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## Comparison of different economic coefficients to select the optimum selection index in tomato [*Solanum lycopersicum* L.]

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### Abstract

In the present study, five biometrical characters *viz.*, fruit yield per plant, days to initial flowering, plant height, average fruit weight and the number of fruits per plant were used to construct selection indices in all possible combination of characters. Thirty- one selection indices were constructed by using different weights like equal weight ( $W_1$ ), heritability ( $W_2$ ), standard deviation ( $W_3$ ), simple correlation with fruit yield ( $W_4$ ). The selection index ( $I_{135}$ ) having fruit yield per plant, plant height and the number of fruits per plant had the highest per cent relative efficiency (PRE) among the combinations of selection indices in equal, heritability weight methods. Whereas, selection index ( $I_{235}$ ) combination of days to initial flowering, plant height, and the number of fruits per plant had highest PRE in standard deviation method and selection index ( $I_{1235}$ ) combination of fruit yield per plant, days to initial flowering, plant height, and the number of fruits per plant had highest PRE in simple correlation. The rank correlation showed that ranks assigned to genotypes by all weight methods were more or less similar. It is concluded that as per the simplicity of arithmetic, equal weight method is suitable for the development of the selection index compared to other weight methods.

**Keywords:** Selection index, per cent relative efficiency, genetic gain, tomato

### Introduction

Tomato is known as poor man's orange in India. Tomato is one of the popular crops compared to other vegetable crops among consumers and farmers for its market value. Tomatoes are not only contributing nutritive elements, colour and flavor to the diet, but also have a valuable source of antioxidants, or chemo protective compounds, and thus it termed as "functional food" (Ranieri *et al.*, 2004) <sup>[1]</sup>.

In general, the yield is a quantitative character controlled by polygenes and it depends upon the action and interaction of several factors. The breeder or researcher can select characters separately or together that are highly correlated with the yield to increase yield (Falconer *et al.*, 1996) <sup>[2]</sup>. Selection is an indispensable component of the crop development. improvement of the economic value of a plant. To assess the maximum and accurate effect of selection, genetic variability along with heritability should be considered (Burton, 1952) <sup>[1]</sup>.

The objective of the selection index is to maximize the "genetic worth" of a population. Selection index technique was employed to study the crop improvement using different characters giving different weights to each character.

### Materials and Method

The fifty-six tomato genotypes used in the present study comprised of forty-five  $F_1$  hybrids developed in half diallel fashion, ten parents and one standard check (Arka Rakshak) were collected from the Main Vegetable Research Station (MVRS), AAU, Anand. The five different biometrical characters *viz.*, fruit yield per plant, days to initial flowering, plant height, average fruit weight and the number of fruits per plant were employed to construct selection indices.

The aim of most of the breeding programme is the simultaneous improvement of several characters. Selection index proposed by Smith (1936) based on the discriminant function of Fisher (1936) <sup>[3]</sup> was used to calculate genetic worth (H, economic value) of genotypes using different biometrical characters of tomato. There is no standard procedure to assign weight and therefore, an attempt has been made to construct selection indices using weights like equal weight [ $W_1$ ], heritability [ $W_2$ ], standard deviation [ $W_3$ ], simple correlation with fruit yield [ $W_4$ ]. In equal weight, a value of 1 was assigned for all characters to construct selection indices.

The broad-sense heritability is the ratio of genetic variance to phenotypic variance was calculated for all characters and used as weight (Lush, 1949) [4]. Standard deviation was calculated by using the method given by Karl Pearson (1896) [6]. The correlation coefficient was calculated between fruit yield and different biometrical characters as per Pearson formula. The Analysis was carried out by using SPAR1 and SPSS 21 software.

The selection indices were constructed by taking five single characters as well as all possible combinations of five different characters for all methods. Each method consists of thirty-one selection indices. The genetic gain for fruit yield with the equal weight used as the base to estimate per cent relative efficiency (PRE) for all selection indices.

**Results and Discussion**

The performance of genotypes was found significant for all characters viz., fruit yield per plant, days to initial flowering, plant height, average fruit weight, and the number of fruits per plant.

The correlation coefficients were estimated between fruit yield and its component characters (Table 2). The fruit yield per plant had a positive and highly significant correlation with plant height (r = 0.528\*\*) and the number of fruits per plant (r = 0.726\*\*). The positive and highly significant correlation (r = 0.482\*\*) was found between plant height and the number of fruits per plant. The true relationship of fruit yield per plant with plant height and number of fruits per plant was supported by Monamodi *et al.* (2013) [5] in tomato.

Selection indices for fruit yield per plant and other biometrical characters were constructed and to assess their per cent relative efficiency in the selection of superior genotypes. The results on selection indices, expected genetic gain and per cent relative efficiency are presented in Table 3. The selection index (I<sub>135</sub>) having fruit yield per plant, plant height and number of fruits per plant had the highest per cent relative efficiency (PRE) in equal (3363.237%) and heritability (2936.679%) weight methods among all the combinations of

characters. Whereas, selection index (I<sub>235</sub>) combination of days to initial flowering, plant height, and the number of fruits per plant had highest PRE (136816.416%) in standard deviation method and selection index (I<sub>1235</sub>) combination of fruit yield per plant, days to initial flowering, plant height, and the number of fruits per plant had highest PRE (2297.411%) in simple correlation weight method.

