Drought Effect on Yield and its Components in winter Rapeseeds (*Brassica napus* L.)

Liu C Q, Zhang X K, Zheng P Y, Liu F L, Fu G P, Cheng Y, Lu G Y
Key Laboratory for Oil Crops Biological Research, Oil Crops Research Institute, CAAS. Wuhan 430062, China.

Abstract

In this study, the effects of drought on seed yield and yield components were investigated during 2009-2010 by growing 39 winter rapeseed genotypes under rain-fed (drought) and irrigated (moisture) conditions in Yunnan Province, China, respectively. Comparison between these two experiments revealed that plant height, height of the first primary branch, length of main raceme, number of pods per plant, number of seeds per pod, 1000-seed weight, and days from seeding to maturity were sharply reduced under drought conditions. Three genotypes, 08SH09, 07za696 and Mianza03-33 showed the best yield stability and were very useful for production in adverse condition. The relationship among seed yield and other component traits under drought condition were also characterized by correlation analysis and path analysis. The results showed that plant height, length of main raceme, number of pods per plant and days from seedling to maturity were all important for seed yield. These traits can be used as selection criteria in developing drought tolerance rapeseed varieties.

Key word: oilseed rape; drought resistance; path coefficients; yield

Introduction

Drought is one of the most important environmental stresses that have a profound negative effect on the growth and development of plants. In most regions of the world, the yield of major crops is defined as their ability to cope with this stress (Boyer, 1982; Tollenaar and Wu, 1999). The production of drought-tolerant crops which are able to grow under restricted water regimes without diminution of yield would minimize drought-related losses and ensure food production in water-limited lands (Rivero, 2007).

Materials and Methods

Thirty nine winter rapeseed varieties from 2009-2010 State Regional Field Trails were used as plant materials. These genotypes were cultivated simultaneously in two near experimental sites in Yunnan Province, each with three replicates. At the seedling stage of rapeseed, Yunnan occurred severely drought. One experiment was well watered and used as control, while the other received no irrigation. The following indices were considered: plant height, effective length of main inflorescence, branch height, density of siliques, the number of effective branches, the number of siliques per plant, seeds per silique, 1000-seed weight, Days from seeding to budding, Days from seeding to bloting, Days from seeding to onset of flower, Days from seeding to end of flower, Days from seeding to maturity, and growth period.

Results

Drought effect

Analysis of variance showed that there was significant difference for plot yield among these two experiments. Comparison between experiments revealed that plant height, height of the first primary branch, length of main raceme, number of pods per plant, number of seeds per pod, 1000-seed weight, and days from seeding to maturity were sharply reduced under drought conditions.

Analysis of the correlation coefficient for yield characters

The correlation coefficients of seed yield with other component traits are listed in Table 1. Under drought stress condition, there were highly positive correlation with seed yield per plot for 1000-seed weight, plant height, effective length of main raceme ($P<0.01$), and for number of pods per plant ($P<0.05$), while pod density and growth period were negatively correlated with plot yield ($P<0.01$).

Under irrigated condition, there was a highly positive correlation with plot yield for the number of primary branches ($P<0.01$). The number of pods per plant was also significantly correlated ($P<0.05$). However, Branch height, Days from seeding to initial of flower, Days from seeding to end of flower and Days from seeding to maturity were negatively correlated with plot yield ($P<0.01$).

The above result showed that the major seed yield components for rapeseed grown in normal and drought condition were quite different.

Index of drought tolerance

The index of drought tolerance (DI) for seed yield was also calculated. The higher values of DI were found for 08SH09, 07za696, Mianza03-33, 07V06 and W215. A lower DI values for plot yield indicated that these varieties are relatively more prone to drought stress.

Path coefficient analysis

Path analysis was used to reveal the direct and indirect effect of the agro-morphological traits on yield. Under irrigated condition, only days from seeding to initial flowering had a significant direct effect on plot yield. Under drought stress condition however, 1000-seed weight and effective length of main raceme had significant positive direct effect on yield. In addition, days from seeding to initial flowering and growth duration had significant negative direct effect on plot yield (Figure1).

It could be concluded that, in term of other yield component factors being kept constant, higher yield could be achieved by increasing 1000-seed weight and reducing days from seeding to initial flowering and Growth duration.

Discussions

In this study, there was highly positive correlation with seed yield for number of pods per plant. Furthermore, there was a positive correlation between number of siliques per plant and seed yield, indicating that lesser number of siliquas per plant would result in lower seed yield (Behl et al., 1994; Patel, 1999). Under drought stress condition, there were highly positive correlation with seed yield for 1000-seed weight, plant height and effective length of main raceme, which were in good agreement with Sabaghnia (2010). He found that in the water-stressed environment, seed yield was significantly positively correlated with 1000-seed weight, Plant height and main stem length.

The present study also showed that, under drought stress condition, 1000-seed weight had significant and positive direct effect on yield. Similar results have previously been reported by Usman Saleem in wheat. They found that 1000-grain weight showed the maximum positive direct effect on grain yield.

In conclusion, in term of the drought stress, 1000-seed weight, effective length of main raceme, days from seeding to initial flowering and growth duration had significantly direct effect on seed yield, which could be served as selecting criteria in breeding program for drought tolerant rapeseed.

