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GENETIC VARIABILITY AND NATURE OF INTERGENERATION ASSOCIATION IN YIELD AND ITS COMPONENTS IN POTATO

JAI GOPAL,* P. C. GAUR AND M. S. RANA

Central Potato Research Station, Jalandhar, Punjab 144003

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ABSTRACT

The segregating population was studied for association between yield and its components within and between four successive generations. The normal and partial correlation coefficients showed that for tuber yield : 1) in the seedling generation, tuber number was more important than individual tuber weight; 2) in the first clonal generation, both tuber number and their weight were equally important; and 3) in the second and third clonal generations, tuber size was much more decisive than their number. But stability of the associations and intergeneration correlation coefficients showed that out of tuber weight and tuber number, both of which are positively associated with tuber yield but negatively among themselves, tuber weight could serve as a more reliable parameter of tuber yield.

Key words: *Solanum tuberosum*, potato, character associations, intra-and intergeneration associations, selection.

Character association study between yield and its components provides an idea which a plant breeder can effectively use for selecting a better plant type. Such studies in potato have been made by several workers. But most of these population studies consisted of advanced stage hybrids and varieties which had been selected for yield and/or other economic characters [1–3]. A few reports [4–6] where character associations have been studied in unselected populations, were confined to only one generation except Maris [6], who conducted it for three successive generations. The performance of potato genotypes in early stages is known to vary from generation to generation [7–10]. Thus, the pattern of associations between characters may also vary in these generations. In the present study, assocation between yield and its components were studied within and between four successive generations.

*Present address: Biotechnology Centre, Genetics Section, Punjab Agricultural University, Ludhiana 141004.

MATERIALS AND METHODS

The study was conducted at the Central Potato Research Station, Jalandhar (Punjab) for four successive autumn crop seasons. From the cross (EX/A 680-16 x composite pollen of Kufri Sheetman, QB/B 47-61, QB/B 77-1 and QB/A 15-14), 2500 seeds were sown in wooden trays containing 1:1 mixture of compost and sand. Twenty days after germination, 300 randomly selected seedlings were transplanted in polythene bags (5 x 10 cm size) containing 1:1 mixture of compost and sand. After another 20 days the seedlings along with soil balls were transplanted in field at a distance of 30 cm within and 60 cm between rows. The data were recorded on 135 random seedlings for four successive generations, i.e. F_1, F_1C_1, F_1C_2 and F_1C_3, respectively. Here C_1–C_3 indicate generations raised through clonal propagation.

Each clone was represented by a single row of four hills in F_1C_1, 12 hills in F_1C_2 and 15 hills replicated four times in F_1C_3. The spacings within and between rows were 20 and 60 cm, respectively. Within the limitation of number of tubers per clone, as far as possible, tubers of uniform size were used to raise the clonal generations. Normal manurial and cultural schedules were followed during the crop seasons.

Observations were recorded for tuber yield per plant, number of tubers per plant and average tuber weight on individual clones in all the generations studied. The mean performance of clones was used in computing the character range, coefficient of variation and intra- and intergeneration correlations between characters.

RESULTS AND DISCUSSION

The range and coefficient of variation (Table 1) showed that large variability was present for all the three characters, i.e. tuber yield/plant, average tuber weight, and number of tubers/plant in all the generations. However, the variation was higher in F_1 seedlings than in the subsequent generations. This may be because number of replications (plants) per genotypes increased in clonal generations resulting in decrease in variability of characters due to environmental effects in these generations. Analysis of variance conducted with F_1C_3 material showed highly significant genetic variability for all three characters.

INTRAGENERATION ASSOCIATIONS BETWEEN CHARACTERS

Normal correlation coefficients. Both tuber number and tuber weight had positive and significant association with tuber yield (Table 2) in all the generations except in F_1C_2 where correlation coefficient between tuber number and tuber yield was nonsignificant, but still positive ($r = 0.05$). Tuber number showed significantly negative association with tuber size (weight) in all the generations except in the seedling generation where it was nonsignificant but positive ($r = 0.02$).

Partial correlation coefficients. The partial correlation coefficients (Table 2) between tuber number and yield (after eliminating the effect of average tuber weight) and between tuber

Table 1. Range and coefficient of variation (CV) of economic traits in different generations of potato

General	Tuber yield/plant		No. of tubers/plant		Average tuber weight	
	range (g)	CV (%)	range	CV (%)	range (g)	CV (%)
F_1	2–1015	85.8	2–78	77.4	0.6–47.5	65.7
F_1C_1	48–535	36.2	7–40	38.0	6.3–35.2	37.5
F_1C_2	87–620	25.3	8–72	38.9	4.9–47.8	35.3
F_1C_3	92–650	25.7	5–31	30.5	14.0–63.6	29.5

weight and yield (after eliminating the effect of tuber number), were significantly positive in all generations. These correlation coefficients were higher than the corresponding normal correlation coefficients, suggesting that variation for tuber weight lowered the normal correlation coefficients between tuber number and yield and variation for tuber number lowered the normal correlation coefficients between yield and tuber weight. The partial correlation coefficients between tuber number and weight after eliminating the effect of tuber yield were significantly negative in all generations.

