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# Path analysis of the relationships between yield and some related traits in canola (*Brassica napus* L.) under salinity stress conditions

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**ABSTRACT**

*Plant salt stress is a condition where excessive salts in soil solution cause inhibition of plant growth or plant death. On a world scale, no toxic substance restricts plant growth more than does salt. Salt stress presents an increasing threat to plant agriculture. The objective of this work was to evaluate the effects of the salinity stress (control, 150 and 300 mM NaCl) on 12 canola (Brassica napus L.) cultivars (Olga ‹Wild cat, Sari gol, Herosr, Cracker, Comet, Option 500, SW hotshot, Amica, SW5001, Eagle and RGS003). The experiment was split plot design under hydroponic culture in Greenhouse of university of Tabriz, Iran. Morphological parameters of root and shoot dry weight, 1000-seed weight, length of pod, number of pods per plant, seed yield and osmotic potentional in leaves canola cultivars were highly significant differences for main and interaction effects of two factors (salinity and Genotype) studied. salinity decreased the roots and shoots dry weight of canola plants and this effect was particularly significant at high level of stress. Phat analysis indicated that, number of pods per plant was thermore influenced traits on seed yield under normal and salinity condition. Therefore, selection based on pod per plant would be more effective to improving seed yield of canola in salinity stress conditions and This trait is easy to determine and would be useful in breeding programs.*

**Keywords**: Path analysis, correlation, canola, Salt Stress.

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## INTRODUCTION

Water deficit stress due to drought, salinity, or extremes in temperature is the main limiting factors for plant growth and productivity resulting in large economic losses in many regions of the world [1]. Water deficit stress has effect on vegetative and reproductive stages of canola. The effect of water deficit stress was more during reproductive growth than vegetative growth of rapeseed [2]. The effect of drought stress is a function of genotype, intensity and duration of stress, weather conditions, growth, and developmental stages of rapeseed [3]. Although the level of salts in most irrigation waters is below the threshold for the more sensitive crops, salt accumulation in irrigated soils from both irrigation and groundwater sources can increase salinity to levels which can reduce growth and yield of even the more tolerant crops. Overcoming salt stress is a main issue in these regions to ensure agricultural sustainability and continued food production. Rapeseed is adaptive in Iran not only as a source of edible oil, but also for many other usages. Rapeseed is the third most important edible oil source in the world, after soybean and palm. Among the oil seed crops, Brassica napus is the amphidiploids in origin. Saline soils and saline irrigation waters present potential hazards to canola production. Canola has a high adaptability under the different environmental conditions especially under the drought, salinity and temperature stresses. Iranian farmers evaluate canola cultivars only in terms of yield potential, earliness and yield fluctuations by location and year. For that purpose, superior varieties must be developed by selection among and within populations that have very rich variations in important agronomic traits. The success of selection depends on the choice of selection criteria for improving seed yield [4]. Seed yield is combination of many traits, which are polygenic in nature and it is difficult to make direct selection for these traits. Therefore, indirect selection through associated component traits is possible to improve the seed yield. To separate correlation coefficients into components of direct and indirect effects, the path-coefficient analysis provides an excellent tool as it can measure the direct and indirect effects of interrelated components of a complex trait like yield [5,6]. The method allows the partition of the correlation coefficients into direct and indirect effects, applied to a causal diagram built according to logical basis. The analysis allows a critical examination of specific factors that produce a given correlation and can be successfully employed in formulating an effective selection strategy. Plant yield components develop sequentially with later-developing components under the control of earlier-developing components [7]. The interrelationships among plant yield and other traits may be varied in different water treatment conditions [8]. Cobos et al. [8] reported that correlation between seed yield and seed size in chickpea was negative and significant at one condition but positive and significant at another condition. Although, there are several reports on correlation and path coefficient analysis in canola [9], detailed cause and effect relationships using sequential path analysis have not been examined in canola [10]. The main objectives of this research were to analyze the correlation between seed yield and related traits in canola by applying sequential path analysis and identifying traits, of genotypes, which may be useful in breeding higher-yielding programs in saline soils.

## MATERIALS AND METHODS

### Plant Materials

The experiment was conducted in hydroponics culture system under greenhouse conditions at the Faculty of Agriculture, University of Tabriz. The experimental design consisted of 36 treatments replicated three times in split plot design, with salinity as main factor and cultivar as sub factor with 5 plants in each subplot. Twelve canola cultivars (Brassica napus L.) Olga , Wild cat, Sarigol, Heros, Cracker, Comet, Option 500, SW hotshot, Amica, SW5001, Eagle and RGS003 were subjected to three NaCl concentrations (0, 150 and 300 mM). Seeds were sterilized and germinated in petri dishes and seven day-oil seedling of uniform size were transferred into large sandbanks housed within an environmentally–controlled greenhouse (14h daily light, 600-800µmol m-2s-1photosynthetic photon flux density (PPFD) thermo-period 25\15ºC day\night, relative humidity 50\60% day\night). The P.V.C. tanks were sub irrigated and flushed four times daily with a modified Hogland nutrient solution. NaCl stress was imposed seven days after the seedlings were transferred.

