MASS SELECTION FOR SEED YIELD IN *TORIA*

C. N. CHAUBEY[1]

Department of Plant Breeding, G. B. Pant University of Agric. & Tech., Pantnagar

TORIA (*Brassica campestris* var. *toria*) is a short duration crop taking about 90 to 100 days to mature. Therefore, it fits well in multiple cropping programme. However, its yielding ability (with less than 5 quintals seed per hectare) is poor. Therefore, the foremost problem is to improve the existing yield level of this crop. Early attempts to enhance the seed yield level of heterogeneous *toria* through (mass) selection failed to achieve significant progress because efficient field plot techniques to pick up genotypically desirable plants and selection under controlled condition of cross-pollination were not available. Gardner (1961) utilized stratified sampling during selection of corn plants. He selected 10 percent highest yielding plants from each of equally sized sectors to produce next generation. By doing so, environmental variation among selected plants got minimized with the result that selection became more effective. Mohammad and Sikka (1941) suggested group breeding method for the improvement of self-incompatible cross-breeding crops. They suggested growing selected plants under insect-proof mosquito-netted cages, using honey-bees within cages for random cross-pollination among selected plants. By this method, frequency of favourable genes sampled in the selected material is kept stable. In the present investigation, these two improved techniques were adopted in order to bring about faster rate of improvement in seed yield of heterogeneous *toria* crop through two cycles of selection.

MATERIALS AND METHODS

Initially, Gardner's modified technique of mass selection was applied to select plants from five different field of *toria* each measuring twenty acres or more. In second year, open pollinated (O. P.) progenies of plants were grown in two replications. One hundred seventy six progenies whose plants revealed normal stand, good fruit set, synchronous maturity and freedom from diseases and insects were divided into following five groups on the basis of their height and maturity: (i) EN, early maturity (90 days and below), normal height (below 75 cms.); (ii) MN, medium maturity (above 90 days to 100 days) normal height. (iii) MT, medium maturity, tall (above 75 cms.). (iv) LT, i.e. late maturity (above 100 days), tall. (v) LN, late maturity, normal height.

The average seed yield of all these progenies were arranged in ascending order within each group and top entries were selected (Table 1). Equal amount of remnant seeds of selected parent plants within each group was pooled and grown next season in five different plots each of 2·5 × 3·0 meters. In order to ensure controlled cross pollination among the selected genotypes within each group, each plot was covered with 1·8 meter high mosquito-net cages two days before flowering, each cage containing three frames of honey bees. At maturity all the plants, except 15 vigorous, disease free and higher yielding ones,

[1]Present address: Department of Plant Breeding and Genetics, C. S. Azad University of Agriculture and Technology, Kanpur-208 002.

TABLE 1—*Grain yield of open pollinated progenies of selected plants*

Group	Distribution of progeny yields in grams						Total number of progenies	Number of selected progenies	Average of all the progenies	Average of selected progenies
	50–70	71–90	91–110	111–130	131–150	151–170				
EN	3	10	2	—	2	—	17	6	88·6	108·0
LT	4	16	24	4	2	—	50	10	94·0	122·7
MN	5	6	18	8	2	2	41	10	102·0	131·6
MT	2	12	24	15	5	1	59	10	105·6	140·6
LN	1	3	3	1	1	—	9	6	98·0	99·7
Total	15	47	71	28	12	3	176	42	97·64	120·52

TABLE 2—*Mean squares for six different characters*

Source	D.F.	Yield		Plant height		Maturity		Number of siliquae per plant		No. of seeds per siliqua		1000 seed weight	
		Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
1	4	2·56**	0·80	216·51**	545·48**	44·70**	21·60**	659·82	152·0	2·10	1·47	0·75**	0·15*
2	4	1·98**	2·12	418·81**	436·33**	34·4**	20·0**	956·1	415·83*	7·87**	1·93	0·31**	0·51**
3	1	0·44	0·14	6·48	1·37	19·6	1·23	138·06	4·90	9·63*	1·72	0·004	0·29*
4	1	0·08	0·64	4·35	477·41**	18·0	28·13**	0·50	690·06*	1·44	0·50	0·06	0·001
5	1	0·21	0·02	100·30	40·30	30·6	2·45	282·13	1·39	2·30	0·69	0·50**	0·80**
6	63	0·28	0·49	29·47	42·76	12·09	4·03	433·0	159·53	1·99	1·18	0·039	0·066

