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PERFORMANCE OF OILSEED *BRASSICA* IN DIFFERENT WATER REGIME

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Abstract

Ten different varieties of *Brassica napus* L., were treated with three different water regimes, single irrigation applied at flowering stage, two irrigations at flowering and pod formation and three irrigations at flowering, pod formation and at maturity stage. Con-III matures early from all the entries indicating that it can escape high temperature stress prevailing at later stage of the crop season. The variety Hyola-42 showed better performance under single irrigation indicating that it has drought tolerance under phenotypic observation than all other entries under study.

Introduction

Oleiferous *Brassica* (rapeseed and mustard) is an important oilseed crop of Pakistan, but its production per unit area is very low i.e., 908 kg ha^{-1} (Anon., 2000). There are many factors responsible for its low yield per unit area, but the most important one is the non-availability of seeds of high yielding varieties. It is therefore, imperative to develop improved varieties of oilseed brassica to bridge the gap between local production and import of edible oil. Genetic selection for higher yield always plays a major role in grain yield (Ghosh & Gulati, 2002; Ghosh *et al.,* 2002). Agronomic practices alongwith gene combination just trigger the inherent potential of varieties (Javed *et al*., 2000; Mahla *et al*., 1990, 1991; Rehman *et al*., 1987; Robbelen, 1990; Rehman, 1996; Shah *et al*., 1990, 1998, 1999). At present, scarcity of water causes lot of reduction in grain yield. According to Singh (1995), drought is the second largest contributor to yield reduction after diseases. Deficiency of water during any growth stage often results in a loss of grain yield. However, the magnitude of yield reduction depends on the growth stage of the crop at the time of stress, the severity and duration of stress and susceptibility of the genotype to stress. Water stress during vegetative development reduces expansion of leaves, stems and roots and ultimately affects the development of reproductive organs and potential grain yield. Although, numerous authors have examined the responses of crop plants to water stress and suggested various mechanisms that may result in improved drought resistance, a clear understanding of the morphological and physiological characteristics that is responsible for differential response to stress does not exist. Information is therefore necessary for identifying differing drought resistance mechanism between genotypes within species.

The present study was therefore, carried out to evaluate the performance of *Brassica napus* varieties for yield and yield components under different water regimes to select drought tolerant varieties to be grown in the Province of Sindh, Pakistan.

Materials and Methods

The experiment was conducted in 2 consecutive Rabi seasons of 1999-2000 and 2000-2001, at the experimental farm, Nuclear Institute of Agriculture, Tandojam. The treatment comprised of three water regimes and 10 varieties of *Brassica napus* L. The treatments were compared in a split plot design keeping the varieties in the main plots and irrigation levels in sub plots replicated three times and each plot consisted of five-meter long, five rows, 30 cm apart. Single irrigation was applied at flowering stage, two irrigations were applied at flowering and pod formation and three irrigations were applied at flowering, pod formation and at maturity stage. The soil of the experimental field was clay loam in texture, having field capacity 15%. The soil moisture content at the time of sowing was 12.5%. The average value of maximum and minimum temperature for the month of October was 40 ^{o}C and 28 ^{o}C, respectively. Ten plants were randomly selected from each plot to record the data on yield and yield components, while three central rows were harvested to estimate yield per unit area. The data were analyzed statistically according to Gomez & Gomez (1984) and the mean values were compared by DMR test at 5 % level of significance.

Results and Discussion

Single irrigation: Significant ($P \leq 0.05$) differences were observed amongst all the entries for the traits under evaluation. The minimum plant height was recorded for Con-III (140.9 cm), followed by Rainbow (149.00) and Hyola-42 (151.1cm) under single irrigation during 1999-2000. Con-III matures in 113.0 days under single irrigation during 1999-2000 (Table 1). Plant height is an important yield contributing character in oleiferous Brassica. The reduction in plant height causes an increase in grain yield, because of good response to higher doses of fertilizer and tolerance to lodging under unfavourable weather conditions (Olejniczak & Adamska, 1999). Hyola-42 (19.80) and Dunckled (19.80) produced highest grains per pod followed by Con-III (19.40) and also exhibited higher 1000-grain weight, whereas, Hyola-42 (1252) followed by Con-III (1240) and Dunckled (1235) were significantly ($P\leq 0.05$) superior to other entries in grain yield (Table 1). Yadava *et al*., (1973) demonstrated that seed per pod and 1000-seed weight directly influenced the seed yield in mustard. Chauhan & Kumar (1986) and Shah *et al*., (1990) also reported similar results. Oil content is a basic important component of oilseed crops. Of all the genotypes under evaluation, the highest oil content was produced by Hyola-42 (38.50%) (Table 1). Similar trends for all the traits were observed in subsequent year (Table 2) and in pooled data over the years (Table 3).

