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Determination of Optimum Irrigation Level and Compatible Canola Varieties in the Mediterranean Environment

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Abstract: The Mediterranean environment in Khuzestan province in the south of Iran is characterizing by over 30°C air temperature and heavy rainfall in early spring. Base on canola planting date, late production and ripening stages interference with high temperature, which result in limited seed yield. A experiment was conducted in Safi-Abad Agricultural Research Center for two years (2001-2003) with split - plot method and four replications. Three irrigation levels as spring irrigation cut off (SIC), one and two spring irrigation (OSI, TSI) and four varieties, i.e., Hayola 308 (H308), Hayola 401 (H401), PF7045/91 (PF) and Option 500 (OP), were examined in main and subplots respectively. Planting to flowering initiation period were completed before water stress started. The varieties in SIC, OSI and TSI treatments could tolerate 10.3, 9.8 and 9.8 days drought periods at 14, 20 and 38 seed ripening percent stages. Pods per plant, seed and oil yield decreased as water stress increased, however, water stress did not affect seed number per pod. Pods per plant, thousands seed weight, seed and oil yield in the earliest maturity variety (H308) in SIC were also decreased compared to TSI treatment by 8.0, 6.6, 8.8 and 2.7% . The results for the latest maturiting cultivar (PF) were 26.6, 10.7, 23.2 and 9.5%, respectively. Finally the results showed that earliest maturiting hybrids with drought escape mechanism are more adapted to water stress condition in this environment . Mid maturity Varieties in case of availability of one or two spring irrigation could be recommended, but the late maturity varieties such as PF for this environment are not advised.

Key words: Canola, varieties, irrigation, drought stress

INTRODUCTION

The Khuzestan's wheat planting area is about 500,000 hectares. Canola is one of the best crops for rotation with wheat. High temperature during maturation and ripening is a major source of stress in Khuzestan's Mediterranean environments. Under this condition, temperature often exceeds 30°C, rainfalls stops and hence, competition increases for irrigation water.

Based on research, the best planting date for canola in this area is about mid November, but the late reproduction and ripening stages are concurrent with high temperature and reduced kernel number and seed yield (Rahnema, 2002). Other researchers like Angadi *et al*. (2003), Mailer and Crnish (1987) and Walton and Bowden (1997) also reported that during their experiments the post anthesis duration was significantly correlated with the post anthesis rainfall and was negatively correlated with the mean daily temperature during seed development. Delayed seeding reduce seed and oil yields even when the crops are irrigated and experience no moisture shortage. Early seeding enhances yield by avoiding high temperature stress during the sensitive reproductive growth stage, so increases the seed number per pods (Rahnema, 2002).

Degenhardt and Kondra (1981) reported a 94% increase in the total dry matter from delayed seeding, but there was a 20% decline in seed production, which was not affected by variety or altering seeding rates from 3 to 12 kg ha^{-1}. There was no impact of delayed seeding on seed size, but the decline in yield was related to number of seeds per unit area.

Gunasekera *et al.* (2003) reported that rainfall and thus soil moisture are the most important factors affecting crop production in the typical Mediterranean environment of southwestern Australia. Seed yield is primarily limited by the relatively short duration of the growing season and the severe deficit of soil moisture during the latter phases of reproductive development. Genotypes having greater tolerance to water stress, in addition to earliness, generally would have positive effect on improving adaptability and seed yield in such environments.

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Nielsen (1997) reported that water stress during the grain-filling stage resulted in a more rapid loss of leaf area than during other growth stages. Lowre yield resulted from fewer branches per plant, pods per branch and smaller seeds.

Sims *et al.* (1993) observed that canola yield in Montana increased with higher availability of water , but had a lower mean oil content. Mailer and Cornish (1987) determines that oil content fell from 36.9 to 31.4% when high temperature occurred during the post anthesis seed development in canola. Final seed number and seed yield reduction was approved by high temperature effect during reproductive and ripening growth stage. For these regions with high temperature and the shortage of water during ripening and maturation stages still we need to introduce new varieties to farmers which could more adapted to this environment and also to identify the best optimum irrigation level for this region.