Y_1=First year; Y_2=Second year; *and **=significant at 5 and 1 percent levels of probability, respectively.
+1. Between groups within first cycle 2. Between groups within second cycle 3. First cycle vs. second cycle of selection vs To 4. Base population 5. Checks vs. selected groups 6. Error.

were harvested group wise. The harvested seeds represented first cycle (C_1) selected material. The remaining 15 plants showing similarity in height and maturity as specified to each respective group were harvested and their seeds pooled and multiplied in 1967 under insect proof mosquito-net cages. Thereafter seeds were harvested which represented second cycle (C_2) selected population.

The performance of all the groups in both the cycles of selection along with the checks, base population (C_0) and standard variety, T9, was evaluated for two consecutive years, in a randomized block design with four replications. Henceforth each selected group is symbolised with 1 and 2 to represent first cycle and second cycle, respectively. Each experimental plot consisted of 3·5 m. long 5 rows which were 45 cm. apart. Plant to plant distance was 8 cm. Twelve plants were randomly chosen from middle rows and observations were recorded on seed yield in grams, plant height in cms., maturity in days, number of siliquae per plant, number of seeds per siliqua and thousand seed weight in grams. The mean values for different characters of randomly chosen plants were subjected to statistical analysis of variance.

Results

As evident from Table 2 groups within cycles differed significantly for seed yield in first year and for plant height, maturity and thousand seed weight in both the years. On the other hand, they mostly showed non-significant differences in case of number of siliquae per plant and number of seeds per siliqua.

The average values for different characters have been presented in Table 3. In first cycle, EN (in first year) and MN (in both the years) yielded significantly higher than remaining groups, but in second cycle MT was significantly superior to all other groups including base population and 'T 9'. There was considerable amount of positive change for seed yield from C_0 to C_1 in MN group. The group, EN_1 also exhibited somewhat similar response to selection. This positive change in seed yield was associated with corresponding changes in 1000 seed weight and number of seeds per siliqua. Both these groups in first cycle were found significantly earlier in maturity than their base population (C_0). EN_1 was significantly shorter than C_0. However, MN_1 did not show such change in plant height. In the second cycle, seed yield of both these groups was significantly reduced. This was accompanied with reduction in thousand seed weight and seeds per siliqua. Their plant height and maturity did not change much from C_1 to C_2. The response to selection as observed with the EN and MN groups was found to be reversed in case of MT group in each cycle. This group showed negative response in first cycle but positive response in second cycle. The remaining two groups, LT and LN which were late in maturity showed negligible response to selection.

On comparing the mean values of all five selected groups in each cycle (Table 4), it was observed that the net genetic gain in seed yield from base population (C_0) to first cycle and from first cycle to second cycle over both years was 1·4 and 3·6%, respectively. However, these positive changes in seed yield were not significant. Significant positive changes were noted in thousand seed weight (in both years) and seeds per siliqua (in first year) from C_0 to C_1. Their performance in second cycle declined. Duration of maturity was somewhat reduced from C_0 to C_1.

Discussion

In the present experiment, considerable amount of variability was present among selected groups in both the cycles for seed yield, plant height, maturity and