Two irrigation: All the varieties for the traits under evaluation were significantly ($P\leq0.05$) different among themselves. The variety Con-III was observed as short stature (139.7, 133.30 cm) and matured early (113.7, 130.7 days), respectively (Table 4 & 5). Maximum grains per pod were observed in Dunckled (20.44) and Con-III (19.68) followed by Hyola-42 (19.43) (Table 4). Con-III (21.40, 20.54) and Hyola-42 (20.58, 20.01) followed by Dunckled (19.27, 19.86) produced highest grains per pod, respectively (Table 5 & 6). Highest 1000-grain weight was observed in Hyola-42 (3.79, 3.92) followed by Con-III (3.68, 3.92), this may be because of bold type of seed than the other entries (Table 4 & 5). Bajpai *et al*., (1981) and Shah *et al*., (1990) also reported similar results. Hyola-42 (1981.00) and Con-III (1922.00) followed by Dunckled (1630.00) produced maximum grain yield (kg ha^{-1}) during 1999-2000 (Table 4). However, Con-III (2173.00) and Hyola-42 (1969.00) were on top during 2000-2001 (Table 5).

Table 1. Performance of Drought Trial I (Single Irrigation) 1999-2000.

	Maturity (Days)	Plant height (cm)	Grains/Pod (No.)	1000 Grain Wt. (g)	Grain yield (Kg/ha)	Oil content (%)
Abasin 95	135.30[cd]	157.50[bcd]	15.62[d]	2.67[bc]	1225.00[a]	36.83[ab]
Con-I	139.00[a]	163.10[abc]	14.31[e]	2.95[b]	888.90[c]	37.08[ab]
Con-II	136.00[bcd]	159.90[abc]	14.78[e]	2.71[bc]	1233.00[a]	35.08[b]
Con-III	113.00[e]	140.90[d]	19.40[a]	3.29[a]	1240.00[a]	36.67[ab]
Dunckled	136.00[bcd]	167.00[abc]	19.80[a]	3.07[ab]	1235.00[a]	37.42[ab]
Hyola-42	136.00[bcd]	151.10[bcd]	19.80[a]	3.08[ab]	1252.00[a]	38.50[a]
Oscar	137.30[abc]	175.80[a]	17.39[b]	3.15[a]	777.80[d]	37.92[a]
Rainbow	138.00[ab]	149.00[cd]	19.00[a]	2.54[c]	1083.00[b]	37.92[a]
Shiralee	135.30[cd]	155.50[bcd]	16.69[c]	3.25[a]	491.70[e]	36.42[ab]
Westar	134.00[d]	168.20[ab]	17.31[b]	3.04[ab]	850.00[c]	37.92[a]

Table 2. Performance of Drought Trial I (Single Irrigation) 2000-2001.

	Maturity (Days)	Plant height (cm)	Grains/Pod (No.)	1000 Grain Wt. (g)	Grain yield (Kg/ha)	Oil content (%)
Abasin 95	145.00[bc]	166.40[b]	16.44[d]	3.52[c]	1721[bc]	38.75[b]
Con-I	144.30[cd]	164.40[b]	19.20[bc]	3.82[a]	1330[de]	38.08[b]
Con-II	146.30[bc]	181.30[a]	19.07[bc]	3.66[abc]	1285[de]	38.50[b]
Con-III	131.70[f]	131.40[f]	20.30[ab]	3.88[a]	1836[ab]	40.33[a]
Dunckled	144.30[cd]	150.80[d]	19.90[abc]	3.86[a]	1737[bc]	38.83[b]
Hyola-42	142.70[de]	141.00[e]	21.47[a]	3.91[a]	2054[a]	38.75[b]
Oscar	142.00[e]	132.30[f]	18.60[bc]	3.77[ab]	1457[cd]	38.33[b]
Rainbow	147.00[ab]	164.70[b]	19.90[abc]	3.55[bc]	1067[e]	38.42[b]
Shiralee	148.70[a]	167.70[b]	16.60[d]	2.88[e]	1676[bc]	38.25[b]
Westar	148.70[a]	157.60[c]	18.47[c]	3.16[d]	1587[bcd]	38.00[b]

Table 3. Performance of Drought Trial I (Single Irrigation) Pooled data over 1999-2001.

