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Cyto Agronomical Variation in Yield and Yield Components in M_4 Generation of Pea (*Pisum sativum*)

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Abstract: Cyto-agronomical variations were studied in M_4 generation of peas and the seeds were irradiated and passed to M_4 generation. The doses were 10, 15, 20, 25, 30, 35 40, 45,50,55,60 Krads. The variation were significant both in agronomic and cytological traits. Maximum pollen fertility (94.00%) was noted in 40 and minimum (75.67%) in control plots. High germination percentage (96.50%), tallest plants (103.00 cm), minimum grain per pod (4.351), maximum days to edible maturity (134.7 days), were noted in control. High fresh yield, (17.50 t ha^{-1}), maximum grains per pod (6.55), maximum pod length (10.33 cm), were noted in 40 Krads. Dwarf plants (66.67 cm), and early flowering (81.33 days), were found in generation of 5 Krads.

Key words: *Pisum sativum*, cyto-agronomical variation, M_4 generation

Introduction

Genes express to morpho logy/agronomy (phenotypes) through environment str esses and changes occur due to interaction of genotype and ecology. Chromosomal interchanges have induced by a variety of physical and chemical mutagens. On the whole, the physical mutagens seem to induce more mutation than the chemical mutagens. X-rays treatments induced interchange resulted in the formation of hexavalents/octavalants and sterility of the plants, but multiple interchanges occurred by treating seeds with gamma rays as reported by Krishnaswamy and Ayyangar (1941).

Radiation may be the easiest/shortest way to modify the hereditary apparatus and hence appear in plant canopy. Recessive gene expression, deletion, translocation and point mutation are direct results of irradiation.

Pea was grown over an area of 1190 hacters, produces 6185 tones fresh with average yield of 5.20 t ha^{-1}. In Swat, pea was sown over an area of 500 ha, which gave a total production of 3610 tones and average yield 7.22 t ha^{-1} was obtained (Agric. Stat. NWFP, 1997-98). One of the major goal of any plant improvement programs is to increase profitability of the crop. Since yield is the major component of profitability, improvement in yield is a major concern in developing new pea cultivars.Various crop improvement procedures e.g. introduction, selection and mutation are used to improve the yield potentials.

Mutation of crops to alter their genetic make up and seek favourable changes to improve the yield potential and certain desirable characters is a common feature of research work all over the world.

Saleem (1984) irradiated two cultivars of mungbean i.e. 71-71 and 6601 with 10,20,30,60 and 80 Krad of gamma-rays and reported significant reduction in plant height, number of branches per plant, number of grains and 100 grains weight. The biological injury increased with the corresponding increase in dosage and was directly proportional to the intensity of dosage. Lower doses to 10 and 20 Kard proved to have stimulatory effects of characters like plant height, stem thickness, pod length and number of grains per pod. The effect of 40 Kard, however, were not uniform, showing either stimulating or inhibitory effects, while higher doses of 60 and 80 Kard showed results in negative direction except 100 grain weight and days to maturity.

Krishnaswami *et al*. (1983) reported that the number of pods and clusters generally increased, while the plant height of mungbean reduced with varying doses (10-40 Krad) of irradiation.

Nalampang *et al*. (1982) irradiated seeds of mungbean with gamma-rays and observed that with the successive increase in dosage, the emergence, plant height and number of nodes were correspondingly decreased in M_1 generation. On the other hand, number of branches increased with 0 to 60 Krad and remained steady between 60 and 90 Krad. The maximum pod number per plant was obtained at 60 Krads. Similarly in black gram plant height and germination were decreased with the increase in dosage of gamma-rays.

Khan and Shakoor (1982) treated dry seed of *Phaseolus aureus* Var. G-65 with eight doses of gamma-rays ranging from 0-40 Krad and the M_1 M_2 and M_3 generations were evaluated for yield and five yield components and observed greatest variability in M_2 for yield, number of branches, number of pods and 100 seed weight.

Kurepin *et al*. (1981) reported that the air dried seed of elite inbred from Co_{60}. M_2 progeny was obtained from 50 M_1 plants phenotypically resembling the original cultivar. In all cases, the cultivars were greater in boll weight, fibre yield, length and seed weight than untreated. Some favourable mutations were found with yield of 91-100 grams per plant.

Khanna and Chandni (1981) observed the effect of gamma-rays on morphological characters of chickpea such as plant height, pod length, number of seeds per pod, 100 seeds weight and yield per plant were affected by ionizing radiation in the M_1 generation. In some cases small doses of gamma irradiation from 5 Krad to 10 Krad were stimulatory, thereby, increasing yield while higher doses were inhibitory.

Dwivedi and Pandy (1981) in M_1 and M_2 generations of irradiated soybean observed mutants differing significantly from the control population for days to flower, days to maturity, plant height, 100 seeds weight, yield per plant, seed per pod and protein percent. Some of the mutants had desirable qualities like early maturity, dwarfing, more pods per plant, high 100 seeds weight, higher yield, more oil and protein as compare to control.