### Measured Traits

Plots were harvested by hand and then threshed to determine seed yield and yield components. Data were recorded for pod height, 1000-seed weight, dry shoot weight, dry root weight, length of pod, seed yield and osmotic potentional. Simple correlation coefficients calculated among all possible combinations of traits related to SY.

### Statistical Analysis

Simple correlation coefficients calculated among all possible combinations of traits related to SY. Correlation coefficients among all pairs of variables, standardized regression coefficients and multi regression using Stepwise method calculated by SPSS 18.0 statistical canola. The path coefficient analysis was conducted according to Lee [11].

**Table 1. Direct and indirect effects between seed yield and some related traits in canola under control conditions**

| Traits | direct effects | Indirect effects via | | | Correlation coefficien |
|---|---|---|---|---|---|
| | | Pod per plant | fresh root weight | dry root weight | |
| Pod per plant | 0.721 | - | 0.100 | 0.094 | 0.91 |
| fresh root weight | 0.471 | 0.065 | - | 0.395 | 0.93 |
| dry root weight | 0.320 | 0.273 | 0.042 | - | 0.64 |

## RESULTS AND DISCUSSION

In order to explain better the achieved results from simple correlations and stage regression and also to determine cause and effect relations to identify direct and indirect effect to components and entered traits into regression model, path analysis by the method of Dewey Wolve was applied [12].

Path coefficient analysis was conducted by considering yield-related traits as pridictor variables and seed yield as the response variable. This method allowed separation of the correlation coefficients with components of direct and indirect effects. In the control condition, comparing the direct and indirect effects between seed yield and some related traits were calculated (Table 1). In this state, seed yield was positively correlated with Pod per plant, fresh root weight and dry root weight (Table 1). In control condition, Pod per plant is best criterion for improving seed yield in canola. In this way, screening for high Pod per plant may bring increase in canola seed yield under control condition. According to path analysis, based on significant genotypic correlations in this condition, Pod per plant had highest positive direct effects on seed yield.

**Table 2. Direct and indirect effects between seed yield and some related traits in canola under mild salinity conditions**

| Traits | direct effects | Indirect effects via | | Correlation |
|---|---|---|---|---|
| | | Pod per plant | Root length | coefficien |
| Pod per plant | 0.523 | - | 0.170 | 0.70 |
| Root length | -0.360 | -0.060 | - | -0.42 |

Comparing the direct and indirect effects between seed yield and some related traits in mild salinity condition were calculated (Table 2). Significant genotypic correlations were used to path analysis and results revealed that trait Root length had negative direct effects on seed yield and Root length had positive direct effect on seed yield (Table 2). Also in mild salinity conditions, Pod per plant is best criterion for improving seed yield in canola.

**Table 3. Direct and indirect effects between seed yield and some related traits in canola under high salinity conditions**

| Traits | direct effects | Indirect effects via | | | | Correlation |
|---|---|---|---|---|---|---|
| | | Pod per plant | fresh root weight | Osmotic potentional | Length of pod | coefficien |
| Pod per plant | 0.275 | - | 0.052 | 0.059 | 0.014 | 0.40 |
| fresh shoot weight | 0.266 | 0.050 | - | 0.020 | 0.04 | 0.37 |
| Osmotic potentional | 0.340 | 0.083 | 0.03 | - | -0.08 | 0.40 |
| Length of pod | 0.307 | 0.160 | 0.04 | -0.070 | - | 0.29 |

In the high salinity condition, comparing the direct and indirect effects between seed yield and some related traits were calculated (Table 3). In this state, seed yield was positively correlated with Pod per plant, fresh root weight, Osmotic potentional and length of pod (Table 1). It is also interesting that in this condition, pods per plant is the best criterion for improving seed yield in canola. In this way, screening for high Pod per plant may bring increase in canola seed yield under high salinity condition. According to path analysis, based on significant genotypic correlations in this condition, Pod per plant had highest positive direct effects on seed yield.

## CONCLUSION

This investigation concluded that in control conditions, genotypic association of seed yield with Pod per plant, fresh root weight and dry root weight is positive and significant. While, in the high salinity conditions, seed yield has positively and significantly correlated with Pod per plant, fresh root weight, Osmotic potentional and length of pod. Considering to our results, Pod per plant can be good selection criteria because they could easily measure and have strong and highly significant positive correlations with seed yield in three conditions. This relationship was confirmed by the path analysis as they had a considerable positive direct effect on seed yield. Also, Osmotic potentional in high salinity conditions has positive direct effect on seed yield. Therefore, selection based on these traits would be more effective to improving canola seed yield under control and salinity conditions.

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