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A FACTOR ANALYSIS OF PLANT VARIABLES RELATED TO SEED YIELD IN FLAX

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ABSTRACT

A principle factor analysis was applied to data for ten morpho-physiological traits measured on five cultivars of flax grown in the Research and Experimental Station of Agriculture at Moshtohor, Zagazig University in 1990/91 and 1991/92 seasons. Three principle factors were extracted from the correlation matrix of the traits.

The analysis indicted that the factor concerned with seed characters and both straw and seed yield/plant was the most important factor. Plant height and its related characters ranked second. The third factor included two traits, number of basal branches/plant and number of fruiting branches/plant. Characters that determined the nature of the source were all included in factors 2 and 3. Characters that determine the nature of "sink" were devided among the three factors. The components of yield formed factor 1. The findings of this investigation may help both biologists and flax breeders in determining traits that could be selected in order to increase seed yield of flax.

INTRODUCTION

Many procedures have been applied by plant breeders in attempts to increase yield as well as other characteristics. It is expected that using modern statistical techniques will lead to increase efficiency in selection programs. Many flax breeders have used selection indices to improve the selection

Walton (1971 and 1972), used factor analysis to identify growth and plant morphological characters related to yield in spring wheat. He identified four factors which were responsible for 98.4% of the total variability in the dependence structure. Danis and Adams (1978). performed factor analysis on 22 morpho- physiological and yield determining traits of dry beans. They were able to isolate factors representing patterns of variables interpreted as weight, number and plant architecture

This investigation aims to search and identify patterns of physio-morpholoical characteristics in a set of different flax cultivars which could be

related to yield. The main procedure used was principle factor analysis in which patterns of traits were equated to one or more principle factors.

MATERIALS AND METHODS

This study was designed to search and identify patterns of physio-morphological characteristics in a set of flax cultivars which could be related to yield. For this purpose, Giza 6, Giza 7 (19/31), 2419/1, 2465/1 and 2467/1 strains, which differed for the most characters.

The field work was carried out during the two successive seasons, 1990/1991 and 1991/92. Both experiments were conducted at the Research and Experimental Station of the Faculty of Agriculture, at Moshtohor, Zagazig University (Benha Branch).

The five strains were arranged in a randomized complete block design with six replications. Flax seeds were sown on plots (3 x 3.5 m).

Planting dates were November 18th and November 15th in the two successive seasons by using 30 kilograms/fed. A11 plots were treated similarly through the duration of the experiments concerning fertilization, irrigation and cultivation. The characters studied were: number of basal branches/plant, number of fruiting branches/plant, plant height, technical stem length, upper branches zone length, number of capsules/plant, number of seeds/capsule, seed index, straw yield/plant and seed yield/plant.

Previous ten traits were retained for the analysis after elimination of certain traits that were completely or essentially duplicate of other traits. The traits are listed in Table (1). Data were subjected to principle factor analysis and varimax rotation. Principle factor analysis consists of the reduction of a large number of correlated variables to smaller number of clusters (or patterns) of variables called factors.

The principle components in agronomic experiments comprise the basic patterns of influence in the data set. A portion of the total variance can be ascribed to each factor.

The factor loadings of rotated matrix (correlations of factors with the original variables), the percentage of variance accounted for by each factor and the communalties (the squared multiple correlation of the variable with all other variables of the set) were determined. The mathematical techniques used have been described by Jardine *et al.*, (1963) and Cattell (1965a). The factors extracted were compared and interpreted biologically. Since the objective was to determine the way in which yield components and other physio-morphological characters related to each other, yield itself was included in the structure. Data were analyzed in the computer of Central Laboratory for Design and Statistical Analysis Research, Agricultural Research Center.

RESULTS AND DISCUSSION

The mean values for characters studied and their standard deviations are recorded in Table (1). All characters possessed considerable amount of variability. The results of factor analysis is presented in Table (2). The analysis gave a good separation of traits into three groups or factors. These factors accounted for 72.178% of the total seed variance in the dependence structure. Five characters constructed factor 1 which accounted for 44.853% of the total seed variation. These variables, having the highest positive loadings on factor 1, were number of capsules/plant, number of seeds/capsule, seed index, straw yield/plant and seed yield/plant. This principle component may be viewed as source factor. This factor may be called "weight factor". Principle component or factor 2 was made up of plant height, technical stem length and upper branching zone length. The factor which accounted for 16.137% of the total variability in the dependence structure may be called size factor. Factor 3 is considered of two traits, number of basal branches/plant and number of fruiting branches/plant. It accounted for 11.683% of the total seed variance in the dependence structure. This principle component may be called "number factor". As it can be seen from the analysis the first factor made up of yield component traits and the other two factors are considered of morph-physiological characters.

