations of betacyanin and betaxanthin component.

It was observed in this experiment that orange form of irradiated treatments was easily changed to pink while changing from pink to

orange was not found. This might be contribute to the effect of radiation on betaxanthin and betacyanin synthetic pathways. The synthesis of betaxanthin seemed to be sensitive to radiation than that of betacyanin since only two betaxanthins were present only in small amount in the pink compared to the original orange form whereas two to four betacyanins were still left in the pink but in less amount (Ootani and Hagiwara, 1969). When the comparison of flower color changes between Double Orange and Double Pink varieties was made, it was found that the flower color of Double Orange could change readily with higher mutation rate than Double Pink.

Radiation effects on flower form

The changes in flower form were found in irradiated treatment of both varieties from double flower to semi-double and single flowers. There was also change in flower color of the orange variety as mentioned in the previous results which were solid and sectorial chimera. The semi-double flower character was not so stable since such character could not be maintained through vegetatively propagation. Mostly, they would return to the normal double or the mutant single.

Other characteristic changes

Apart from the changes in flower color and form as shown in Table 1, some changes in flower shape and size could be found (Figure 3). Still they were not stable, for such changing characters could not be maintained for so long. Some abnormalities of stamen and pistil were also observed. For example, some flowers had neither stamen nor pistil while some were either staminate or pistillate. Those abnormalities agreed with the work of Lata and Gupta (1971) and Banerjee (1967). For pollen fertility, it was found that single flower mutants tended to have higher pollen fertility than both double flower mutants and the control. This

character would be beneficial to seed setting, thus seed propagation could be pursued. Similar results were also reported by Lata and Gupta (1971).

New released varieties

Phenotypic mutants obtained from this experiment appeared in both stable and unstable characters as shown in Table 1. Only three mutants were released as new varieties. The first mutant, Chompoo Prapararat, was obtained from both irradiated Double Orange and Double Pink varieties. The second mutant, Pattik, was obtained from irradiated Double Orange variety only while the third mutant, Som Arunee, was obtained from 40

gray treatment of Double Orange variety. The flower colors of Chompoo Prapararat, Pattik and Som Arunee are pink (Red Purple Group # 73 A–B), orange (Red Group # 40 B–C) and deep orange (Red Group # 41 A–B) as classified by the Royal Horticulture Society color chart respectively. Chompoo Prapararat and Pattik have single form of petal while Som Arunee has double form. The other characters, except for the flower color and form, of these mutants are not different from the original varieties. Comparison of flower characters of the mutants to the original varieties was shown in Table 2 and Figure 2.



(a)



(b)



(c)



(d)

Figure 1 The color change of *P. grandiflora* flower after gamma irradiation, (a) original variety, Double Orange (b) sectorial chimera, orange and pink (c) solid orange from sectorial chimera (d) solid pink from sectorial chimera



(a)



(b)



(c)



(d)



(e)

Figure 2 Original varieties and mutants of *P. grandiflora* flower after gamma irradiation, (a) original variety, Double Orange (b) original variety, Double Pink (c) mutant, Som Arunee (d) mutant, Pattik (e) mutant, Chompoo Preparat



Figure 3 Some unstable changes in flower form and color of *P. grandiflora*, Double Orange variety.

Table 1 Phenotypic mutants of flower and their status obtained from two varieties of perennial *Portulaca grandiflora* after treating with gamma radiation.

| Original variety | Phenotypic mutants | Status ¹ |
|------------------|---|---------------------|
| Double Orange | 1. Double pink | Stable |
| | 2. Double sectorial chimera, orange and pink | Unstable |
| | 3. Double sectorial chimera, orange and white | Unstable |
| | 4. Semi-double pink | Partially stable |
| | 5. Semi-double orange | Partially stable |
| | 6. Semi-double sectorial chimera, orange and pink | Unstable |
| | 7. Single pink | Stable |
| | 8. Single orange | Stable |
| | 9. Single sectorial chimera, orange and pink | Unstable |
| | 10. Single orange with undulate margin | Unstable |
| | 11. Double deep orange | Stable |
| Double Pink | 1. Semi-double pink | Partially stable |
| | 2. Single pink | Stable |
| | 3. Double sectorial chimera, pink and white | Unstable |

