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Influence of morphological characters on the yield of apricot (*Prunus armeniaca* L.) – A statistical approach

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ABSTRACT

Discriminate Analysis was carried out to formulate the categorization rule for allocating the apricot tree to "High Yielder Group" and "Low Yielder Group". Factor Analysis method was also applied to extract the basic factors underlying the observed morphological characters of apricot for both the High and Low Yielder groups. The study brought out five basic factors explaining 69.35% of the total variation in the case of High Yielder population and six factors explaining 74.14% of the total variation in the case of Low Yielder population, respectively. The first factor in both the populations contains the same variables viz. stem girth, number of branches and leaf area which indicate that these variables play an appreciable/significant role in increasing the yield of apricot (21% in the case of High Yielder and 16.33% in the case of Low Yielder population).

Key words: Apricot, morphological character, yield

INTRODUCTION

Apricot (*Prunus armeniaca* L.) is an important fruit crop of temperate regions of the world. In India, it is one of the most remunerative fruit crops cultivated in the mid hill zone of Himachal Pradesh. For improvement in productivity of a crop having enriched qualitative properties, the genetic selection of desirable traits is of utmost importance. Impact of morphological characters of a fruit crop on yield is desirable for its crop improvement programme and this can be achieved through multivariate statistical techniques. Moore (1965), for the first time, reported the use of multivariate analysis for quantifying yield component interactions in a horticultural crop. Ramachander *et al* (1979) used Factor Analysis in onion and reported two basic factors representing indices of plant vigour and flowering responsible for increasing the yield of onion. Schrevens *et al* (1995) used principal component analysis, Factor Analysis and biplots to characterize the quality evaluation of tomatoes during shelf life in relation to specific treatments. In this paper, an attempt has been made to bring out the basic factors (linear combination of morphological characters) contributing significantly towards the yield by using discriminant and factor analyses. The techniques are described in detail in standard statistical books such as Anderson (1958) and Kendal and Stuart (1968).

MATERIAL AND METHODS

The data for the present investigation were taken on the 'New Castle' variety of Apricot, growing in the research farm of the department of Pomology of the Dr Y S Parmar University, Solan during the year 2003. The optimum sample size (n = 30) of trees was determined by following a two step approach proposed by Stein (1945) and Cox (1952). Thereafter, thirty apricot trees were selected using simple random sampling technique (without replacement) from an orchard having one hundred trees of 25 years old plantation. From each of these thirty trees, four branches were chosen randomly from each of the four directions as per the practice in vogue and observations on the following characters were recorded:

X_1 : Number of spurs per branch	X_7 : Stem girth (cm)
X_2 : Length of spurs (cm)	X_8 : Height of tree
X_3 : Number of flowers per branch	X_9 : Number of branches
X_4 : Number of fruits per branch	X_{10} : Leaf area (cm)
X_5 : Fruit weight (g)	X_{11} : Spread of tree
X_6 : Annual shoot extension growth (cm)	

Discriminate analysis was carried out to define a systematic and statistically valid procedure for categorizing the trees as 'low' and 'high' yielder. To bring out the basic factors associated with the above referred morphological characters of apricot, the data of two populations-High Yielder (Population I) and Low Yielder (Population II)-were subjected to factor analysis.

RESULTS AND DISCUSSION

Observations were first divided into two groups on the basis of previous year's data. Thereafter, a discriminant function was fitted by considering the above referred eleven characteristics and was found to be

$$D = -5.023+0.648X_4+0.016X_5$$

This equation reveals that the characters of fruit weight (X_5) and number of fruits (X_4) play a significant role to discriminate the two groups. To test the statistical hypothesis of no difference in mean vectors (μ_1 and μ_2) of eleven characters for these two groups, the value of Wilk's lambda (Λ) was obtained to be 0.214. In turn, the computed value of chi-square (χ^2) was 151.887 and hence the hypothesis of equality of group mean vectors was rejected. Having found that the groups differ statistically, the individuals/trees were assigned to group I (High Yielder) if $D \geq m$ otherwise to group II (Low Yielder), where m=0.359 is the average of groups centroids. The groups formed on the basis of this allocation rule were subjected to factor analysis and population wise the results are discussed below:

Population I (High Yielder)

The rotated factor matrix and communalities are given in Table 1. This table reveals that the first five factors be retained and the sixth factor corresponding to an eigen value $\lambda = 0.945$ is ignored (Guttman's lower bound principle according to which any $\lambda<1$ should be ignored). Ignoring the non-significant correlations, the orthogonal factors extracted can be expressed as:

Factor	Variance explained (% of total)
$F_1 = 0.75X_9+0.68X_{10}+0.61X_7$	21.00
$F_2 = 0.76X_6+0.75X_9$	14.91
$F_3 = 0.71X_4+0.57X_8+0.51X_5$	13.90
$F_4 = 0.71X_2+0.45X_7$	09.81
$F_5 = 0.58X_3+0.39X_4+0.35X_5$	09.73

Table 1. Rotated Factor Matrix – Population I (High Yielder)

