USE OF INDUCED MUTATIONS FOR POTATO IMPROVEMENT*

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Abstract

The investigations aim at the utilization of induced mutations for potato improvement. The effect of x-rays was tested on selfed seeds and hybrid seeds as well as on tubers of several potato varieties. Chemical mutagens have been successfully employed to produce daylength neutral clones. An attempt to induce resistance against Pseudomonas solanacearum did not give conclusive results.

Potato improvement in relation of yield and other characters of economic significance like maturity and attributes of tubers has been handicapped by several technical considerations world over. The crux of the problem lies in the narrow genetic base (variability) for potato breeders to work with. The use of mutation breeding, therefore, offers a good tool for this. Improvement by mutation breeding for the quantitative characters besides the resistance to disease and pest has been demonstrated in other crops like white mustard variety Primex (Anderson and Olsson, 1954), barley (Gustafsson, 1965) and peanut (Gregory, 1956). Keeping these in view and the success we had in isolating photoperiod insensitive types (Upadhaya et al, 1973, 1974) study was enlarged to use mutagens to increase as wide a spectrum as possible of the variability for quantative and qualitative characters.

I. EFFECT OF GAMMA RADIATION

Seeds of three selfed hybrids and two crosses were irradiated with 2, 4, 5, 6, 8 and 10 Kr doses of gamma rays (Co 60 source). The population was scored for maturity, vigour, leaf shape, variegation and various morphological abnormalities. Chlorphyll mutants and plants with entire single leaf have been found in high

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frequency in the irradiated population. Matruity behavior was also influenced. The tendency was to produce some early types. It was observed that the response depended upon the genetic architecture as well as the dose of radiation. Thus the maximum effect was observed for tuber shape with 4 Kr. in the selfed population of Hybrid A-2235, 8 Kr. in Kufri Lovekar and 2 Kr. in Hybrid EM/F 2128. Changes in skin colour, depth of eyes and texture of skin were also recorded. The range of variability was comparatively large for characters like tuber shape, tuber size and texture of skin. The tuber skin colour has given a very low frequency of alterations. Populations raised from irradiated hybrid seeds showed more abnormalities.

After irradiation of tubers, 5 Kr gave 50 to 70 percent survival rate but near maturity it was reduced to 24 to 63 percent showing progressive lethality. The dose of 10 Kr and 15 Kr proved to be lethal. High doses of radiation were associated with different types of abnormalities like formation of aerial tubers, swollen nodes, stunted growth, etc. The tuber characters exhibited changes in shape, skin colour, depth of eyes and eyebrow types. Tuber characters were found less sensitive to mutagens in varieties Kufri Lovkar, Kufri Alankar and Kufri Sheetment. The recovery of plants with parental morphology has been highest in Kufri Lovkar and Kufri Chandramukhi showing thereby that these varieties may be more radioresistant. Some of the variants obtained in the present study are hoped to be of more economic potential than the parents.

II. USE OF CHEMICAL MUTAGENS FOR INDUCING DAY NEUTRAL AND DISEASE RESISTANT CHARACTERS IN POTATO

(a) Behaviour of day netural mutants obtained by Hydrazine treatment MV_1 to MV_3 generations

Upadhya et al (1973) outlined the screening procedure for physiological efficiency in potato and later (1974) described isolation of day neutral mutants through NMU and Hydrazine treatment. This report summarizes the yield behaviour of these selections isolated from hydrazine treatment under long photoperiod (summer) in the temperate region of India (Table 1).

Table 1. Yield behavior of day neutral mutants of variety 'OT' (MV_1 to MV_3 generation)

Year	Generation	Treatment	Yield Range in GMS/Plants (Average of four Replications)				
			101-200	201-300	301-400	400-above	Total Population
1972	MV1	0.01 M	16	39	14	5	74
1973	MV2	0.01 M	37	25	9	1	73
1974	MV3	0.01 M	12	33	22	4	71
1972	MV1	0.001M	57	13	4	1	75
1973	MV2	0.001M	57	12	1	2	72
1974	MV3	0.001M	12	40	19	4	75

The analysis of data indicated that among these selections of 'OT' were better yielding types as well. The yield range obtained in these for MV1 to MV3 generations are given in Table 2.