	Maturity (Days)	Plant height (cm)	Grains/Pod (No.)	1000 Grain Wt. (g)	Grain yield (Kg/ha)	Oil content (%)
Abasin 95	140.15[a]	161.95[b]	16.03[d]	3.10[f]	1473.00[c]	37.79[ab]
Con-I	141.65[a]	163.75[b]	16.76[d]	3.39[d]	1109.45[e]	37.58[ab]
Con-II	141.15[a]	170.60[a]	16.93[d]	3.19[e]	1259.00[d]	36.79[b]
Con-III	122.35[b]	136.15[e]	19.85[b]	3.59[a]	1538.00[b]	38.50[a]
Dunckled	140.15[a]	158.90[c]	19.85[b]	3.47[c]	1486.00[c]	38.13[a]
Hyola-42	139.35[a]	146.05[d]	20.64[a]	3.50[b]	1653.00[a]	38.63[a]
Oscar	139.65[a]	154.05[c]	17.99[c]	3.46[c]	1117.40[e]	38.13[a]
Rainbow	142.50[a]	156.85[c]	19.45[b]	3.05[g]	1075.00[f]	38.17[a]
Shiralee	142.00[a]	161.60[b]	16.65[d]	3.07[g]	1083.85[f]	37.34[ab]
Westar	141.35[a]	162.90[b]	17.89[c]	3.10[f]	1218.50[d]	37.96[ab]

Value with a common letter within a single character are not significantly different of 5% level.

Table 4. Performance of Drought Trial II (Two Irrigation) 1999-2000.

	Maturity (Days)	Plant height (cm)	Grains/Pod (No.)	1000 Grain Wt. (g)	Grain yield (Kg/ha)	Oil content (%)
Abasin 95	138.00^{bc}	167.50^{bc}	18.75^{c}	3.07^{f}	1278.00^{e}	35.50 A
Con-I	140.30^{ab}	189.00^{a}	17.41^{d}	3.52^{c}	996.70^{g}	34.22 ABC
Con-II	135.00^{cd}	162.10^{c}	15.80^{e}	3.19^{e}	1111.00^{f}	33.08 ABC
Con-III	113.70^{e}	139.70^{d}	19.68^{b}	3.68^{b}	1922.00^{b}	31.17 C
Dunckled	136.00^{cd}	173.00^{abc}	20.44^{a}	3.65^{b}	1630.00^{c}	34.17 ABC
Hyola-42	136.00^{cd}	171.70^{bc}	19.43^{b}	3.79^{a}	1981.00^{a}	35.42 A
Oscar	134.30^{d}	180.50^{ab}	19.00^{bc}	3.15^{e}	888.90^{g}	31.33 BC
Rainbow	138.00^{bc}	161.20^{c}	19.11^{bc}	3.19^{e}	1380.00^{d}	35.58 A
Shiralee	136.30^{cd}	165.20^{bc}	17.80^{d}	3.57^{c}	1278.00^{e}	33.92 ABC
Westar	143.00^{a}	175.60^{abc}	19.30^{b}	3.44^{d}	1481.00^{d}	34.50 AB

Table 5. Performance of Drought Trial II (Two Irrigation) 2000-2001.

	Maturity (Days)	Plant height (cm)	Grains/Pod (No.)	1000 Grain Wt. (g)	Grain yield (Kg/ha)	Oil content (%)
Abasin 95	148.00^{a}	158.00^{bc}	16.77^{d}	3.70^{ab}	1732^{cd}	40.08^{ab}
Con-I	145.70^{bc}	174.70^{a}	18.60^{bcd}	3.74^{ab}	1528^{d}	39.92^{ab}
Con-II	145.00^{c}	162.40^{b}	16.60^{d}	3.85^{a}	1266^{e}	40.42^{a}
Con-III	130.70^{e}	133.30^{f}	21.40^{a}	3.92^{a}	2173^{a}	39.25^{ab}
Dunckled	140.30^{d}	150.20^{d}	19.27^{abc}	3.89^{a}	1948^{b}	40.25^{ab}
Hyola-42	142.00^{d}	143.10^{e}	20.58^{ab}	3.92^{a}	1969^{b}	39.33^{ab}
Oscar	142.00^{d}	137.90^{ef}	16.43^{d}	3.79^{a}	1593^{d}	39.50^{ab}
Rainbow	145.00^{c}	155.60^{cd}	17.27^{cd}	3.81^{a}	1733^{cd}	39.33^{ab}
Shiralee	147.30^{ab}	156.90^{bc}	16.97^{d}	3.56^{b}	1851^{bc}	39.00^{b}
Westar	147.70^{a}	160.30^{bc}	18.67^{bcd}	3.84^{a}	1556^{d}	39.17^{ab}

Table 6. Performance of Drought Trial II (Two Irrigation) Pooled data over 1999-2001.