TABLE 3

Average values of different characters in each group

Name of the groups	Seed yield (gms. per plant) Y_1	Seed yield (gms. per plant) Y_2	Plant Height (cms.) Y_1	Plant Height (cms.) Y_2	Maturity (Number of days) Y_1	Maturity (Number of days) Y_2	Siliquae per plant Y_1	Siliquae per plant Y_2	Seeds per Siliqua Y_1	Seeds per Siliqua Y_2	1000-seed weight Y_1	1000-seed weight Y_2
First Cycle												
EN	6·89	3·13	69·4	62·4	104·5	110·8	133·0	93·7	15·62	14·73	3·17	3·15
LT	5·63	3·65	85·4	93·2	112·0	116·3	124·0	131·0	14·27	15·20	3·02	3·07
MN	6·46	3·81	76·4	80·2	104·5	114·2	110·0	103·0	14·30	15·43	3·33	3·60
MT	5·17	2·76	85·2	76·8	105·5	113·8	137·0	101·0	13·75	13·93	3·16	3·39
LN	5·09	2·99	72·1	68·8	199·3	116·3	108·0	91·6	14·72	15·40	2·86	2·94
Second Cycle												
EN	5·81	3·26	70·1	64·2	108·0	112·0	134·0	114·2	15·07	15·70	2·79	3·04
LT	6·11	3·17	80·5	81·9	110·3	116·5	121·0	98·4	13·90	14·08	2·73	2·79
MN	5·81	2·72	86·6	79·1	103·8	112·5	160·0	91·1	12·05	14·45	2·92	2·91
MT	7·22	4·64	89·6	88·4	109·5	115·3	131·0	100·4	14·55	13·95	3·29	3·60
LN	5·36	3·16	66·1	66·1	111·3	116·8	125·0	87·9	12·15	14·45	3·09	3·29
Checks												
T_9	5·77	3·60	84·9	90·3	109·3	113·0	147·0	115·9	13·77	14·65	2·73	2·88
Co	5·97	3·03	83·3	73·4	113·3	116·8	121·5	97·3	12·92	14·15	2·81	2·89
C.D. (5%)	0·74	0·98	7·66	9·24	4·92	2·82	29·3	17·9	2·0	1·52	0·28	0·34
(1%)	0·98	1·30	10·20	12·30	6·54	3·75	38·9	23·75	2·66	2·02	0·37	0·45
C.V. (%)	9·0	20·9	6·7	8·2	4·21	1·75	15·9	12·7	10·2	7·49	6·3	7·6

TABLE 4

Response to selection averaged over all the five selected groups in each cycle

Characters	C_0		C_1		C_2		CD (5%) for C_0 vs. C_1 or C_2		C.D. (5%) for C_1 vs. C_2	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Seed Yield	5·97	3·03	5·85	3·29	6·06	3·39	0·57	0·76	0·33	0·44
Plant height	83·3	73·4	77·7	76·9	78·6	75·9	5·78	7·16	3·42	4·13
Maturity	113·3	116·8	107·4	114·8	108·4	114·6	3·81	2·19	1·88	1·26
No. of Siliquae per plant	121·5	97·3	122·8	114·1	97·3	98·4	22·72	13·84	13·11	7·99
No. of seeds per siliqua	12·92	14·15	14·53	14·95	14·15	14·53	1·55	1·18	0·89	0·68
1,000 seed weight	2·81	2·89	3·11	3·23	2·89	3·13	0·22	0·26	0·13	0·15

Y_1=First Year; Y_2=Second Year.

thousand seed weight. It is, therefore, evident that selection for seed yield along with grouping (based on height and maturity) was effective in evolving groups with different genetic make up. However, variability for number of siliquae and seeds per siliqua was limited among selected groups.

In certain groups, EN and MN, response to selection was positive from base population to first cycle and negative from first cycle to second cycle. These two groups EN and MN in the first cycle exceeded base population by about 11 per cent and 14 per cent, respectively. They were also significantly superior to other remaining groups selected in first cycle, but from first cycle to second cycle their performance declined by 9·5 per cent and 17 per cent, respectively. Therefore, the resultant gain by the end of second cycle was almost absent in these two groups. It has been well understood that mass selection works quite effectively under the preponderance of additive genetic variance (Hull, 1945; Robinson *et al.*, 1955, Lonnquist *et al.*, 1966 and Harris *et al.*, 1972). If non-additive components are prevalent, mass selection would not be so effective to bring any genetic improvement. It, therefore, appears that initial rapid gain in first cycle in the above two groups was due to increase in the frequency of non-additive genes which in second cycle segregated out resulting in the reduction of seed yield. The only group in which response to selection in second cycle was positive was MT group. It exceeded base population (C_0) by 31·8 per cent and T9 by 26·6% in seed yield. The selection with grouping, therefore, was found highly effective in this group only. Genes governing yield might have been tightly linked in this group. Intercrossing and recombinations among selected plants of this group might have released bound variability into free variability from which desirable combinations were sampled in second cycle. The genetic gain over all the groups was 1·4 per cent in first cycle and 3·6 per cent in second cycle. It, therefore, indicates that selection exclusive of grouping would dilute the genetic gain. Therefore, selection with grouping, as practised in present investigation, is at least advantageous in creating groups that showed homogeniety for plant height and maturity as well as in evolving rare groups (for example EN_1, MN_1 and MT_2) that revealed faster rate of genetic gain in one or the other cycle of selection. However, it revealed one disadvantage. The total genetic variability got divided and became restricted within some groups. Therefore, there was negligible response to selection in such groups.