The top three ranking selection indices in different methods having different combinations of variables are listed in Table 4. The results showed that standard deviation had highest PRE than other weights which was followed by equal weight, heritability, simple correlation coefficient. Thus, it can be concluded that standard deviation followed by equal weight, can be used for the construction of selection indices to achieve higher genetic gain.

The spearman’s rank correlation study revealed that the equal weight with heritability, standard deviation, simple correlation had highly significant and perfect positive correlation (rs ≥ 0.92) which indicated that these weight methods had a more or less similar ranking of genotypes based on the selection indices (Table 5).

The results of the present investigation can be concluded based on per cent relative efficiency and genetic gain; the standard deviation had the highest per cent relative efficiency followed by equal weight method. The rank correlation showed that ranks assigned to genotypes by all weight methods were more or less similar. Compared to all other weight methods as per the arithmetic simplicity, equal weight method is most suitable for the development of the selection index. Based on the equal weight method, the following selection index may be used to select the best genotypes for improvement of fruit yield per plant.

$$I_{135} = -4.572 X_1 + 2.000 X_3 + 0.623 X_5$$

**Where**

X<sub>1</sub> = Fruit yield per plant(kg), X<sub>3</sub> = Plant height (cm), X<sub>5</sub> = Number of fruits per plant.

**Table 1:** Different weights used in the construction of the selection index

Characters	Weights			
	Equal	Heritability	Standard deviation	Simple correlation
Fruit yield per plant	1	0.959	2.796	1.000
Days to initial flowering	1	0.681	4.152	-0.419
Plant height	1	0.766	34.991	0.528
Average fruit weight	1	0.869	14.364	-0.034
Number of fruits per plant	1	0.934	47.794	0.722

**Table 2:** Simple correlation coefficients between fruit yield and its component characters in tomato

Character	Fruit yield per plant	Days to initial flowering	Plant height	Average fruit weight	Number of fruits per plant
Fruit yield per plant	1	-0.419**	0.528**	-0.034	0.726**
Days to initial flowering		1	-0.368**	0.020	-0.350**
Plant height			1	-0.132	0.482**
Average fruit weight				1	-0.228
Number of fruits per plant					1

\*\* - significant @ 1% level of significance

**Table 3:** Selection indices having a high genetic gain and per cent relative efficiency (PRE) among the different combination of characters in different weight methods

S. No	Selection Index	Genetic Gain	PRE
1	<b>Equal weight as weight [W<sub>1</sub>]</b>		
I <sub>5</sub>	I = 0.934 X <sub>5</sub>	93.694	1672.086
I <sub>35</sub>	I = 1.191 X <sub>3</sub> + 0.755 X <sub>5</sub>	180.787	3226.374
I <sub>135</sub>	I = -4.572 X <sub>1</sub> + 2.000 X <sub>3</sub> + 0.623 X <sub>5</sub>	188.457	3363.237
I <sub>1235</sub>	I = -5.439 X <sub>1</sub> - 0.753 X <sub>2</sub> + 2.037 X <sub>3</sub> + 0.540 X <sub>5</sub>	179.754	3207.940
I <sub>12345</sub>	I = -6.192 X <sub>1</sub> - 1.560 X <sub>2</sub> + 2.038 X <sub>3</sub> + 0.757 X <sub>4</sub> + 0.515 X <sub>5</sub>	166.012	2962.686
2	<b>Heritability as weight [W<sub>2</sub>]</b>		
I <sub>5</sub>	I = 0.872 X <sub>5</sub>	87.510	1561.728
I <sub>35</sub>	I = 0.879 X <sub>3</sub> + 0.769 X <sub>5</sub>	156.185	2787.326
I <sub>135</sub>	I = -3.089 X <sub>1</sub> + 1.466 X <sub>3</sub> + 0.674 X <sub>5</sub>	164.554	2936.679
I <sub>1235</sub>	I = -3.776 X <sub>1</sub> - 0.738 X <sub>2</sub> + 1.493 X <sub>3</sub> + 0.607 X <sub>5</sub>	158.756	2833.201
I <sub>12345</sub>	I = -4.390 X <sub>1</sub> - 1.411 X <sub>2</sub> + 1.494 X <sub>3</sub> + 0.672 X <sub>4</sub> + 0.586 X <sub>5</sub>	146.748	2618.893
3	<b>Standard deviation as weight [W<sub>3</sub>]</b>		
I <sub>5</sub>	I = 44.621 X <sub>5</sub>	4478.047	79916.262
I <sub>35</sub>	I = 39.121 X <sub>3</sub> + 40.938 X <sub>5</sub>	7664.415	136780.945
I <sub>235</sub>	I = -141.361 X <sub>2</sub> + 31.226 X <sub>3</sub> + 36.138 X <sub>5</sub>	7666.403	136816.416
I <sub>1235</sub>	I = -198.762 X <sub>1</sub> - 41.825 X <sub>2</sub> + 65.975 X <sub>3</sub> + 34.598 X <sub>5</sub>	7594.051	135525.212
I <sub>12345</sub>	I = -206.846 X <sub>1</sub> - 51.503 X <sub>2</sub> + 65.991 X <sub>3</sub> + 11.881 X <sub>4</sub> + 34.283 X <sub>5</sub>	7372.377	131569.162
4	<b>Simple correlation as weight [W<sub>4</sub>]</b>		
I <sub>5</sub>	I = 0.674 X <sub>5</sub>	67.614	1206.648
I <sub>15</sub>	I = 0.524 X <sub>1</sub> + 0.732 X <sub>5</sub>	79.670	1421.823
I <sub>135</sub>	I = -1.670 X <sub>1</sub> + 0.976 X <sub>3</sub> + 0.556 X <sub>5</sub>	125.136	2233.213
I <sub>1235</sub>	I = -1.741 X <sub>1</sub> - 0.696 X <sub>2</sub> + 0.970 X <sub>3</sub> + 0.548 X <sub>5</sub>	128.733	2297.411
I <sub>12345</sub>	I = -1.634 X <sub>1</sub> - 0.612 X <sub>2</sub> + 0.970 X <sub>3</sub> + 0.004 X <sub>4</sub> + 0.549 X <sub>5</sub>	129.227	2306.218