	Maturity (Days)	Plant height (cm)	Grains/Pod (No.)	1000 Grain Wt. (g)	Grain yield (Kg/ha)	Oil content (%)
Abasin 95	143.00^{a}	162.75^{b}	17.76^{f}	3.39^{g}	1505.00^{d}	37.79^{a}
Con-I	143.00^{a}	181.85^{a}	18.01^{ef}	3.63^{d}	1262.35^{e}	37.07^{a}
Con-II	140.00^{a}	162.25^{b}	16.20^{h}	3.52^{ef}	1188.50^{f}	36.75^{ab}
Con-III	122.20^{c}	136.50^{d}	20.54^{a}	3.80^{b}	2047.50^{a}	35.21^{b}
Dunckled	138.15^{b}	161.60^{b}	19.86^{c}	3.77^{c}	1789.00^{c}	37.21^{a}
Hyola-42	139.00^{b}	157.40^{c}	20.01^{b}	3.86^{a}	1975.00^{b}	37.37^{a}
Oscar	138.15^{b}	159.20^{c}	17.72^{f}	3.47^{f}	1240.95^{e}	35.42^{b}
Rainbow	141.50^{a}	158.40^{c}	18.19^{e}	3.50^{f}	1556.50^{d}	37.46^{a}
Shiralee	141.80^{a}	161.05^{b}	17.39^{g}	3.57^{e}	1564.50^{d}	36.46^{ab}
Westar	145.35^{a}	167.95^{b}	18.99^{d}	3.64^{d}	1518.50^{d}	36.84^{ab}

Value with a common letter within a single character are not significantly different of 5% level.

Table 7. Performance of Drought Trial III (Three Irrigation) Pooled data over 1999-2000.

	Maturity (Days)	Plant height (cm)	Grains/Pod (No.)	1000 Grain Wt. (g)	Grain yield (Kg/ha)	Oil content (%)
Abasin 95	142.00^{bc}	151.00^{cd}	19.37^{cd}	4.18^{a}	1500.00^{e}	41.25^{a}
Con-I	146.00^{a}	145.00^{e}	17.62^{d}	3.62^{cd}	1333.00^{f}	40.50^{b}
Con-II	141.30^{cd}	157.40^{ab}	15.98^{e}	3.63^{cd}	1501.00^{ef}	41.25^{a}
Con-III	115.70^{g}	139.40^{f}	20.50^{b}	3.90^{a}	2344.00^{c}	39.62^{c}
Dunckled	137.70^{e}	160.10^{a}	21.44^{a}	3.90^{a}	2722.00^{a}	40.25^{bc}
Hyola-42	138.70^{de}	154.80^{bc}	21.51^{a}	3.96^{a}	2500.00^{b}	40.37^{b}
Oscar	142.70^{bc}	150.00^{d}	19.87^{c}	3.77^{bc}	1008.00^{g}	40.25^{bc}
Rainbow	139.70^{d}	149.00^{de}	19.24^{cd}	3.80^{b}	1589.00^{e}	40.75^{ab}
Shiralee	138.30^{de}	144.00^{e}	19.58^{c}	3.94^{a}	1528.00^{e}	40.50^{b}
Westar	146.00^{a}	152.00^{cd}	19.66^{c}	3.51^{d}	1933.00^{d}	40.25^{bc}

Table 8. Performance of Drought Trial III (Three Irrigation) Pooled data over 2000-2001.

	Maturity (Days)	Plant height (cm)	Grains/Pod (No.)	1000 Grain Wt. (g)	Grain yield (Kg/ha)	Oil content (%)
Abasin 95	145.00^{ab}	160.30^{bc}	18.87^{a}	3.67^{bc}	2199.00^{b}	39.83^{a}
Con-I	149.00^{a}	164.30^{b}	15.27^{b}	3.79^{ab}	1676.00^{cd}	40.17^{a}
Con-II	144.70^{ab}	155.30^{c}	15.67^{b}	3.47^{c}	1763.00^{c}	39.17^{ab}
Con-III	133.70^{c}	124.90^{e}	20.05^{a}	3.91^{ab}	2819.00^{a}	39.75^{a}
Dunckled	143.30^{b}	144.10^{d}	18.88^{a}	3.99^{a}	2371.00^{b}	39.42^{a}
Hyola-42	144.30^{b}	130.90^{e}	19.60^{a}	3.86^{ab}	2650.00^{b}	39.33^{ab}
Oscar	145.00^{ab}	141.90^{d}	16.27^{b}	3.79^{ab}	2369.00^{b}	39.17^{ab}
Rainbow	145.30^{ab}	144.90^{d}	16.93^{b}	3.75^{abc}	1450.00^{d}	39.42^{a}
Shiralee	149.00^{a}	164.50^{b}	16.67^{b}	3.79^{ab}	1425.00^{d}	38.00^{b}
Westar	146.30^{ab}	181.80^{a}	12.30^{c}	3.89^{ab}	1823.00^{c}	39.00^{ab}

Table 9. Performance of Drought Trial III (Three Irrigation) Pooled data over 1999-2001.