Table 2. Yield behavior of high yielding day-neutral selections

Mutant No.	Yield in GMS/Plant in Generation & Year		
	MV1 (1972)	MV2 (1973)	MV3 (1974)
Treatment 0.01 M			
22-3	235	175	379
29-2	389	233	350
34-2	285	146	232
35-1	408	165	172
71-1	340	150	492
Treatment 0.001M			
17-1	290	187	432
94-2	450	149	356
128-1	165	113	354
153-3	145	154	208
156-1	256	83	208
170	141	105	240

N.B. The crop was severely damaged by late blight in 1973.

The mutants were screened again for day neutral behaviour to confirm the previous observations. The population is now being planted under short photoperiod in subtropical plains of India to study their yield behaviour.

(b) Use of mutagens to increase the frequency for better resistance to brown rot (Pseudomonas solanacearum) in the resistant selections of potato.

Brown rot is among the most damaging diseases of potato in mid- and high-hill altitudes of India. Sources of resistance have been located in Solanum phureja and Solanum papita and already some hybrids between Solanum tuberosum haploids and these species showing a good degree of resistance have been selected. Study is in progress to increase the heritability for resistance and tuber characters by repeated hybridization between resistant selections and S. tuberosum varieties and selections. But, to accelerate the range of variability in the resistant selections and isolate more resistant types, the selfed seed of nine/seven of these hybrids were irradiated with 10 Kr, 20 Kr and 30 Kr of gamma rays (Co 60 source) and treated with 20 ppm solutions of EMS and NMU for one hour and two hours duration for each.

The treated seeds were sown in pots and a population of 12415 seedlings was inoculated with bacterial suspension (brown rot bacteria multiplied in nutrient beef-peptone broth). The surviving seedlings in the RO and MVO generation were harvested and checked for any subsequent infection of brown rot. These resistant selections were planted next year and reinoculated with bacterial suspension by needle price method. Those surviving the infection of R_1 and MV_1 generation were considered highly resistant. The data on the study is presented in Table 3 and 4.

It cannot be concluded from the preliminary data if irradiation or chemical mutagens have been able to increase significantly the percentage of the resistant seedlings clones. It is considered, however, that the resistance to brown rot is controlled by polygenes and with the method described here it may be possible to develop selections with high horizontal resistance.

Table 3. Recovery of brown rot resistant seedlings from gamma ray treated selfed seed of resistant hybrids

Selfed seedlings of hybrids		Recovery of resistant seedlings from treatments(in per-cent): Control		10 Kr		20 Kr		30 Kr	
		0	1	RO	R1	RO	R1	RO	R1
1.	BR/Am 4	5.4	2.3	15.0	6.7	5.5	1.4	1.7	1.1
2.	BR/Am 5	7.5	2.5	7.5	2.5	1.9	0.0	1.6	0.0
3.	BR/Am 10	0.8	0.0	3.3	2.2	2.2	0.0	1.5	0.0
4.	BR/Am 36	2.5	0.0	2.7	0.0	0.8	0.0	0.9	0.0
5.	BR/Am 81	13.3	5.6	0.0	0.0	16.8	2.6	12.1	2.3
6.	BR/Am127	6.2	1.5	5.7	2.1	6.3	0.2	3.6	0.0
7.	BR/Am10-1	17.5	2.5	28.3	11.7	21.7	6.7	10.0	3.3
8.	BR/Am42-13	40.7	14.8	26.3	10.0	15.0	5.0	25.0	16.7
9.	BR/Am242	5.6	2.2	7.6	2.9	1.3	0.0	0.0	0.0
	Average	11.1	3.5	10.7	4.2	5.9	1.8	6.3	2.8