**Table 4:** Different combinations of variables in the top three ranking selection indices in different weights methods

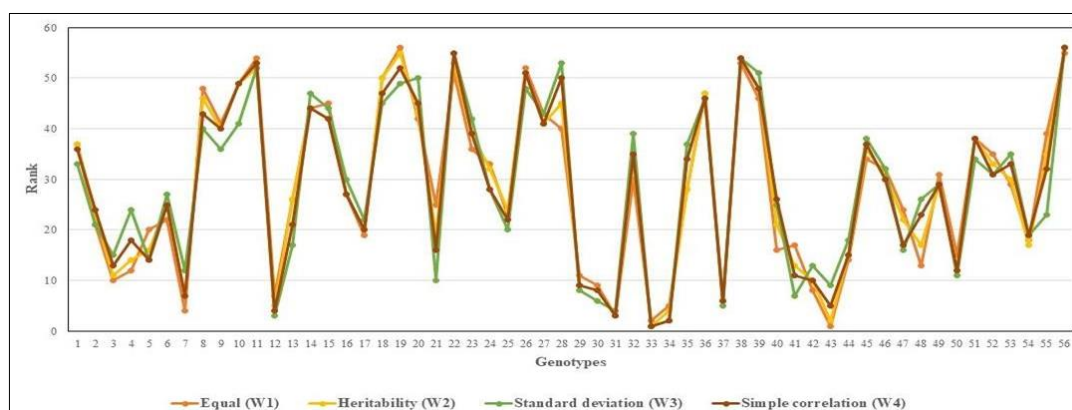
Rank		Equal	Heritability	Standard deviation	Simple correlation
Combination of two variables	1	I <sub>35</sub> (3226.37)	I <sub>35</sub> (2787.32)	I <sub>35</sub> (136780.94)	I <sub>35</sub> (2064.41)
	2	I <sub>15</sub> (1889.73)	I <sub>15</sub> (1770.31)	I <sub>15</sub> (80329.79)	I <sub>15</sub> (1421.82)
	3	I <sub>25</sub> (1548.72)	I <sub>25</sub> (1482.21)	I <sub>25</sub> (80250.31)	I <sub>25</sub> (1282.22)
Combination of three variables	1	I <sub>135</sub> (3363.24)	I <sub>135</sub> (2936.68)	I <sub>235</sub> (136816.42)	I <sub>135</sub> (2233.21)
	2	I <sub>235</sub> (3102.35)	I <sub>235</sub> (2703.42)	I <sub>135</sub> (136100.04)	I <sub>235</sub> (2134.78)
	3	I <sub>345</sub> (2988.22)	I <sub>345</sub> (2572.52)	I <sub>345</sub> (132954.15)	I <sub>345</sub> (2075.20)
Combination of four variables	1	I <sub>1235</sub> (3207.94)	I <sub>1235</sub> (2833.20)	I <sub>1235</sub> (135525.21)	I <sub>1235</sub> (2297.41)
	2	I <sub>1345</sub> (3125.70)	I <sub>1345</sub> (2727.00)	I <sub>2345</sub> (133980.66)	I <sub>1345</sub> (2242.35)
	3	I <sub>2345</sub> (2922.88)	I <sub>2345</sub> (2527.70)	I <sub>1345</sub> (132136.87)	I <sub>2345</sub> (2151.87)

Parenthesis value indicates per cent relative efficiency (PRE)

**Table 7:** Rank correlations between different weight methods

Weight	Equal	Heritability	Standard deviation	Simple correlation
Equal	1.000	0.990**	0.921**	0.968**
Heritability		1.000	0.957**	0.990**
Standard deviation			1.000	0.981**
Simple correlation				1.000

\*\*,\*- Correlation is significant @ 0.01 & 0.05 level of significance



**Fig 1:** Rank of genotypes in different weight methods in the best selection

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