The magnitude of normal and partial correlations between tuber number and yield, and between yield and tuber weight in different generations (Table 2) showed that 1) tuber number was more important than tuber weight for tuber yield in the seedling generation, 2) both tuber number and their weight were equally important in the first clonal generation and 3) tuber weight was much more important than the tuber number in the second and third clonal generations. These findings differ from those of Maris [6], who reported that tuber number and weight were almost equally important for total tuber yield in the seedling and second clonal generation and tuber number was much more decisive for higher tuber yield than tuber weight in the first clonal generation. The cause of difference may be the fact that Maris [6] raised seedlings in pots under greenhouse conditions, whereas in the present study, seedlings were grown in field under normal crop conditions. The correlation coefficients are known to change under the impact of environment [1, 3].

Table 2. Intrageneration associations between characters in potato

Generation	Nature of correlation coefficient	Correlation coefficient between characters		
		tuber No. and yield	tuber wt. and yield	tuber No. and tuber wt.
F_1	Normal	0.70**	0.50**	0.02
	Partial	0.80**	0.67**	−0.53**
F_1C_1	Normal	0.41**	0.45**	−0.46**
	Partial	0.79	0.80**	−0.34**
F_1C_2	Normal	0.05	0.59**	−0.52**
	Partial	0.38**	0.99**	−0.62**
F_1C_3	Normal	0.20*	0.54**	−0.38**
	Partial	0.52**	0.68**	−0.34**

*,**Significance at P = 0.05 and 0.01, respectively.

The stability of correlation parameters between tuber number and

yield varied from generation to generation (r = 0.05 to 0.7) whereas those between tuber weight and yield were more or less consistent (r = 0.45 to 0.49). This indicated that for tuber yield, average tuber weight would serve as a more reliable parameter than their number.

INTERGENERATION ASSOCIATIONS BETWEEN CHARACTERS

The correlations between tuber weight in a generation and yield in subsequent generations and vice versa were positive (Table 3). The magnitude of correlation coefficients varied from low to moderate (r = 0.17 to 0.48). These were significant except that of tuber yield in F_1 with tuber weight in F_1C_1 and F_1C_2, where these were non significant. This means that genotypes with larger tubers are generally expected to display high yield potential in all subsequent generations.

The correlation coefficient (Table 3) between tuber number in a generation and tuber yield in subsequent generations and vice versa were non significant except between tuber number in F_1 and tuber yield in F_1 C_3, where it was significant. Thus, tuber number in a generation has generally no bearing on tuber yield in subsequent generations.

Table 3. Intergeneration associations between characters in potato

Character pair	Correlation coefficients between generations					
	F_1 vs. F_1C_1	F_1 vs. F_1C_2	F_1 vs. F_1C_3	F_1C_1 vs. F_1C_2	F_1C_1 vs. F_1C_3	F_1C_2 vs. F_1C_3
No. of tubers–yield	0.12	0.16	0.23*	0.00	0.01	−0.03
Yield–No. of tubers	0.07	−0.03	−0.12	−0.02	−0.01	0.16
Av. tuber wt.–yield	0.29**	0.17*	0.24**	0.45**	0.40**	0.31**
Yield–Av. tuber wt.	0.16	0.04	0.38**	0.26**	0.31**	0.48**
No. of tubers–tuber wt.	0.07	0.09	0.10	−0.34**	−0.30**	−0.41**
Av. tuber wt.–No. of tubers	−0.12	−0.18*	−0.18*	−0.34**	−0.26**	−0.22*

*,** Significant at P = 0.05 and 0.01, respectively.

Note. The first mentioned character in first column corresponds with the first mentioned generations (upper) in the subsequent columns.

Intergeneration correlation coefficients between tuber number and tuber weight were negative, low to moderate (r = –0.18 to –0.41) and significant. However, there was no correlation between tuber number in F_1 and tuber weight in later generations. Thus tuber number and tuber weight generally affected each other adversely.

In conclusion, tuber weight is a better parameter than tuber number to assess tuber yield. Genotypes with high average tuber weight would have high yield not only in that very generation but also in the subsequent generations whereas genotypes with more number of

tubers in a generation may not have high yield in the subsequent generations. However, due to negative association between number of tubers and average tuber weight, number of tubers as selection parameter cannot be ignored totally, otherwise, it may result in the retention of genotypes with over size and fewer number of tubers. To overcome this problem, it is suggested that a standard be fixed for the minimum number of tubers required in the selected types, before employing average tuber weight as selection parameter for high yield.

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