Advances in Environmental Biology, 4(3): 350-352, 2010
ISSN 1995-0756

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ORIGINAL ARTICLE

Study of Some Morphological and Phonological Traits in Exotic and Native Safflower Genotypes Using Multivariate Statistical Methods

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ABSTRACT

In order to study variations among traits detecting suitable selection index, regarding their similarity, an experiment with 49 safflower genotypes was conducted at Research Farm of Saveh University in 2009-2010 The experimental design was a 7 x 7 simple lattice. Phenotypic and genotypic correlations showed that the oil yield per plant is significantly correlated with seed yield per plant, plant height, number of head and number of secondary branches, for most of the characters, genotypic correlation coefficients were very closed to phenotypic correlation coefficient. A multiple stepwise regression analysis showed that the most important oil yield components were Biomass, number of head per plant and number of secondary branches .The results of the path coefficient analysis revealed that the increase of oil yield was associated with the increase of seed yield which can be effected by plant height and the number of head per plant.

Key words: Safflower, stepwise regression.

Introduction

Safflower (*Carthamus tinctorius* L.) is an oilseed crop which is grown throughout the semiarid region of the temperate climates in many areas of the world for use as vegetable and industrial oils, spices, and birdfeed.

Safflower has a long history of cultivation as an oilseed crop and as a source of red dye (carthamin). Carthamin is extracted from its flowers and it is used for treatment in the form of infusion, for circulatory system related diseases The crop was grown for its flowers, used for colouring and flavouring foods and making dyes, especially before cheaper aniline dyes became available, and in medicines[6].

Safflower petals have immense medicinal and therapeutic properties as revealed Chinese researchers. Petals of safflower from India were analyzed for carthamin (red pigment) (0.83%), oil(5.0%), protein(1.9%), ash(10.4%), fiber(12.2%) and fatty acid compositions .The petal oil was shown, for the first time, to contain some short chain fatty acids(10:02,12:0 and 14:0),gamma linolenic acid along with fatty acids such as palmitic,stearic, oleic and alpha linolenic acids. Similary the petals were rich in Ca (530mg), Mg (287mg) and Fe (7.3mg/100g)[8].

Safflower is a highly branched, herbaceous, thistle-like annual or winter annual, usually with many long sharp spines on the leaves. Plants are 30-150 cm tall with globular flower heads (capitula) and, commonly, brilliant yellow, orange or red flower.[10] India is the biggest safflower producing country, following by the USA and Mexico[6].

Study of yield components and detecting suitable selection indexes has a very important role in safflower breeding programmes.

Abel *et al.*[1] showed that the number of head per plant or number of seeds per head or both traits could be responsible for high yielding safflower lines.

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Digming and Yuguang[3] in a study of 30 safflower cultivars, reported that the number of effective branches, main stem diameter, diameter of top seed, 1000 seed weigh, oil content and angle of the first branch were the six principal components.

Omidi[9] reported that the seed yield per plant is significantly correlated with seed yield per plot, biomass, number of capitula, 100 - seed weight, number of secondary branches and oil yield per plant. The results showed a positive correlation between kernel% and oil content, therefore selection for high oil content can be based on thin-hull seeds. Consentino *et al.* [2] showed that the number of head per plant and seeds per head were significantly and positively correlated.

Yazdi-Samadi and Abd-Mishani[11] grouped all 1618 Iranian and American safflower genotypes into 5 clusters according to their similarities and reported that the of lines from USA and Iran and other eastern countries were classified into same cluster, as they had similar genetic base.

Jajarmi, *et al.*[4] in study of more than 90 Iranian safflower genotypes reported a significant correlation between seed yield and oil yield (r=0.89) and the number of seeds per pod (r=0.8).

Mokhtassi, [7] found a correlation between seed yield and oil yield (r=0.89) and the number of seeds per pod (r=0.8) that was closely related to high-yield genotypes. Johnson *et al.*[5] indicated that seed yield was positively correlated with seed weight, and plant height.

In this study variation among traits detecting suitable selection index, regarding their similarity will be evaluated.

