Bulgarian Journal of Agricultural Science, 18 (No 3) 2012, 330-333
Agricultural Academy

DETERMINATION OF THE BEST INDIRECT SELECTION CRITERIA FOR IMPROVEMENT OF SEED AND OIL YIELD IN CANOLA CULTIVARS (*BRASSICA NAPUS* L.)

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Abstract

GOLPARVAR, A. R. and M. KARIMI, 2012. Determination of the best indirect selection criteria for improvement of seed and oil yield in canola cultivars (*Brassica napus* L.). *Bulg. J. Agric. Sci.,* 18: 330- 333

To evaluate the relationship between seed and oil yield as well as determine the best indirect selection criteria for genetic improvement of seed and oil yield in canola a randomized complete block design with three replications was conducted using 17 cultivars. Step-wise regression of seed and oil yield revealed that 98.4% and 98.9% of total variation exists in these traits accounted for by the traits seed yield, oil percent, plant height and days to physiological maturity for oil yield while the traits biological yield, harvest index, days from planting to flowering initiation and no. grain/pod for seed yield . Path analysis for seed and oil yield designed high efficiency of the traits plant height and days to physiological maturity as indirect selection criteria for genetic improvement of oil yield and the traits biological yield and no. grain/pod for seed yield improvement in canola cultivars especially in early generations of breeding programs.

Key words: canola, correlation analysis, path analysis, indirect selection, selection criteria, genetic improvement

Introduction

Determination of the traits affects oil and seed yield is very efficient in breeding of this trait in canola (*Brassica napus* L.). Oil and seed yield are the quantitative trait that direct selection per se is not effective for improvement these. Therefore, indirect selection through traits having higher heritability and correlated strongly with oil and seed yield has more genetic efficiency than direct selection in genetic improvement of these traits (Falconer, 1998).

Assessment of relationship using correlation coefficient analyses help breeders to distinguish significant relation between traits. Step-wise regression can reduce effect of non-important traits in regression model, in this way, traits accounted for considerable variations of dependent variable are determined (Agrama, 1996). Path analyses that present by Li (1956) have been extensively used for segregating correlation between oil yield and its components in oilseed crops. Path analysis is used to determine the amount of direct and indirect effects of the variables on the dependent variable (Li, 1956; Farshadfar et al., 1993).

Bagheri et al. (2008) reported positive and significant relation among oil yield and the traits seed yield, plant height and 1000-seed weight. Fathi et al. (2008) emphasized on importance of 1000-seed weight and no.seed/plant as efficient indirect selection criteria for genetic improvement of seed yield in canola cultivars. Farhudi et al. (2008) showed positive and direct effect of the traits no.seed/plant, seed yield, biological yield and 1000-seed weight on oil yield in canola genotypes.

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This study was undertaken in order to determine the dependence relationship between seed and oil yield of canola cultivars and other traits as well as identify the best selection criteria for genetic improvement of this traits via indirect selection.

Materials and Methods

The 17 canola cultivars namely; Option 500, Hyola 300, Slm 046, Hyola 401, Sargol, Modena, Hysun 110, Swc-Motshot, Echo, Parkland, Landrace, Rinbow, SLM 046, Opera, Zarfam, RGS 003 and Elite were planted at the beginning of November 2009 at the research field of Islamic Azad University in a randomized complete block design.

The plots comprising four rows were 5 m long and 0.3 m apart. Distance between plants with in rows was 0.06 m. Therefore, plant density was 555,000-plant ha^{-1}. In spring 2010 the trial was irrigated every 10 days. Amount of precipitation was 165 mm. Measurement for 14 traits days to shooting, days to flowering initiation, days to full flowering, days to physiological maturity, flowering duration, plant height (cm), no.pod/plant, no. seed/pod, 1000-seed weight (g), biological yield (g), seed yield (g), harvest index (%),oil percent (%) and oil yield (g) were achieved on 10 normal plants randomly selected from two middle rows in each plot.

Relationships between traits were investigated using simple correlation coefficient analysis. Step-wise regression was achieved for determination of the best model, which accounted for variation exist in plant seed and oil yield as dependent variables in separate analysis. Direct and indirect effects of traits entered to regression model were determined by using path coefficient analysis. In this study path analysis was carried out based on method given by Dewey and Lu (1959). Data analysis was done using SPSS, Minitab and Path2 soft wares.

Results and Discussion

Correlation coefficient analysis showed positive and significant relationships of oil yield with the traits days to shooting, days to full flowering, days to physiological maturity, plant height, no. seed/pod, 1000-seed weight, biological yield, seed yield, harvest index and oil percent. Efficacy of these traits as the effective selection criteria in order to genetic improvement of oil yield in canola cultivars have been emphasized by Bagheri et al. (2008) and Tang et al. (1997).

Step-wise regression analysis for oil yield as dependent variable (Table 1) revealed that traits seed yield, oil percent, plant height and days to physiological maturity accounted for 98.4% of variation exist in oil yield. Therefore, these traits were determined as the main oil yield components. Amongst, trait seed yield accounted for 86.1% of total variation of oil yield lonely, that designated importance of this trait to explain variation of oil yield. Traits oil percent, plant height and days to physiological maturity accounted for 3.1%, 6.6% and 2.6% of variation of oil yield, respectively (Table 1).

