Indian J. Genet., **52** (3): 280–284 (1992)

MORPHO-PHYSIOLOGICAL DETERMINANTS OF OIL YIELD IN *BRASSICA JUNCEA* UNDER DRYLAND CONDITIONS

R. K. BEHL, B. D. CHAUDHARY*, R. P. SINGH AND D. P. SINGH

Directorate of Research, Haryana Agricultural University, Hisar 125004

(Received: November 8, 1990; accepted: December 19, 1991)

ABSTRACT

Selection criteria specific for oil improvement in *Brassica juncea* under dryland conditions are defined using data on six main and nine subcomponent characters recorded on 25 genotypes. Phenotypic correlation coefficients of oil yield with siliquae/plant, seed yield and turgor potential were positive and significant. Path coefficient analysis extended to determine effects of main and subcomponents via main components revealed that direct effects of most of the main components towards oil yield were low, except seed yield. Siliquae per plant, seed weight and turgor potential had high indirect effects via seed yield. Subcomponents shoot length, seeds per siliqua, secondary branches, siliqua length, relative water content and osmotic potential contributed to oil yield via one or more main components. Selection based on these main and subcomponents would facilitate integration of improved oil yield and homeostatic effects.

Key words: Oil yield, water stress, morpho-physiological determinants, *Brassica juncea*.

Various plant physiological processes are influenced under water stress conditions [1, 2] which hamper growth, alter character associations and result in reduced grain yield. Selection indices effective for oil yield improvement in assured input condition, thus, may not be applicable in rainfed condition. Further, the oil yield per se in Brassicas is a function of seed yield and oil content which, in turn, are influenced by many sequential morpho-physiological characters. Genetic variability for these morpho- physiological determinants has been reported in earlier paper [2]. The present investigation, therefore, aims to identify causal relationship among main morpho-physiological components of oil yield and other secondary characters influencing these main components in Brassicas under dryland conditions.

MATERIALS AND METHODS

Ecologically and morpho-physiologically diverse twenty five genotypes of *Brassica*

---

*Author for correspondence.

juncea were sown in a randomized block design with three replications at the Dryland Farming Research Centre, Bawal (sandy loam soil retaining 15.4% and 3.6% water at 0.3 and 15 bar tension, respectively, 0.18% organic carbon). Each genotype was accommodated in 10 rows of 1.2 m length with 30 x 15 cm spacing.

Data were recorded on 5 randomly selected competitive plants for seed yield and yield attributes. Leaf water potential using pressure chamber (PMS Instrument Corporation, USA) and leaf osmotic potential using 5100-B vapour pressure osmometer (Wescor, U.S.A.) were measured concurrently to compute turgor potential [2]. Water loss from the whole excised plants was calculated on the basis of changes in initial weight and weight after 24 h of air drying. Mean data were used to compute correlations. These fifteen characters were partitioned into main and subcomponents for computing direct and indirect effects following [3, 4].

RESULTS AND DISCUSSION

Phenotypic correlation coefficients revealed that oil yield was positively associated with No. of siliquae (0.56) and seed yield (0.99) per plant. Harvest index was positively correlated with secondary branches (0.42), relative water content (0.54), seed weight (0.40), and turgor potential (0.62). Shoot length was positively associated with seeds per siliqua (0.60), secondary branches (0.54), osmotic potential (0.49), siliquae/plant (0.57), and negatively with harvest index (–0.53). Amongst physiological parameters, turgor potential was associated with secondary branches (0.45), osmotic potential (0.67), siliquae/plant (0.40), and harvest index (0.62). Most physiological components were loosely associated among themselves.

The 15 component characters of oil yield were partitioned into six main and nine subcomponents to determine causal relationship. The characters exhibiting significant correlation with oil yield, siliquae/plant, seed yield, seed weight, harvest index, oil content, and turgor potential were considered as first order variables (main components). All the remaining characters were grouped as second order variables (subcomponents).

Path coefficient analysis involving first order variables indicated that seed yield was the major component of oil yield (Table 1). Direct effects of seed weight and turgor potential

Table 1. Direct (in bold) and indirect effects of main components on oil yield in Brassicas under dryland conditions

Component	Silique per plant	Seed weight	Yield per plant	Harvest index	Oil content	Turgor potential	Total
Siliquae/plant	**–0.090**	–0.013	0.531	0.066	–0.004	0.074	0.564
Seed weight	0.008	**0.150**	0.248	–0.092	–0.010	–0.027	0.277
Yield/plant	–0.051	0.040	**0.944**	0.007	–0.005	0.062	0.997
Harvest index	0.026	0.060	–0.027	**–0.231**	0.013	0.116	–0.043
Oil content	–0.005	0.021	0.066	0.045	**–0.069**	–0.016	0.042
Turgor potential	–0.036	–0.022	0.312	–0.143	0.006	**0.187**	0.304

were substantial. Among the nine second order variables, shoot length and secondary branches contributed directly and indirectly, whereas primary branches, siliqua length, seeds/siliqua, and relative water content contributed directly via siliquae (Table 2; Fig. 1). Only seeds per siliqua and primary branches contributed via seed weight. However, shoot length and osmotic potential contributed via seed yield, whereas siliqua length and osmotic potential contributed via harvest index. Secondary branches and osmotic potential contributed directly and indirectly via oil content and turgor potential. Thus, all the second order variables were contributing for higher oil yield directly as well as indirectly via one or more first order variables. However, water loss was contributing only directly.