Table 4. Recovery of brown rot resistant seedlings from EMS and NMU treated selfed seed of resistant hybrids

Selfed seedlings of hybrids	Recovery of resistant seedlings from treatments (in percent): Control		EMS-1 hr		EMS-2 hr		NMU-1 hr		NMU-2hr	
	0	1	MVO	MV1	MVO	MV1	MVO	MV1	MVO	MV1
1. Kufri Jyoti	2.2	1.1	3.1	1.1	10.2	7.5	2.7	2.0	8.2	6.0
2. BR/Am 4	8.7	4.7	0.0	0.0	8.4	2.1	0.0	0.0	0.0	0.0
3. BR/Am 10	0.0	0.0	0.0	0.0	3.6	2.1	0.0	0.0	0.0	0.0
4. BR/Am 81	4.9	0.0	0.0	0.0	15.4	1.3	3.1	0.8	2.9	1.5
5. BR/Am 127	0.0	0.0	0.0	0.0	5.2	2.0	0.0	0.0	0.0	0.0
6. BR/Am 10-1	9.1	1.8	7.0	3.0	15.0	6.7	1.8	0.9	7.5	3.8
7. BR/Am 42-13	3.0	1.2	0.0	0.0	13.0	3.9	0.0	0.0	2.6	0.0
Average	4.2	1.3	1.4	0.6	10.1	3.8	1.1	0.5	3.3	1.6

III. RADIATION IN BREEDING SUPERIOR POTATO VARIETIES

A mutation breeding programme in potato to improve the total yield and components of yield alongwith the tuber characters was started in 1973. The idea was to increase the genetic variability by exposing the true seeds (selfed and hybrid) to lower doses of gamma irradiation. The selection was made to eliminate undesirable genotypes by selecting the higher yielding progenies.

For this a random sample of irradiated selfed true seed progenis of two hyorids A 2235 and EM/F 2128 alongwith unirradiated selfed progenies of Kufri Jeewan, EM/F 2128 and JF 27 and three families of hybrid used derived from CP 1463 x A 2235, JF 27 x EM/H 68 and EM/C x CP 1468 crosses were initially subjected to selections for economic characters, and thereafter used for the present study.

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Yield and yield components i.e. number of tubers per plant and average tuber size per plant for all these were recorded in pot experiments. Genotypes having more than 50 gms. total tuber weight, five or more tubers per plant and average single tuber size weighing more than 10 gms. were found to be of higher proportion in EM/F 2128 (2 Kr) and in 2235 (8 Kr) as compared to the progenies derived from unirradiated selfed seed or seed of hybrid origin (Table 5).

It is planned to hybridise the high yielding selections in successive generations and expose such hybrid population in each generation to the same dose of irradiation.

Table 5. Comparative tuber weight, number and size in selections out of the selfed and hybrid seedling population treated with gamma rays and untreated.

	Material	Doses	Total seedlings	Plants from initial selection	Number of plants with : Tuber wt. above 50 gm	Tuber no. above 5	Tuber size above 10gm
.	A 2235 (selfed)	2 Kr	1068	60	19	50	9
		4 Kr	642	71	14	61	6
		8 Kr	1032	140	117	132	30
2.	EM/F 2128 (selfed)	2 Kr	714	56	45	43	35
		8 Kr	378	22	19	16	15
		10 Kr	306	2	2	1	1
3.	EM/F 2128 (selfed)	-	722	49	23	25	35
4.	JF 27 (selfed)	-	696	31	21	13	25
5.	Kufri Jeewan (selfed)	-	589	88	4	34	16
6.	CP 1463 x A 2235	-	493	81	1	24	3
7.	JF 27 x EM/H 68	-	554	120	22	56	4
8.	EM/C 1021 x CP 1468	-	224	78	13	28	39

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