¹ Stable = mutants can be maintained by vegetatively propagation
 Unstable = mutants disappear after vegetatively propagation
 Partially stable = after vegetative propagation, mutant occasionally disappear and reappear

Table 2 Comparison of flower characters of original *Portulaca grandiflora* varieties and their mutants.

| Original variety | Mutant | Radiation dose (Gy) | Flower color (RHS ¹) | Flower form | Flower diameter (cm) | Mean \pm S.E | | Pollen fertility (%) | | | | | | |
|------------------|--------|---------------------|----------------------------------|----------------------|----------------------|------------------|------------------------------|----------------------------------|----------------------|----------------|------------------|----------------|----------------------------------|----------------------|
| | | | | | | Number | Petal Length (cm) Width (cm) | | | | | | | |
| Double orange | - | 0 | Orange (Red Group # 40 B-C) | Double (Multipetals) | 3.6 \pm 0.04 | 41.5 \pm 2.55 | 1.7 \pm 0.03 | 1.3 \pm 0.04 | 6.64 | | | | | |
| | | | | | | Chompoo Preparat | 10-40 | Pink (Red Purple Group #73 A-B) | Single (Five petals) | 3.2 \pm 0.07 | 5.2 \pm 0.13 | 1.6 \pm 0.03 | 1.8 \pm 0.05 | 12.72 |
| | | | | | | | | | | | Pattik | 10-40 | Orange (Red Group #40 B-C) | Single (Five petals) |
| Double pink | - | 0 | Pink (Red Purple Group # 73 A-B) | Double (Multipetals) | 3.1 \pm 0.06 | 43.6 \pm 1.6 | 1.4 \pm 0.03 | 1.2 \pm 0.03 | 2.57 | | | | | |
| | | | | | | Som Arunee | 40 | Deep Orange (Red Group # 41 A-B) | Double (Multipetals) | 3.6 \pm 0.04 | 43.2 \pm 2.20 | 1.7 \pm 0.03 | 1.4 \pm 0.04 | 6.63 |
| | | | | | | | | | | | Chompoo Preparat | 10-40 | Pink (Red Purple Group # 73 A-B) | Single (Five petals) |

¹ RHS = the Royal Horticulture Society color chart.

CONCLUSION

Three mutant varieties namely “Chompoo Praparat”, “Pattik” and “Som Arunee” are obtained from the original varieties, Double Pink and Double Orange through gamma irradiation. All characters of the mutants except flower color and form are similar to the original varieties.

LITERATURE CITED

- Abraham, V. and B.M. Desai, 1977. Induced tetraploidy in a perennial *Portulaca* mutant. *Indian J. Hortic.* 34 (3) : 301–305.
- Banerjee, S.K. 1967. Effect of gamma radiation on some perennial ornamentals. *Indian J. Genet. Plant Breed.* 27 (3) : 417–422.
- Desai, B.M. 1974. New cultivars of perennial *Portulaca* through gamma radiation. *Indian J. Hortic.* 19 (2) : 19–23.
- Gupta, M.N. 1970. Use of gamma irradiation in production of new varieties of perennial *Portulaca*, pp. 206–214. *In Proceedings of the Symposium on Radiation and Radiomimetic Substances in Mutation Breeding.* Food and Agri. Comm. Dept. of Atomic Energy, Bombay.
- Lata, P. and M.N. Gupta. 1971. Morphological and cytological studies on gamma ray induced mutants of perennial *Portulaca grandiflora*. *Jpn. J. Breed.* 21 (3) : 121–128.
- Ootani, S. and T. Hagiwara. 1969. Inheritance of flower colors and related chymochromic pigments in F₁ hybrids of common portulaca, *Portulaca grandiflora*. *Japan J. Genetics.* 44(2): 65–79.
- Wongpiyasatid, A. and N. Roongtanakiat. 1992. Effects of gamma radiation on flower colors and types of perennial *Portulaca grandiflora* Hook., pp. 695–704. *In the 30th Kasetsart University Conference Proceedings, Bangkok, Thailand (In Thai with English abstract).*

Received date : 29/05/00

Accepted date : 14/09/00