Table (1): Mean value and standard deviation for 10 traits measured in five flex cultivars.

Character	Mean	Standard
X1 Number of basal branches/plant	1.6720	0.8870
X2 Number of fruiting branches/plant	7.8240	2.7151
X3 Plant height	69.4320	11.6877
X4 Technical stem length	58.2000	8.6724
X5 Upper branches zone length	11.5840	4.4598
X6 Number of capsules/plant	4.8320	1.3839
X7 Number of seeds/capsule	6.5092	0.5147
X8 Seed index	7.4442	1.3757
X9 Straw yield/plant	0.7217	0.2569
X10 Seed yield/plant	0.3389	0.1163

Table (2): Loadings of ten traits on three principle factors derived from data on five flax cultivars grown at the Research and Experimental Center at Moshtohor in 1990/1991 and 1991/1992 seasons.

Character	Prin 1	Prin 2	Prin 3
X1 Number of basal branches/plant	0.180	0.163	0.543
X2 Number of fruiting branches/plant	0.183	-0.139	0.674
X3 Plant height	0.285	0.584	-0.098
X4 Technical stem length	0.227	0.586	-0.154
X5 Upper branches zone length	0.253	0.266	0.229
X6 Number of capsules/plant	0.380	-0.190	0.044
X7 Number of seeds/capsule	0.364	-0.231	-0.244
X8 Seed index	0.379	-0.095	-0.319
X9 Straw yield/plant	0.384	-0.219	-0.011
X10 Seed yield/plant	0.411	-0.228	-0.046
% variability	44.358	16.137	11.683

The biological interpretation assigned to principle components extracted in such analysis will depend to a considerable extent upon the genetic make-up of the cultivars at the experiment and upon the particular set characters chosen for the test. Jardine *et al.*, (1963), illustrated that factors are hypothetical constructs aristing from a correlated complex of test properties. Thus, principle factor analysis is a tool for hypothesis generation and not for hypothesis testing. In this study, the hypothesis which emerged that although flax plant is complex structurally and compositionally, no more than three factors appeared to be governing most of its traits. A major portion of the seed variability (72.178%) in the test data depend on these three principle components.

One important finding in factor analysis technique that it would tell us which tests were measuring the similar basic components and the number and nature of causal influences on which more intensive research can be concentrated (Cattell, 1965b). It would also reveal the importance of variable to particular factors. Furthermore, since yield is an inherently complex character, the researcher might wish to seek the basic underlying influence that best characterize it. In this investigation the ten characters were grouped in three factors. The analysis revealed also the importance of variable to particular factors. Characters did not apear in more than one factor in the analysis. From the patterns of loading, variables with high loading were more important. Thus breeder could select high loading characters in the three factors as an important variables for his breeding programs or in his selection index. Instead of working with many variables measuring similar basic components, only those of high loading could be selected and tested intensely. It is also important that the breeding program must contain variables from all the three factors. The factor analysis had grouped the ten variables and gave the relative importance of its factors in the dependence structure by estimating the percentage variance accounted for each factor. It selected as one of the most important groups the

number of capsules/plant, number of seeds/capsule, seed index, straw yield/plant and seed yield/plant. The second factor indicated that plant height, technical stem lengh and upper branches zone length were also important. For the circumstances under which these cultivars were studied seed characteristics, plant height and its characters and number of basal and fruiting branches/plant had positive effects with the factors. For the plant breeder such information may well assist then by increasing his understanding of the importance of the growth and development of his breeding material the nature and sequence of traits for which selections were made in his breeding program.

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التحليل العاملى لمحصول البذرة فى أصناف الكتان

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أستخدم التحليل العاملى على خمسة أصناف كتان متباينة فى صفاتها زرعت بمركز البحوث والتجارب الزراعية بمشتهر جامعة الزقازيق خلال موسمى الزراعة ١٩٩١/٩٠، ٩١، ١٩٩٢م. ودرس تأثير عشرة متغيرات أشتملت على بعض مكونات المحصول وكذا بعض الصفات المورفولوجية والفسيولوجية. وقد استعمل التحليل الأحصائى لإيجاد درجة تشبع كل عامل وكذلك المصفوفة المدارة والنسبة المئوية لتأثير كل عامل على تباين التركيب التابع وقد نتج عن التحليل العاملى تجميع المتغيرات فى ثلاثة عوامل رئيسية وكان العامل الأول هو المتعلق بمكونات محصول البذرة بينما احتوى العامل الثانى على معنى طول النبات أما العامل الثالث احتوى على عدد الأفرع سواء القاعدية أو الثمرية. وقد تبين من التحليل العاملى أن الصفات التى تكون "المصدر" تجمعت فى العاملين الثانى والثالث بينما توزعت الصفات التى تكون "المخزون" على العوامل الثلاثة.