MATERIALS AND METHODS

This study was conducted for two years, (i.e., 2001-2002 and 2002-2003) in Safi -Abad Agricultural Research Center in south of Iran, which is located of coordinates 32°26" N and 48°26" W and an altitude of 82.9 meter with a mean annual rainfall of 343 mm, on annual mean temperature of 32.8°C, with maximum and minimum temperatures of 35°C and 6°C respectively. Experimental were conducted in soil with a silt clay texture, EC=1.5 Millimouse and pH = 7.7. Trail were carried out in randomized complete block design in split plot with four replications. The three irrigation levels included Spring Irrigation main plots cut off (SIC), one and Two Spring Irrigations (OSI and TSI) were applied. The four canola sub plots varieties included Hayola 308(H308), Hyola 401 (H401), Option 500 (OP) and Pf 7045/91 (PF) with different maturity duration were used. Nearly seven days after irrigation ended, leaf temperature was measured by infrared thermometer of Everest model no. S10B which advised by Coardner *et al.* (1992).

Two lines from each sub plots of 2.4 sq·m were harvested for yield and yield components records. Row data were analyzed by MSTATC and means ANOVA were compared by Duncan's Multiple Range Test at 5% level.

RESULTS AND DISCUSSION

Over the long term, Khuzestan's mean temperature and evaporation rates, suddenly increased in April, while humidity decreased and with no or few effective rainfall occurrence. Out of 35 recorded rainfalls in 2001, only 6 were effective however no effective rainfall occurred in spring 2002. So under such a good condition, SIC was accomplished. In the autumn 2002, only, nine effective rainfall occurred, but just once in April 2003 that was considered as irrigation chance. The planting to flowering initiation period occurred before water stress was experienced. For the two Hayola hybrides flowering began 75 days after planting and ended 105 days after planting. This period started at 96 and 120 days for OP and PF varieties respectively. The SIC and OSI related to TSI showed shorter growth duration as 7.8 and 3.8 days.

Based on the moisture curve and leaf surface temperature, varieties grown in the SIC and OSI irrigation regimes could tolerate in average 10.3 and 9.8 days drought period which was accompanied by 14 and 20% pod maturity, therefore pods per plant were decreased as water stress increased. Drought stress for even short period during pod formation drastically reduced the pods number even when the drought stress was removed (Angadi *et al.*, 2000; Coardner *et al.*, 1992).

The TSI treatment experienced 9.8 days drought during the stage of 38% of pods maturity without any damage to them and so was considered as control (Table 2). Angadi *et al.* (2000) also reported that drought treatment in Canola had no negative effect on seed number per residual pods when there was negative relationship between yield components.

Table 1 and 2 shows that SCI and OSI treatments led to a decrease of 15 and 5% seed weight compared to TSI. Also seed and oil yields in the SCI and OSI treatments were decreased compared to TSI. Walton and Bowden (1997) also reported that varieties, soil moisture and temperature during crop production stage in Canola are three major factors that impact seed and oil levels. As crop growth duration increased for and PF respectively. The drought period also increased from 6.3 to 14.3 days at pods maturity stage and resulted in reduction of Pods per plant, seed weight, seed and oil yields. The reduction was higher for PF variety compared to H308. In other word in case of drought period, there was a negative relation between maturity, yield and yield components. The same results also were reported by Angadi *et al.* (2000) and Jensen (1996).

The critical ripening period of Hayola hybrids with earliest maturity avoided the drought period, so had less drought damage than the two other varieties.

The results presented in Table 1, shows that the OP variety had similar seed yields in OSI and TSI treatments but in SCI it suffered from significant loss of 421.8 kg in seed yield. The yield of the late maturing cultivar in OSI and TSI treatments were not significantly different but in the SCI treatment it produced 32.1% less yield, indicating the highest drought damage.