Internal plant water balance integrates the effect of soil moisture and atmospheric stress operating through plant system [5]. All the growth phenomenon including stomatal movement, transpiration and photosynthesis are turgor dependent. Maintenance of turgor in moisture stress condition is, therefore, essential as plant must retain the ability to function metabolically through osmotic adjustment. In an earlier study it was observed that genotypes with higher degree of osmotic adjustment were generally more productive under dryland conditions and osmotic adjustment was controlled by single gene and its component characters by two or more genes in *Brassica juncea* [6]. Blum [7] suggested that such simply inherited characters conferring some measure of tolerance to water stress must be used as selection indices. The present study in that context revealed that physiological

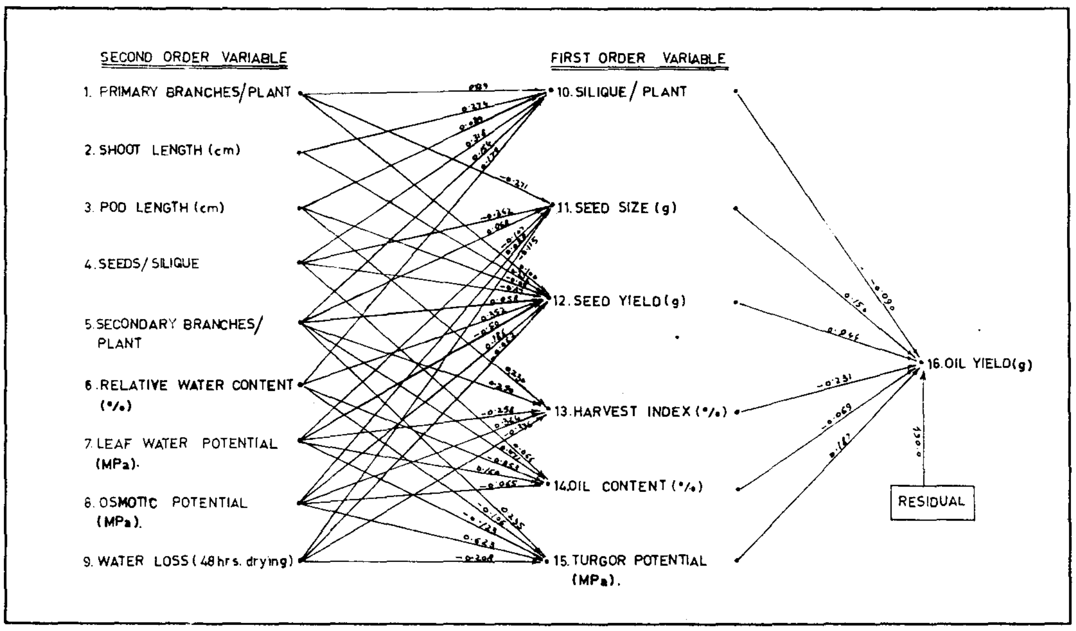

Fig. 1. **Contribution of first and second order variables to oil yield in Brassica under dryland conditions.**

Table 2. Direct and indirect effects of sub components* on main components of oil yield in Brassicas under dryland conditions

