Canola as affected by sowing date In Iran region

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Abstract

The work reported in this paper examines yield altering on under different sowing date in Iranian regions of Brassica species. Sowing date is an important determinant of yield in canola. However, the decline in yield with delayed sowing has been poorly defined for different environments. We show from collated published studies and sowing date studies carried out on canola in the all cropping region in 1998-2003, that the decline in yield with delayed sowing is highly variable from -10% to +4% per week delay in sowing. The mean value 7% per week delay in sowing date agrees well with that already published. studies for one location are used to highlight the risks associated with sowing early to avoid end-of-season high temperatures and water deficit, which depresses seed yield and oil concentration, and sowing later to lessen the risk of damaging frosts during rosette and early grain-filling.

Key words: dry land, oil concentration, irrigated farming, rapeseed, canola, sowing date.

Introduction

Sowing date is an important determinant of yield in canola. In dry land Iranian environments there is a trade-off between sowing early to avoid end-of-season high temperatures and water deficit, which depresses seed yield and oil concentration, and sowing later to lessen the risk of damaging frosts rosset and during early grain-filling. Knowledge of the consequences of delaying sowing for yield, oil concentration and frost risk can be used to define optimum sowing dates for different varieties, climates and farming systems (Hodgson, 1979). We examine previously published sowing date studies conducted in a range of Iranian environments, and compare these with sowing date studies carried out on canola in the all cropping regions, which is a new region for canola production. Last studies are used to analyses the variability in yield response to sowing date accounting for frost risk. Iranian environmental conditions present very different patterns of temperature, day length and moisture supplies from those countries where the greatest part of the oilseed rape varieties are constituted. Studies on the phenology and optimal conditions for each phase of the crop cycle are essential in searching for the most suitable varieties and sowing times for particular regions (Myers et al, 1982). Weekly irrigation was necessary to maintain field capacity condition, and metallic channel among all rows of the plot were necessary to avoid rain water and to determine a plant stress condition. The new trends of the Iranian, aiming to food surplus reduction and to vegetal and environmental resources protection, are determining a new interest for industrial crops. For that reasons and because the need, in the semi-arid Mediterranean environments, of an economically suitable crop for the Iranian cropping systems rapeseed could found a right place in the inland environment of Iran (Ahmadi,1992; Benvenuti and Salera, 1999). The species widely cultivated in the South and East of Iran, is characterized by low productive stability because the erratic climatic trend, the unsuitability of cultural techniques and because a lack in varieties choice (Ahmadi, 1992), even though 96 varieties are registered in the Iranian National Varieties Register. To refining agronomic techniques to improve rapeseed suitability for the semi-arid environment, seems to be very important the soil moisture control during stem elongation and flowering. During those phases rapeseed prefers low temperatures, while during grain filling it tolerates high temperature but not tolerate soil water shortage, determining, if not, oil content and yield decrease (Toniolo, 1989).While in other countries rapeseed water requirement, also in relation to cultural practices, is deeply studied (Choudhury et al., 1990; Ahmadi, 1992), in Iran there is a lack on the argument. This paper reports the responses of cultivars of oilseed rape to the environmental conditions of localities in the all of Iran potentially suitable to the diffusion of this crop.

Materials and Methods

Published sowing date studies in East and South of Iran showed that grain yield was collated from studies where grain yield was measured in response to sowing date (Table 1). Yields were hand-harvested and corrected to oven-dry basis. Experiments in northern Iran carry out and four sowing date studies were conducted in the northern grains region in 1998-2003 (Table 2) at Sari, Gonbad, Amol and Gorgan. The Amol study was complete irrigated, while the others were different in irrigation to dryland. Crops were grown at 40-60 plants m-2 with 20-30 cm row spacing, and supplied with 100-120 kgN ha-1 at sowing. Some pests, disease and weed limitations were recorded. The dates were recorded of open flowers on 50% of plants and at least 95% brown pods on all plants. Grain yield and above-ground biomass at maturity was measured from 0.9-2.7 m2 quadrates at least 3 replications. Experiments in south and East southern Iran lay out and some experiments were conducted for Ilam, Ahwaz and Shiraz in south-west (43.50oN 24.9oE), a potential new area for canola production. Sowings of cultivar Hyola 402 were estimated for 15th of Sept, Oct, and Nov. The crops were sown at 40 plants m-2, supplied with100 kgN ha-1 and starting soil nitrate of 58 kgN ha-1. Initial soil conditions were reset each year at sowing.

The risk of frost during grain-filling damaging yield potential was quantified by the occurrence of at least one day when the minimum temperature reached a threshold temperature during simulated early grain-fill. The rate of decline in yield (oven-dry basis) with delayed date of sowing was calculated using linear regression between sowing date and yield from the studies, the 1998-2003 experiments and the other studies. All regressions were statistically significant. The rate of decline was expressed both in absolute terms (kg/ha/d) and relative to the yield of the earliest sowing date (% per week) in order to account for differences in yield levels across studies. This method of expressing the response to sowing date has been used previously for wheat in Australia by Kohn and Storrier (1970), Doyle and Marcellos (1974), and McDonald et al. (1983). The aim of this paper is to analyse previously published data in terms of the likely impact of these factors, and to present data on wheat and canola yields from the northern region in 1998. We analyse variation in grain yield (GY) in terms of its two components of total dry matter produced (TDM) and harvest index (HI), to ascertain some physiological basis for the underlying causes. Simulation analysis is used to assess the likely variation in the ratio.