Matrials and methods

In september 2009, 49 Iranian and exotic safflower varieties were planted for study yield and yield components and other agronomic characters, using a simple lattice design (7 x 7) in Saveh university at48°,26"and 35°,16" with an altitude of 1030 m above sea level. Based on meteorological statistics, the annual rainfall is 350 mm, mean annual air temperatures are +35c °, maximum and minimum absolute annual temperature are +44 c ° and -11 c ° respectively. Seeds were sown by hand on an inter-row spacing of 0.5m and with an intra-row spacing of 5cm; each plot consisted of rows 3m long. After emergence, manual thinning was used to obtain normal density. For the experiment, 70kg/ha of P2O5 as ammonium phosphate and 25kg/ha of nitrogen as urea were supplied prior to sowing and 30kg/ha of nitrogen as urea at the start of stem elongation. Weeds were controlled by manual weeding before stem elongation. Irrigation was applied at 7 stages: After emergence, stem elongation, bud formation, beginning of flowering, 50% of flowering, finishing of flowering and seed filling. Data on yield per plant and yield components and other agronomic traits such as Plant height, Head and seeds number per head, number of secondary and tertiary branches, were recorded on plants randomly selected from the two middle rows.

Phenotypic and genotypic variances were estimated:

$$\sigma_g^2 = \frac{(MSt - MSe) - [(MSb - MSe)(2/k+1)]}{2}$$

Where MST is the mean square of the genotypes, MSe is the mean square of error, MSb is the mean square of the block, K is the number of genotypes in a block and r is replication. Phenotypic and genotypic correlations were calculated as follwoes: (Singh, M, 1991)

$$\gamma_p = \frac{COV_p(x,y)}{\sigma_{px}\sigma_{py}} ,$$

$$\gamma_g = \frac{COV_g(x,y)}{\sigma_{gx}\sigma_{gy}}$$

All analysis employed standard SAS/STAT procedures.

Results

The phenotypic and genotypic correlation of yield per plant and its components are shown in Table 1. The results of phenotypic and genotypic correlations indicated that seed yield is correlated with some traits such as: the number of head per plant, plant height and the number of secondary branches. The highest phenotypic and genotypic correlations were observed between seed yield and oil yield(r=0.95). The number of head per plant had a significant positive effect (r=0.891) on single plant yield (Table 1). This effect can be explained by the positive correlation between the number of secondary branches and the numbers of heads per plant (r=0.56), the plant height(r=0.62) and also positive correlation between plant height and the number of heads(r=0.61) as with increase of the plant height and the number of branches, the number of head increases and fallowing that the plant seed yield increases.

Stepwise regression for oil yield indicated that 3 traits, including plant height, number of head per plant and number secondary branches entered the model. Plant height had the highest partial determination coefficient (R2=70.8) and in path analysis it has thus the highest direct effect. The strongest variable was the number of heads per plant (p=0.69). The final equation of single plant yield based on three variables showing is: Y= -4.96 + 0.071 x1+ 0.69 x2 +0.09 x3

Table 1: Phenotypic and (genotypic) correlations of winter safflower traits

Trait	Oil yield	Seed yield	No.Head	Seed/head	Branches	Plant height
Oil yield	1					
Seed yield	0.95**(0.94)	1				
No.Head	0.90**(0.89)	0.89**(0.88)	1			
No.Seed/head	0.19(0.17)	0.01(0.02)	-0.14(0.01)	1		
No.Branches	0.77**(0.75)	0.78**(0.77)	0.51**(050)	0.12(0.11)	1	
Plant height	0.87**(0.86)	0.91**(0.89)	0.61**(0.6)	0.04(0.03)	0.62**(0.61)	1

**Significant at 1%lvele of probability

Table 2: Regression coefficients of oil yield traits using stepwise method

Trait	Regression coefficients	Standard error	F	R2-partial	R2-Model
Costant number	-4.69871	0.9067			
Plant height	0.07110	0.18205	7.56**	70.8	70.8
No.Head	0.69712	0.10224	5.19**	5.11	75.91
No.Branches	0.09788	0.20899	3.88**	0.91	76.82

**Significant at 1%lvele of probability

In this equation Y is the single plant yield; x1, x2 and x3 are plant height, number of heads and number of secondary branches, respectively. (Table2).

Study of the path coefficient when the trait of seed yield consider as a dependent variable and the traits of plant height, number of heads and number of secondary branches consider as independent variable, indicated that the plant height had the highest direct effect (0.49) while the number of heads had the least direct effect (0.201) on seed yield. The number of heads showed the highest indirect positive effect (0.49) via the plant height on the yield.(Table3). It can be concluded that researchers should select new desirable single plants based on plant height and number of heads in field, specially in F2 generations or safflower landraces population .The new safflower cultivars such as: Padideh ,Goldasht an Soffeh have improved for number of heads per plant at oil research department of SPII in Iran

Evaluation of the path coefficient when the trait of oil yield consider as a dependent variable and the traits of seed yield, plant height, number of heads and number of secondary branches consider as independent variable demonstrated that the seed yield had the highest direct effect (0.49) on seed yield. (Table4)As a conclusion increasing in oil yield was primarily associated with the increase in seed yield which in turn was affected by plant height and number.

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