Table 1: Comparison of Mean for yield and yield component

		2001-2002					2002-2003				
Treat		PPP	SPP	SW	SY	Oi	PPP	SPP	SW	SY	Oi
SIC		60.8b*	28.0a	3.4b	1877.4c	37.6d	68.2c	30.3a	3.5c	2317.0c	40.2b
OSI		63.5b	27.7a	3.8a	2030.1b	41.5b	80.5a	30.5a	3.8b	2605.7a	40.2b
TSI		75.3a	26.6b	3.9a	2480.7a	42.3a	84.0a	28.9b	4.1a	2589.3ab	41.5a
H308		73.8b	31.1a	4.1a	3014.9a	40.3b	83.9b	32.7a	4.5a	3354.5a	40.8b
H401		83.8a	22.2b	4.1a	2768.4b	41.7a	97.2a	31.9b	4.3a	3321.6a	41.5a
OP		47.9d	22.7d	3.2b	1162.8d	40.3b	55.1d	26.2d	3.1b	1471.7c	40.6b
PF		60.6c	26.7c	3.3b	1571.6c	39.5c	74.0c	28.7c	3.2b	1868.2b	39.6c
SIC	H308	69.9c	31.8ab	4.0b	2713.4cd	37.9e	77.3c	33.6ab	4.2d	3397.1a	41.3a-c
	H401	79.8b	29.4a-c	3.7c	2481.9d	39.7d	92.4ab	31.6ac	3.9e	3254.5a	41.7ab
	OP	39.9f	22.8e	3.1e	983.9h	37.5e	43.2e	26.4ef	3.0hi	1197.9d	39.3de
	PF	53.5de	27.9cd	2.7f	1330.4fg	35.4f	59.3d	29.7c	2.9i	1418.6c	38.4e
OSI	H308	74.5bc	32.4a	4.1b	2911.6bc	41.3bc	84.7bc	34.4a	4.5bc	3394.7a	40.5b-d
	H401	79.8b	28.5bc	4.1b	2713.6cd	42.4ab	103.6a	30.5c	4.4cd	3318.9a	40.4cd
	OP	46.0ef	22.4e	3.3de	1084.6gh	41.6bc	59.8d	27.4df	3.1gh	1597.4c	41.0bc
	PF	53.7d	27.6cd	3.7c	1410.7f	40.8cd	73.9c	29.6cd	3.4fg	2111.7b	39.0e
TSI	H308	77.0bc	29.1a-c	4.2b	3419.6a	41.8a-c	89.7b	30.1c	4.8a	3271.6a	40.6bc
	H401	91.8a	29.8a-c	4.5a	3109.7b	42.9a	95.6ab	33.6ab	4.7ab	3391.4a	42.5a
	OP	57.7d	22.9e	3.3de	1419.8f	41.9a-c	61.7d	24.9f	3.3fg	1619.7c	41.5a-c
	PF	74.5bc	24.6de	3.5cd	1973.6e	42.4ab	88.9b	26.8ef	3.5f	2074.3b	41.4a-c

PPP= Pod Per Plant, SW = Seed Weight, Oi = Oil Percent, SPP = Seed Per Plant, SY = Seed Yield, * = Duncan multiple range test

Table 2: Considered traits , yield and yield components reduction due to drought stress, mean of two years

Treat		Days to maturity	dry duration	Drought stage stress (%)	Water stress index	Pod reduction per plant (%)	Seed weight reduction (%)	Seed yield reduction (%)	Oil percent reduction(%)
SIC		159.8	10.3	14 pod maturity	16.8	19.1	13.7	17.4	7.1
OSI		163.6	9.8	20 // //	15.1	9.4	5.0	9.1	2.5
TSI		167.6	9.8	38 // //	14.2	0.0	0.0	0.0	0.0
H308		159.4	6.3	33 pod maturity	15.6	8.0	6.6	8.8	2.7
H401		162.4	8.0	25 // //	15.6	7.4	12.5	9.8	3.9
OP		165.0	11.3	18 // //	14.9	21.1	5.3	20.4	4.5
PF		164.8	14.3	18 // //	15.5	26.6	10.7	23.2	9.5
SIC	H308	157.1	7.0	20 pod maturity	16.6	11.5	8.7	10.3	4.7
	H401	158.0	8.0	15 // //	17.0	8.2	17.4	12.1	4.7
	OP	161.1	12.0	10 // //	16.8	30.4	7.6	28.3	7.9
	PF	163.3	14.0	10 // //	16.9	30.8	20.0	32.1	11.9
OSI	H308	158.1	6.0	30 pod maturity	16.0	4.4	4.4	7.4	0.7
	H401	162.0	8.0	20 // //	15.8	6.5	7.6	7.4	3.1
	OP	165.1	11.0	15 // //	13.6	11.7	3.0	12.5	1.0
	PF	169.0	16.0	15 // //	15.1	22.4	1.4	14.3	7.1
TSI	H308	163.0	6.0	50 pod maturity	14.2	0.0	0.0	0.0	0.0
	H401	164.1	8.0	40 // //	14.0	0.0	0.0	0.0	0.0
	OP	169.1	11.0	30 // //	14.2	0.0	0.0	0.0	0.0
	OP	171.0	13.0	30 // //	14.4	0.0	0.0	0.0	0.0

Irrigation and variety interaction effects showed that as irrigation increased the day to maturity in the varieties also increased by 3 to 9 days. More damage was observed when drought stress occurred during pods maturity stage (Table 2).