The objective of the experiment was to study cyto agronomical variation in yield and yield components in M_4 generation of Pea (*Pisum sativam* L.).

Materials and Methods

The research project was carried out at the Agriculture Research Station (North) Mingora Swat, during the year 1998-1999. Seeds of land race variety, Swat local, of peas was irradiated with 5,10,15,20,25,30,35,40,45,50,55 and 60 Krads of gamma rays from Co_{60} at NIFA, Peshawar. The seeds were passed to the present status (M_4) through progeny production under natural condition.

The study was laid out in Randomized Complete Block Design.

Plot size was kept 3 x 2 m^2. Rows and plants spacing were kept as one meter and 10 cm respectively. Data were recorded on germination, days to Ist flowering, height at edible maturity, days to edible maturity pod length, No. of grains/per pod, pods kg^{-1}, , fresh yield (t ha^{-1}), and pollen fertility. The data were analyzed statistically and means were separated by LSD test, as given in the Tables 1,2 and 3.

Results and Discussion

Agronomical Parameters

Germination percentage: Germination was recorded after 14 days of sowing when all the seedlings were emerge. The number of seedlings emerged within each treatment were counted and the data thus obtained were converted into germination percentage according to the following formula:

$$\text{Germination \%age} = \frac{\text{Germinated seeds}}{\text{Total seeds sown}} \times 100$$

The data recorded on germination percentage are given in Table-1. The analysis of variance showed that there was no significant difference in germination due to lines. However, mean values for lines revealed that maximum germination 96.50% took place in control while minimum (79. 17%) was observed in K45. Irradiation decrease germination percentage. But the effect was not co-related to radiation doses. The injury caused by radiation doses should be higher for higher doses. Actually there was no such condition and the viability was not dependent. The result is in agreement with Chaudhary and Haq (1976), who worked on soybean and reported reduction in percent germination and delay in maturity.

Average Days to First Flower Initiation : The data recorded on days to first flower initiation are given in Table-1, The analysis of variance showed that days to first flower initiation was highly significant due to lines. Maximum days (103) to flowering were recorded in control while minimum days (81.33) were recorded in K5. It was clear that mutation has decreased the time required to reach in flowering stage in all mutants.
The results are in agreement with Akilov (1970), who worked on soybean and early and late in flowering habit of soybean.

Average Plant Height at Pod Edible Maturity: The data recorded on plant height at edible maturity is given in Table 1. Maximum plant height (88.67 cm) was observed in control while minimum plant height (66.67 cm), was observed in K5. Decrease in plant height at edible maturity showed that there is a considerable variation in plant height in mutants but all were dwarf than control, indicating that irradiation with Co_{60} has decreased plant height of the original variety. The results are in agreement with Shakoor *et al.* (1979) who worked on mungbean and reported 5 out of 6 varieties in M_4 generation shorter than parents. The results are also in agreement with Monti and Donini (1968), they reported decrease in plant height at edible Maturity.

Average Number of Days to Edible Maturity: The data recorded on average days to edible maturity is given in Table 2, which showed that maximum days to edible maturity (134.7) were recorded in control while minimum days to maturity (121.3) were recorded in K60. Decrease in days to maturity is a positive change in pea crop .In mountainous region of the NWFP. The results are in agreement with Saleem (1984), who worked on peas and reported earliness in maturity in some lines in M_4 generation.

Average Podsr kg^{-1}: The data recorded on average pods per kg^{-1} is given in Table-2, and showed that maximum pod kg^{-1} (483.3) were observed in control, while minimum (248.7) in K40. Decrease in pod kg^{-1} due to radiation is a positive change, because pod size was increased due to mutation. One of the main causes in reduction of pods per kg^{-1} was the higher pod length of the irradiated lines.

Average Number of Grains Per Pod: The data recorded on average grains per pod are given in Table 2. The analysis of variance showed that average grains per pod is highly significant due to lines. Maximum grains per pod (6.55) were recorded in K40, while minimum grains per pod (4.35) were recorded in control. The number of grains per pod is important character because grains are the edible part. There is significant variation in number of grain per pod in the mutants as well as in control indicating that this character is affected by level of irradiation. The results are in agreement with Kale *et al.* (1980) who worked on cicer aurientinum N-59 and reported positive association of number of seeds per pod with yield.

Average Pod length: Maximum pod length (10.33 cm) was observed in K40, while minimum pod length (7.0 cm) was

Table 1: Showing mean values for germination percentage, days to flower initiation and height at edible maturity of peas mutant lines.