	Maturity (Days)	Plant height (cm)	Grains/Pod (No.)	1000 Grain Wt. (g)	Grain yield (Kg/ha)	Oil content (%)
Abasin 95	143.50^{a}	155.65^{b}	19.12^{b}	3.93^{a}	1849.50^{b}	40.54^{a}
Con-I	147.50^{a}	154.65^{b}	16.45^{d}	3.71^{c}	1504.50^{d}	40.34^{a}
Con-II	143.00^{a}	156.35^{b}	15.83^{e}	3.55^{d}	1632.00^{c}	40.21^{a}
Con-III	124.70^{b}	132.15^{d}	20.28^{a}	3.91^{a}	2581.50^{a}	39.69^{ab}
Dunckled	140.50^{a}	152.10^{b}	20.16^{a}	3.95^{a}	2546.50^{a}	39.84^{ab}
Hyola-42	141.50^{a}	142.85^{c}	20.56^{a}	3.91^{a}	2575.00^{a}	39.85^{ab}
Oscar	143.85^{a}	145.95^{c}	18.07^{c}	3.78^{c}	1688.50^{c}	39.71^{ab}
Rainbow	142.50^{a}	146.95^{c}	18.09^{c}	3.78^{c}	1519.50^{d}	40.09^{a}
Shiralee	143.65^{a}	154.25^{b}	18.13^{c}	3.87^{b}	1476.50^{e}	39.25^{b}
Westar	146.15^{a}	166.90^{a}	15.98^{e}	3.70^{c}	1878.00^{b}	39.63^{ab}

Value with a common letter within a single character are not significantly different of 5% level.

The pooled analysis revealed that Con-III maintained its superiority for maturity and dwarfness. Con-III ranked at the top by producing highest grain yield (2047.50). The varieties Hyola-42 and Dunckled ranked 2nd and 3rd position, respectively (Table 6).

Three irrigation: Significant differences ($P \leq 0.05$) were observed among varieties for the traits under evaluation. The variety Con-III was not only short stature (139.40, 124.90 cm), but also early in maturity (115.70, 133.70 days) during 1999-2000 and 2000-2001, respectively (Table 7 & 8). Chauhan & Kumar (1986), Das & Rahman (1988) and Shah *et al*., (1990) revealed that the dwarfness in plant height is associated with earliness in maturity. Maximum grains per pod was produced by Hyola-42 (21.51) and Dunckled (21.44), followed by Con-III (20.50) (Table 7). Dunckled (2722.00), Hyola-42 (2500.00) and Con-III (2344.00) produced maximum grain yield during 1999-2000 (Table 7). Highest grains per pod were observed in Con-III (20.05) followed by Hyola-42 (19.60) and Dunckled (18.88). Con-III (2819.00) and Hyola-42 (2650.00) followed by Dunckled (2371.00) showed maximum grain yield during 2000-2001 (Table 8).

The pooled analysis revealed that Con-III maintained its superiority for maturity and dwarfness. Con III produced highest grain yield (2581.50 kg ha^{-1}) and Hyola 42 (2575.00 kg ha^{-1}) followed by Dunckled (2546.50 kg ha^{-1}) (Table 9).

Conclusion

The overall performance of the genotypes for yield and yield components indicates that under single irrigation, varieties Hyola-42 and Con-III followed by Dunckled are superior to all other entries under study, hence they can withstand low levels of water regimes. Stone *et al*., (2001) reported that in sweet corn drought affects the grain yield by reducing the floret fertility. Whereas, Sharma & Kumar (1989) and Majid & Simpson (1997) reported that low water condition may be attributed to increased senescence of leaves which reduced photosynthetic rate thus causing low yield. In our result it was observed that two and three irrigations yielded better results as compared to single irrigation. Con-III matures early from all the entries indicating that it can escape high temperature stress prevailing at later in the crop season. The variety Hyola-42 performs best under single irrigation revealed that it has drought tolerance under phenotypic observation than all other entries under study. Biochemical analysis will be carried out to confirm drought tolerance phenomenon in Hyola-42 and Con-III.

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