Variables	F_1	F_2	F_3	F_4	F_5	F_6	Communalities
Number of spurs (X_1)	0.545	0.383	0.042	-0.377	-0.389	0.272	0.833
Length of spur (X_2)	-0.350	0.243	-0.205	0.706	-0.179	0.348	0.840
No. of flowers per branch (X_3)	-0.354	-0.276	-0.273	-0.152	0.575	0.108	0.930
No. of fruits per branch (X_4)	0.234	0.066	0.719	0.267	0.385	-0.099	0.915
Fruit weight (X_5)	-0.088	0.531	0.512	-0.086	0.348	0.388	0.879
Shoot extension (X_6)	0.074	0.763	0.197	-0.054	0.014	-0.395	0.847
Stem girth (X_7)	0.613	-0.023	0.043	0.455	-0.203	-0.091	0.713
Height of tree (X_8)	-0.350	-0.465	0.571	-0.177	-0.378	-0.229	0.906
No. of branches (X_9)	0.748	0.748	-0.346	-0.220	0.175	0.060	0.875
Leaf area (X_{10})	0.682	-0.181	-0.343	0.214	0.259	-0.339	0.789
Spread of tree (X_{11})	0.412	-0.486	0.376	-0.007	-0.005	0.490	0.805
Eigen values	2.310	1.640	1529.000	1.079	1.069	0.945	

*Variable's highest loading is underlined

Table 2. Rotated Factor Matrix – Population II (Low Yielder)

Variables	F_1	F_2	F_3	F_4	F_5	F_6	Communalities
Number of spurs (X_1)	0.316	0.439	0.350	-0.346	-0.371	0.118	0.703
Length of spur (X_2)	-0.194	-0.018	0.248	0.533	-0.445	-0.450	0.892
No. of flowers per branch (X_3)	-0.158	0.435	-0.113	-0.328	0.388	-0.018	0.919
No. of fruits per branch (X_4)	0.239	-0.099	0.700	-0.060	0.362	-0.197	0.842
Fruit weight (X_5)	0.105	-0.408	0.502	0.333	0.269	0.144	0.838
Shoot extension (X_6)	-0.162	0.100	-0.033	0.504	0.142	0.767	0.911
Stem girth (X_7)	0.715	0.404	-0.106	0.430	-0.139	-0.031	0.892
Height of tree (X_8)	0.326	0.583	0.402	0.120	0.298	-0.078	0.794
No. of branches (X_9)	0.544	-0.507	-0.100	-0.168	0.246	-0.074	0.660
Leaf area (X_{10})	0.781	0.201	0.044	-0.025	0.007	0.142	0.759
Spread of tree (X_{11})	-0.118	-0.252	0.406	-0.410	-0.299	0.388	0.880
Eigen values	1.796	1.436	1.396	1.355	1.122	1.051	

*Variable's highest loading is underlined

In the present case, the first factor (F_1) is a combination of number of branches (X_9), leaf area (X_{10}) and stem girth (X_7). This factor signifies *Plant Vigor*, which indicates the general health of the plant. The second factor (F_2) is the combination of the annual shoot extension growth (X_6) and number of branches (X_9). If we ignore the relative low weighting 0.53 of fruit weight, the second factor (F_2) signifies *Plant Growth*. The third factor (F_3) is the combination of number of fruits (X_4), height of tree ($X\text{-}_8$) and fruit weight (X_5). This factor signifies *Yield Factor*. The fourth factor (F_4) is the combination of length of spurs (X_2) and stem girth (X_7). This factor signifies *Volume and Spur of plant* and the fifth factor (F_5) is combination of fruit weight (X_5), number of fruits per branches (X_4) and number of flowers per branches (X_3). This factor may be regarded as *Fruitfulness or Fruiting*.

Population II (Low Yielder)

As per eigen values (Table 2), six factors extracted along with the contributing variances are given below:

Factors	Variance explained (% of total)
$F_1 = 0.78X_{10}+0.72X_7+0.54X_9$	16.33
$F_2 = 0.58X_8+0.44X_1+0.43X_3$	13.05
$F_3 = 0.70X_4+0.50X_5$	12.69
$F_4 = 0.53X_2+0.50X_6+0.43X_7$	12.32
$F_5 = 0.39X_3+0.36X_4$	10.20
$F_6 = 0.77X_6+0.39X_{11}$	09.55

In this case, first factor (F_1) is the combination of leaf area (X_{10}), stem girth (X_7) and number of branches (X_9). This factor signifies the *Plant Vigour*, which indicates the general health of a plant. The second factor (F_2) may be interpreted as the *Plant Vigour and Fruitfulness* factor. Third factor (F_3) is the combination of the number of fruits (X_4) and weight of fruits (X_5). This factor signifies the *Yield Factor*. Fourth factor (F_4) is the combination of length of spurs (X_2), annual shoot extension growth (X_6), stem girth (X_7) and spread of tree (X_{11}). This factor signifies the *Plant Growth*. Fifth factor (F_5) is the combination of the number of flower per branch (X_3) and number of fruits (X_4). It refers to the *Fruitfulness or Fruiting*. Sixth factor (F_6) is the combination of annual extension growth (X_6) and spread of tree (X_{11}). This factor again signifies the *Plant Growth*.

Thus, the Factor Analysis has brought out the basic factors (after ignoring non significant correlations at 5% level of significance) associated with the morphological characters of the apricot for low yielder and high yielder populations. It is evident from the results that in the case of high yielder population stem girth, number of branches and leaf area are the variables that form part of the first factor. This factor accounts for 21% of the total variation towards yield. The same variables were found to be responsible in forming the first factor which contributes 16.33% of the total variation towards yield in the case of low yield population. Similar inference can be drawn from the remaining factors for both populations as detailed in the population – wise discussion. It may be added that without resolution of the rotated orthogonal matrix to oblique axis, it would not have been possible to bring out the meaningful factors for apricot.

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