In the present finding, selection for seed yield resulted in concurrent increase in number of seeds per siliqua and thousand seed weight in one or the other cycle of selection. Several workers, Singh *et al.* (1969) · Gopani and Kabaria (1970), Chowdhury and Chowdhury (1970), Pundir and Rai (1971) Zuberi and Ahmad (1973) have also reported seed yield to be positively correlated with the above two traits.

Summary

In the present findings, five groups of *toria* population formed on the basis of plant height and maturity were subjected to two cycles of selection for seed

yield. Groups showed considerable amount of variability among themselves for seed yield, plant-height, maturity and test weight. The selection for yield was effective in two groups (EN and MN) in first and only in one group (MT) in second cycle. Selection with grouping offered two advantages: faster rate of genetic gain in certain groups and partitioning of population into different homogeneous groups. However, there was one disadvantage and it was that the total genetic variability became limited and restricted within some groups resulting in little or no scope for future selection work. Number of seeds per siliqua and thousand seed weight appeared to be important yield contributing characters.

ACKNOWLEDGEMENTS

The author is grateful to the Director, Experiment Station, G. B. Pant University of Agric. and Tech., Pantnagar, for the financial assistance and necessary facilities during the course of investigation. Valuable suggestions and guidance of Dr. R. L. Paliwal is also acknowledged with gratitude.

REFERENCES

Chowdhury, R. K. and J. B. Chowdhury. (1970). Studies on variability and correlation in some varieties of *brown sarson*. *J. Res. Punjab Agri. Univ.* **7**(3): 296–300.

Gardner, C. O. (1961). An evaluation of effects of mass selection and seed irradiation with thermal neutrons on yield of corn. *Crop Sci.*, **1**: 241–45.

Gopani, D. D. and M. M. Kabaria. (1970). Correlation of yield with agronomic characters and their heritability in Soybean, *Glycine max* (L) Merrill.). *Indian J. agric. Sci.*, **40**(10): 847–53.

Harris, R. E., C. O. Gardner and W. A. Compton. (1972). Effects of mass selection and irradiation in corn measured by random S 1 lines and their test crossess, *Crop Sci.*, **12**: 594–98.

Hull, F. H. (1945). Recurrent selection for specific combining ability in corn. *J. Amer. Soc. Agron*, **37**: 134–45.

Lonnquist, J. H., A. O. Cota and C. O. Gardner. (1966). Effect of mass selection and thermal neutron irradiation on genetic variances in a variety of the seed. *Sverig Utsades foren Tidskr.*, **73**: 101–07.

Mohammad, Ali and S. M. Sikka. (1941). Improvement of *Toria* (*Brassica nanus* L. Var. *dichotoma Prain*) and Taramira (*Eruca sativa* L.) by group breeding. *Indian J. agric. Sci.*, **11**: 587–96.

Pundir, R. P. S. and B. Rai (1971). Multiple selection criteria in the genetic improvement of *Toria* population. *Indian J. Genet.*, 377–82.

Robinson, H. F., R. E. Comstock and P. H. Harvey. (1955). Genetic variances in open pollinated varieties of corn. *Genetics*, **40**: 45–60.

Singh, D. P., D. Singh, S. P. Singh, A. B. Singh and S. N. Mishra. (1969). Relationship among some important agronomic characters in Indian mustard (*Brassica juncea*). *Indian J. agric. Sci.*, **39**: 362–65.

Zuberi., M. I. and S. U. Ahmad. (1973). Genetic study of yield and some of its components in *Brassica campestris* L. *Dav.* Toria. *Crop Sci.*, **13**: 13–15.