With increasing levels of spring irrigation, the heat index of the varieties decreased. In all varieties, pods per plants, kernel weight, seed and oil yields also decreased with increasing maturity period and reducing irrigation levels. Nielson (1997) and Gunasekera (2003) also emphasized that lower stress in addition to earliness would improve adaptation and seed yield in these environments.

The highest rate of yield reduction was occurred by SIC and OSI irrigation treatments in PF which was the late maturity variety. Also the lowest rate of yield reduction were obtained in SIC and OSI treatments in H308 hybrid respectively. Based on the obtained results varieties H308 and H401 were found to be highest in yield as well as in terms of water economy in this condition which colleted by high temperature and water shortage during grain filling and ripening stage, therefore could be selected for this region and introduced to farmers.

In Khuzestan's Mediterranean environment, relatively short duration of canola growing season and soil moisture deficits of the end season are the most important factors affecting canola seed yield production. Early maturiting genotypes, like Hyola-308 and Hyola-401 avoided severe drought stress through timely flowering at the end of season and therefore proved better adaptability to water stress. In addition, they would have an advantage for improving adaptation and seed yields in these environments, and are recommend for planting in khuzestan. Mid maturiting varieties like Option 500 are proposed under unlimited water availability in spring where complete irrigation would be provided in April. Finally, late maturiting varieties are not recommended under any circumstances for planing in the regions like south of Iran .

The physiological bases of the adaptability of these varieties are under further investigation by the authors. The results will be presented elsewhere.

REFERENCES

Angadi, S.V., H.W., Cutforth, B.G. McConkey and Y. Gan, 2003. Yield adjustment by canola growth at different plant populations under semiarid conditions. Crop Sci., 43: 1358-1366.

Angadi, S.V., H.W. Cutforth, P.R. Miller, B.G. McConkey, M.H. Entz. Volkmar and S. Brandt, 2000. Response of three *Brassica* species to high temperature injury during reproductive growth. Can. J. Plant Sci., 80: 693-701.

Degenhardt, D.F. and Z.P. Kondra, 1981 . The influence of seeding date and seeding rate on seed yield and yield components of five genotypes of (*Brassica napus* L.). Can. J. Plant Sci., 61: 175-183.

Loardner, B.R., D.C. Nielsen and C.C. Shock, 1992. Infrared thermometry and the crop water stress index. Sampling procedures and interpretation. J. Prod. Agric., 5: 466-475.

Gunasekera, C.P., L.D. Martin, R.J. French, K.H.M. Siddigue and G.H. Walton, 2003. Effect of water stress on water relations and yield of indian mustard (*Brassica Juncea* L.) and canola (*Brassica napus* L.). Proceedings of the 22th Australian Agronomy conference, Geelong. 2003.

Milford, G.F.I., M.N. Andersen and J.H. Thage, 1996. Seed glucosinolate, oil and protein contents of Field grown rape (*Brassica napus* L.) affected by soil drying and evaporative demand. Field Crop Res., 47: 93-105.

Mailer, R.J. and P.S. Cornish, 1987. Effects of water stress on glucosinolate and oil concentrations in the seed of rape (*Brassica napus* L.) and turnip rape (*B. rapa* L. var. *silvestris*). Aus. J. Exp. Agric., 27: 707-711.

Nielsen, D.C., 1997. Water use and yield of canola under dry land conditions in the centeral great planins. Agriculture, 10: 307-313.

Rahnema, A., 2002. Optimum canola date planting determination in khuzestan. Finall Report. Safi-Abad Agricultural Research Center. Khuzestan. Iran. pp: 45.

Smis, J.R., D.J. Solum, D.M. Wichman, G.D. Kushnk and L.E. Welty *et al*., 1993. Canola variety yield trials. Montana Agro. Res., 10: 15-20.

Walton, G., P. Si and B. Bowden, 1997. Environmental impact on canola yield and oil. www. Canola-ra/canola/ca7. htm.