Lines	Means		
	Germination % age	Days to Ist flower	Height at edible maturity
K5	87.50 BCD	81.33 F	66.67 D
K10	85.17 CDE	83.33 DE	69.67 D
K15	88.33 BCD	84.33 CD	67.33 D
K20	80.83 E	85.33 C	71.33 CD
K25	90.00 ABC	83.33 DE	81.00 B
K30	82.50 DE	87.00 B	79.33 B
K35	90.33 ABC	85.33 C	76.33 BC
K40	90.33 ABC	85.33 C	75.67 BC
K45	79.17 E	83.67 D	68.67 D
K50	87.50 BCD	83.33 DE	69.33 D
K55	91.67 ABC	82.00 EF	69.33 D
K60	92.00 AB	82.00 EF	79.33 B
Control	96.50 A	103.00 A	88.67 A
LSD	6.568	1.641	5.765

LSD for Lines at 5% level of significance

Table 2: Showing mean values for days to edible maturity, No of pods kg^{-1} and No of grains per pod.

Lines	Means		
	Days to edible maturity	Pod kg^{-1}	Grains per pod
K5	122.0 D	478.3 A	5.23 FG
K10	121.7 D	374.3 E	5.42 DE
K15	121.7 D	314.3 I	6.33 B
K20	123.7 CD	303.3 J	5.63 C
K25	122.3 D	427.0 B	5.18 G
K30	128.0 B	323.3 H	5.38 DEF
K35	125.3 BC	338.0 G	5.49 CD
K40	125.3 BC	248.7 K	6.55 A
K45	126.0 BC	412.3 C	5.14 G
K50	127.7 B	365.7 F	4.65 H
K55	126.0 BC	377.3 E	4.52 H
K60	121.3 D	386.7 D	5.30 EFG
Control	134.7 A	483.3 A	4.35 I
LSD	2.692	6.595	0.1698

at 5% level of significance

Table 3: Showing mean values for average pod length, Yield Tons/ha and Pollen Fertility.

Lines	Means		
	Pod length	Yield t ha^{-1}	Pollen fertility
K5	9.67 B	10.67 F	78.67 I
K10	8.17 EF	10.23 F	76.33 J
K15	7.00 H	12.22 E	81.33 H
K20	7.33 GH	13.99 D	87.00 D
K25	8.50 DE	13.62 D	84.67 F
K30	7.33 GH	14.86 BC	89.33 C
K35	9.33 BC	15.11 B	78.00 I
K40	10.33 A	17.58 A	94.00 A
K45	8.50 DE	12.89 E	83.67 G
K50	7.83 FG	14.18 D	86.00 E
K55	8.67 DE	14.06 D	83.33 G
K60	8.83 CD	14.22 CD	92.33 B
Control	7.67 FG	10.66 F	75.67 J
LSD	0.5215	0.6710	0.6969

5 % level of significance

observed in K15 (Table 3). The results are in agreement with Shakoor *et al*. (1978) and Debelyj (1968) who worked on peas and reported that most of the mutants suppressed its parents in length of pods and plants in M_2 generation.

Fresh yield (t ha^{-1}): The data recorded on yield (t ha^{-1}) are given in Table 3, The analysis of variance showed that yield t ha^{-1} was highly significant due to lines. Maximum yield (17.58) that was recorded in K40, while minimum yield (10.23) was recorded in K10, followed by the control. Increase in yield per hectare can be predicted from performance on other parameters, K5 and control are comparable while K40 was the highest yielding mutant. The results are in agreement with Shakoor *et al*. (1979), who worked on *Vacia feba* varieties Giza-2 and Rebaya-40 and reported increase in no. of tillers, pods per plant, seed yield and seed weight in the M_3 generation, in both the varieties.

Cytological Studies: For the studies on pollen fertility of Peas lines (K5, K10, K15...K60) the matured flower buds with undesisced anthers were collected from Agricultural Research Station (North), Mingora, Swat and were fixed in fixative as acetoalocohol (1:3) solution overnight. The floral buds were then transferred and stored in 70% ethanol at room temperature. The underside and matured anthers were then ruptured and pressed in a drop of acetocarmine on the microscopic slide, covered with glass cover slip and then pollens were observed under microscope for pollen fertility.

Pollen fertility: The data given in Table-3 revealed that maximum pollen fertility (94%) was recorded in K40, while minimum pollen fertility (75.67%) was recorded in control one. It means pollen fertility increased with radiation. The results are in agreement with Malavia and Shukla (1984) reported that pollen fertility ranged between 66-87% in different lentil plants. Awasthi and Dubey (1985) reported that viable pollens were fully turgid and were stained uniformly by acetocarmine or iodine, while sterile pollens, which do not have any cytoplasm content fail to pick up the stain.

The analysis of variance showed that pollen fertility is highly significant due to lines. The progenies of K40 were segregated for yield and yield components and at M6 (2000) a line was selected and submitted to Federal Seed Certification and Registration Dept., for Registration under the name of DASAN as a mutant variety of pea.

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