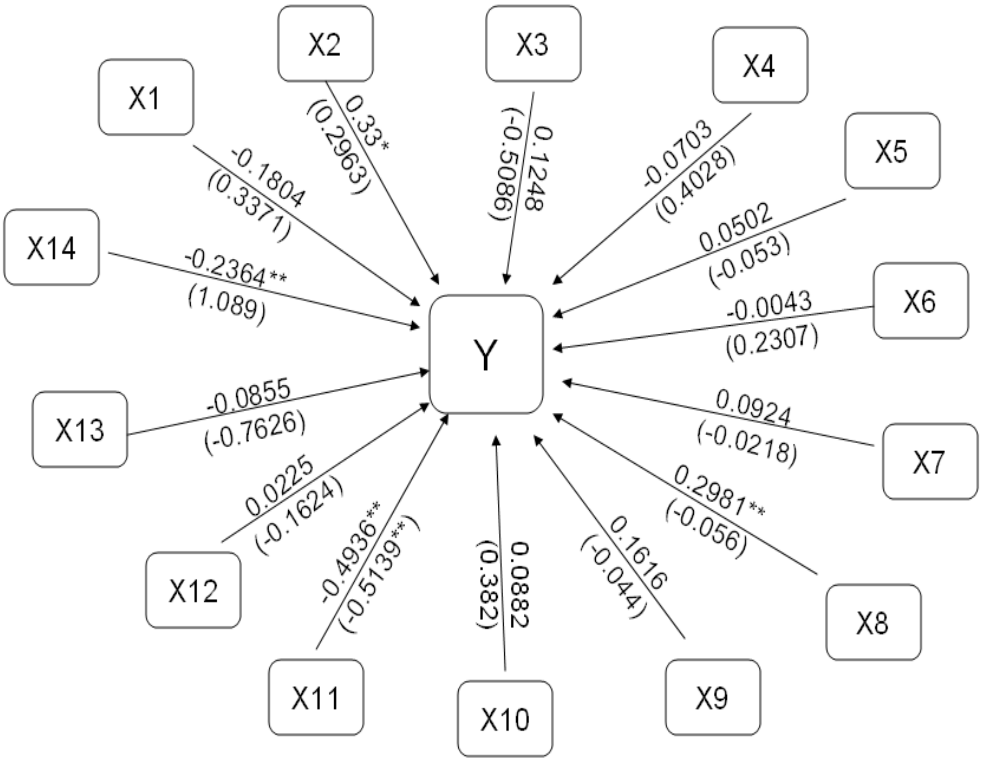

Figure 1 Path coefficient diagrams showing the effects of plant height (X1), effective length of main raceme (X2), branch height (X3), pod density (X4), the number of primary branches (X5), number of pods per plant (X6), number of seeds per pod (X7), 1000-seed weight (X8), days from seeding to budding (X9), days from seeding to bloting (X10), days from seeding to initial flowering (X11), days from seeding to end of flower (X12), days from seeding to maturity (X13) and growth duration (X14) on plot yield (Y). Path coefficient within and outside parentheses were measure under irrigated and drought stress condition, respectively.

Table 1 Correlation coefficients of agronomic traits for rapeseed under drought and irrigated conditions

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	y
x1		0.146	0.747**	0.325*	-0.397*	-0.238	0.157	-0.103	0.099	0.099	0.420**	0.454**	0.201	0.083	-0.260
x2	0.655**		0.231	0.115	-0.307	0.066	0.170	0.022	0.267	0.280	0.390*	0.400*	0.080	-0.127	-0.100
x3	0.669**	0.075		0.337*	-0.320*	-0.131	0.137	-0.035	0.137	0.209	0.672**	0.586**	0.479**	0.279	-0.529**
x4	-0.150	-0.466**	0.088		-0.352*	0.198	0.061	-0.156	0.665	0.580**	0.322**	0.102	0.040	-0.513**	-0.169
x5	0.194	0.426**	-0.254	-0.183		.655**	-0.290	0.156	-0.433	-0.433**	-0.547**	-0.455**	-0.334*	0.048	0.513**
x6	0.380*	0.575**	-0.244	-0.181	0.478**		-0.196	-0.053	0.108	0.028	-0.214	-0.250	-0.242	-0.345*	0.324*
x7	0.024	-0.095	-0.037	0.664**	-0.111	0.042		-0.389*	0.297	0.227	0.245	0.240	0.229	-0.020	-0.290
x8	0.266	0.378*	0.168	-0.169	-0.099	0.133	0.052		-0.389*	0.297	0.227	0.245	0.240	0.229	-0.020
x9	-0.449**	-0.620**	-0.062	0.255	-0.020	-0.386*	-0.357*	-0.567**		.847**	0.455**	0.163	0.098	-0.570**	-0.348*
x10	-0.489**	-0.636**	-0.224	0.225	-0.049	-0.323*	-0.085	-0.473**	0.671**		0.601**	0.306	0.138	-0.434**	-0.355*
x11	-0.486**	-0.735**	0.004	0.360*	-0.158	-0.425**	-0.209	-0.530**	0.871**	0.646**		0.743**	0.584**	0.171	-0.712**
x12	-0.409*	-0.581**	0.000	0.389*	-0.061	-0.381*	-0.226	-0.492**	0.871**	0.445**	0.851**		0.719**	0.470**	-0.532**
x13	-0.471**	-0.627**	-0.066	0.444**	-0.180	-0.208	-0.144	-0.267	0.721**	0.569**	0.806**	0.778**		0.703**	-0.567**
x14	-0.478**	-0.681**	-0.044	0.615**	-0.248	-0.283	0.034	-0.244	0.709**	0.533**	0.800**	0.804**	0.958**		-0.189
y	0.487**	0.785**	0.042	-0.474**	0.238	0.362*	0.052	0.605**	-0.769**	-0.602**	-0.898**	-0.788**	-0.788**	-0.801**	

See Figure 1 for traits abbreviations. The upper triangle was measured under irrigated condition, while the lower triangle was measured under drought stress condition. *and**denote significance at 0.05 and 0.01 levels, respectively.