Character associations	Total	Primary branches	Shoot length	Siliqua length	Seeds per siliqua	Secondary branches	Water content	Water potential	Osmotic potential	Water loss
Silique per plant vs.:										
primary branches	0.24	0.13	0.07	0.01	–0.01	0.06	–0.02			
shoot length	0.57	0.04	0.27	0.01	0.19	0.08	–0.02			
siliqua length	0.21	0.02	0.04	0.09	0.01	0.04	0.01			
seeds/siliqua	0.52	–0.01	0.16	0.01	0.32	0.02	0.02			
secondary branches	0.40	0.05	0.15	0.02	0.04	0.15	–0.01			
water content	0.17	–0.01	–0.03	0.01	0.04	–0.01	0.18			
Seed weight vs.:										
primary branches	–0.22	–0.27			0.01	0.03		–0.02	0.01	0.03
seeds/siliqua	–0.25	0.03			–0.36	0.01		0.04	0.02	0.04
secondary branches	–0.05	–0.10			–0.04	0.07		–0.01	0.03	–0.01
water potential	–0.01	–0.04			0.12	0.01		–0.11	0.01	0.01
osmotic potential	–0.04	–0.02			–0.09	0.03		–0.02	0.09	–0.02
water loss	0.09	0.07			0.12	0.01		0.01	0.02	–0.12
Yield per plant vs.:										
primary branches	0.11	0.10	0.08	–0.01	0.01	0.02	–0.03	–0.07	0.02	0.02
shoot length	0.20	0.03	0.28	–0.01	–0.22	0.03	–0.04	0.05	0.09	0.01
siliqua length	–0.03	0.02	0.04	–0.09	–0.01	0.01	0.01	0.01	–0.02	–0.01
seeds/siliqua	0.07	–0.01	0.17	–0.01	–0.37	0.01	0.04	0.17	0.05	0.02
secondary branches	0.22	0.04	0.15	–0.02	–0.04	0.06	–0.01	–0.03	0.07	–0.01
water content	0.27	–0.01	–0.03	–0.01	–0.04	–0.01	0.35	0.04	–0.02	–0.02
water potential	–0.39	0.02	–0.03	0.01	0.12	0.01	–0.03	–0.51	0.03	0.01
osmotic potential	0.14	0.01	0.14	0.01	–0.09	0.02	–0.04	–0.08	0.19	–0.01
water loss	0.17	–0.03	–0.01	–0.01	0.12	0.01	0.11	0.01	0.03	–0.06
Harvest index vs.:										
siliqua length	0.26			0.23		0.06		0.01	–0.03	–0.01
secondary branches	0.42			0.06		0.25		–0.01	0.14	–0.02
water potential	–0.19			–0.01		0.01		–0.26	0.06	0.01
osmotic potential	0.34			–0.02		0.09		–0.04	0.36	–0.06
osmotic potential	–0.26			0.01		0.01		0.01	0.07	–0.34
water loss	–0.01				0.07	0.01	–0.01	–0.05	–0.02	
Oil content vs.:										
seeds/siliqua	0.06				0.01	0.07	0.01	0.01	–0.02	
secondary branches	–0.05				0.01	–0.01	–0.05	–0.01	0.01	
water content	0.14				–0.02	0.01	0.01	0.16	–0.01	
water potential	0.09				0.02	0.03	0.01	0.03	–0.07	
osmotic potential	0.45					0.24	0.01	–0.01	0.23	–0.01
Turgor potential vs.:										
secondary branches	–0.23					–0.01	–0.11	0.01	–0.07	–0.06
water content	–0.01					0.01	0.01	–0.12	0.10	0.01
water potential	0.67					0.09	0.01	–0.02	0.62	–0.04
osmotic potential										
water loss	–0.11					0.01	–0.03	0.01	0.11	–0.21

characters influencing seed/oil yield, such as leaf water potential, osmotic potential, relative water content, turgor potential and water loss from excised leaves furnish reliable indices to explain moisture stress vis-a-vis homeostatic mechanism under limited soil moisture conditions as reported earlier [8, 9]. Therefore, concomitant selection criteria based on these characters may complement conventional methods and hasten effective improvement in Brassicas for maximizing oil yield under rainfed conditions.

REFERENCES

1. T. C. Hsiao. 1973. Plant responses to water stress. Ann. Rev. Plant Physiol., **24**: 519–570.

2. R. P. Singh, B. P. S. Malik and D. P. Singh. 1987. Variation for morphophysiological characters in genotypes of Indian mustard. Indian J. agric.Sci., **57**: 225–230.

3. D. R. Dewey and K. H. Lu. 1959. A correlation and path coefficient analysis of crested wheat grass seed production. Agron. J., **51**: 515–518.

4. M. H. Ismail. 1983. Investigation on Using Small Plot Sizes in Performance Tests and on Evolving an Ideotype for Higher Grain Yield in Peas (*Pisum sativum* L.). D. Sc. Thesis. Georg- August-University, Goettingen, Germany.

5. N. C. Turner. 1986. Crop water deficits: a decade of progress. Adv. Agron., **39**: 1–51.

6. B. D. Chaudhary, D. P. Singh, P. Singh and A. Kumar. 1989. Inheritance studies of plant water relations in *Brassica juncea*. Biol. Plant., **31**: 202–206.

7. A. Blum. 1979. Genetic Improvement of drought resistance in crop plants. A case for sorghum. *In*: Stress Physiology in Crop Plants (eds. H. Mussell and R. Staples). Wiley, New York: 429–445.

8. S. K. Thukral, R. K. Behl and R. Kumar. 1985. Water stress effects on some important physio-morphological attributes in oilseed brassica. Ann. Bio., **1**: 209–215.

9. J. B. Passioura. 1986. Resistance to drought and salinity: avenues for improvement. Aust. J. Pl. Physiol., **13**: 191–201.