Path analysis for oil yield (Table 2) based on traits entered to regression model indicated that traits seed yield and oil percent have the high and negative direct effects on oil yield. On the other hand, these traits correlated positively and significantly with oil yield. Therefore, positive indirect effects of these traits on oil yield via the traits plant height and days to physiological maturity must be considered, simultaneously (Farshadfar, 2008; Chaudhaty et al., 1999).

Table 1
Step-wise regression for oil yield (dependent variable) in canola cultivars

Variable	$b_{(1)}$	S.E	R^2	t	Prob
Seed yield	0.44	0.01	0.861	58.42	0.000
Oil percent	23.76	1.64	0.892	14.51	0.000
Plant height	-1.26	0.49	0.958	-2.60	0.014
Days to physiological maturity	0.71	0.23	0.984	3.09	0.004
Intercept	-1074.79	57.19		-18.80	0.000

(1): b values have been tested relative to zero.

Table 2
Path analysis for oil yield in canola cultivars

Variable	(1)	(2)	(3)	(4)	Sum of effects
(1) Seed yield	-2.64	-0.48	1.89	2.22	0.99
(2) Oil percent	-0.88	-1.42	1.05	2.15	0.89
(3) Plant height	-2.12	-0.63	2.36	1.21	0.82
(4) Days to physiological maturity	-2.20	-1.15	1.08	2.66	0.38
Residual effects	1.39				

Traits plant height and days to physiological maturity have the positive and high direct effects on oil yield. In addition, indirect effects of plant height via days to physiological maturity and days to physiological maturity via plant height on oil yield are positive (Table 2). Thus, indirect selection for oil yield improvement through these traits and consider theirs direct and indirect effects on oil yield can be efficient in canola breeding programs. Therefore, these traits are introduced as the effective traits for indirect selection of genotypes having higher oil yield specifically in early generations. These results are inconsistent with reported by Bagheri et al. (2008) and Farhudi et al. (2008) in canola, Abolhasani and Saeidi (2006) and Arslan (2007) in safflower.

Correlation coefficient analysis showed positive and highly significant relationships of all the traits studied except traits days to flowering initiation, days to physiological maturity, flowering duration, no.pod/plant and harvest index with seed yield.

Step-wise regression analysis for seed yield as dependent variable (Table 3) revealed that traits biological yield, harvest index, days to flowering initiation and no. seed/pod accounted for 98.8% of variation exist in seed yield. Amongst, traits biological yield and harvest index accounted for 72% of total variation designated importance of these traits to explain variation of seed yield. Traits days to flowering initiation and no. seed/pod accounted for 23.2% and 3.2% of variation of seed yield, respectively (Table 3).

Path analysis for seed yield (Table 4) based on traits entered to regression model indicated that traits biological yield and no. grain/pod have the highest and positive effects on seed yield. Therefore, these traits are introduced as the effective traits for indirect selection of genotypes having higher seed yield specifically in early generations.

Harvest index has negative direct effect on seed yield, while its correlation with seed yield is positive. On the other hand, direct effect of harvest index on seed yield is positive and considerable. Therefore, indirect effect of this trait on seed yield via biological yield must be considered in selection program.

Days to flowering, initiation has positive but low direct effect on seed yield. Indirect effects of this trait also are low. Overall, this trait is improper for using in selection superior canola genotypes.

Bagheri et al. (2008) reported no. grain/pod as the best indirect selection criteria for genetic improvement of seed yield in canola genotypes. Fathi et al. (2003), Tang et al. (1997) and Rai et al. (1993) determined the traits no. grain/pod, no. pod/plant and biological yield as the most efficient criteria for selection superior canola and linseed genotypes especially in early breeding

Table 3
Step-wise regression for plant seed yield (dependent variable) in canola cultivars

Variable	$b_{(1)}$	S.E	R^2	t	Prob
Biological yield	0.240	0.010	0.644	30.500	0.000
Harvest index	102.950	3.070	0.720	33.580	0.000
Days to flowering initiation	-1.270	0.620	0.952	-2.050	0.0490
No. seed/pod	-40860	3.040	0.988	1.600	0.021
Intercept	-2185.990	140.720		-15.530	0.000

(1): b values have been tested relative to zero.

Table 4
Path analysis for plant seed yield in canola cultivars

Variable	(1)	(2)	(3)	(4)	Sum of effects
Biological yield	1.250	-0.298	0.001	-0.243	0.712
Harvest index	0.873	-0.426	0.003	0.046	0.499
Days to flowering initiation	0.055	-0.044	0.032	-0.008	0.035
No. seed/pod	-0.304	-0.020	-0.001	0.998	0.674
Residual effects	-0.352				

generations. These results are consistent with finding given by my research. Also, the similar results reported by Farhudi et al. (2008) in canola, Abolhasani and Saeidi (2006) and Golparvar et al. (2009) in safflower.

Conclusion

In conclusion, we can suggest indirect selection in early generations via traits that have the highest direct effect on dependent variables. These traits usually determine by means of statistical procedure like correlation, regression and path analysis. In this research, revealed that traits plant height and days to physiological maturity are the best indirect selection criteria for genetic improvement of oil yield in canola cultivars. On the other hand, traits biological yield and no. grain/pod are the best indirect selection criteria for seed yield improvement specifically in early generations.

Acknowledgements

This research project has been supported by Islamic Azad University, Khorasgan branch, Isfahan, Iran. This support is highly appreciated.

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Received July, 2, 2011; accepted for printing February, 12, 2012.