Results and Discussion

Published studies on the response to sowing date were under dryland conditions with the exception of that of Saeedi (2002) and Omidi (2003) (Table 1). One spring sowing study from Canada (Degenhardt and Kondra, 1981) was included for comparison with Iranian data. The published studies exhibited a wide range in yield response to sowing date. In all, yield declined with delay in sowing date (i.e. the linear regression slope coefficient between sowing date and grain yield was negative). The response ranged from a decline of 36.8 kg/ha/d to an increase of 11 kg/ha/d. Relative yield loss ranged from -10.8 to 4.2 % per week, with a mean of -5.1 % per week. Expressing the yield loss in terms relative to the yield potential, reduced the variability across studies, as found for wheat by Doyle and Marcellos (1974). The variability in response to sowing date possible at just one location (Rahnama: -10.7 to 4.2 % per week) due to differences in season and nitrogen supply, was notable. The strongest response to sowing date of -10.8 to -7.9 % per week was recorded and was similar with the study of Richards and Thurling (1978), under dryland conditions in Western Australia. The study of Thurling (1974), also in Western Australia, but under irrigation, had a weaker response to sowing date. The Western Iranian Mediterranean-type environment is known for the rapid onset of high temperatures and water deficit in summer, which results in like large yield penalties to late-sown annual crops (Fischer, 1979), and explain the strong response to sowing date in the study of Richards and Thurling (1978). Interestingly, the response in the spring sowing study in Canada (-5.1% per week) was similar to the mean of the Iranian studies. The experiments conducted in northern region in 1998-2003 produced a range of yield loss values from -3.1% per week at Sari to -10.5% per week at Gorgan (Table 2). The decline at Gorgan and Gonbad was steeper than that at Sari and Amol because heavy rain resulted in waterlogging during early growth in the later sowing, exaggerating the decline. There were no frosts recorded that would be expected to reduce yield. It is notable that the winter growing season in Sari was one of the wettest on record so that the response to sowing date would have been largely a function of crop phenology, rather than the occurrence of a more severe water deficit in the later sowings. Omidi (2003) found that under irrigated conditions the decline in seed yield was associated primarily with a reduction in the total dry weight of the plant at final harvest which, in turn, was most closely correlated with the duration of vegetative phase of growth. Overall, the relative yield decline from published studies and the 1998 experiments are similar to those published previously for wheat, in those situations where frost was not a complicating factor. Doyle and Marcellos (1974) measured a 5-7% reduction in relative grain yield of wheat for each week that sowing was delayed beyond the end of Nov. Kohn and Storrier (1970) arrived at a value of 3.7% for the Wagga Wagga district measured over 5 seasons, while McDonald et al. (1983) recorded 6% per week from Nov for irrigated wheat. All studies showed evidence of seasonal variation around the mean value, as in the current study. Crop growth offers a powerful tool to examine the tradeoffs between sowing time, yield potential, frost risk and high temperatures during grain-filling. Before being able to use with some confidence it is necessary to validate the response to sowing date. The model was able to capture the variation in yield with sowing date at Amol in 1998. The shorter period of sowing to flowering and flowering to physiological maturity was also well, although the model consistently under-predicted the date of maturity. This has been an artifact of the accurate assessment of physiological maturity in the field. Traditional practice in the northern grain belt is to sow winter grain crops in mid-Sep to early Oct, a time which in some years predisposes the crop to damage by spring frosts through flowering being too early (Single 1961). The yield of the crop therefore becomes a compromise between yield loss due to frost if it flowers too early, or from water deficit if too late. In addition, with canola, high temperatures during grain-filling are known to depress seed oil concentration and hence crop profitability. The difficulty in optimizing sowing time, mean grain yield declined by 3.6 % per week from 1686 to 1030 kg ha-1 with sowing date delayed from 15th Aug to 15th Nov. With Oct and Nov sowing, 25% of years would yield less than 600 kg ha-1 versus 1200 kgha-1 for Sept sowing. Mean daily air temperature during grain-filling also increased sharply with delayed sowing, which would translate to seed oil concentrations 5% moisture) of 42.6, 38.6, 37.0 and 35.6 % for the four sowing dates. For canola in Iran, seed oil concentrations below 40% are subject to a price penalty, indicating that delayed sowing beyond early Sep in Ilam is likely to lead to reduced grain prices. Frost risk for this scenario is presented for a range of frost thresholds from 20C to -4oC, because of lack of a well-defined threshold for canola. Also, the relationship between screen temperature and crop temperature will be a function of paddock aspect, topography, and the extent of crop canopy development, so that the air temperature causing yield loss will vary from situation to situation. These studies suggest that there are strong reasons to delay the sowing of canola beyond the end of Aug to Sep, if the avoidance of significant frost risk is an important priority of the grower. However, this delay will come at the cost of a lowered yield potential, higher temperatures during grain-filling and possible conflict with the sowing time of other winter crops on the farm. Clearly, the arrival at an optimum sowing time will depend on the risk attitude of the grower. Information, such as that in Table 3, will allow the various risks to be assessed.

Conclusions

The analysis here suggests that the yield response of canola to sowing date is highly variable; however the mean value across all studies in similar to that already published for wheat and canola in others countries (around 7% per week). In the cold region frost risk from early sowing needs to be balanced with lower yield potential and high temperatures during grain-filling from later sowings. Studied analysis can be used to evaluate the risks associated with different sowing dates.

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Table1: Studies of the response of Brassica napus to sowing date in East and South Iran.

Authors	Location/ treatment	Cultivar	Sowing dates	Max yield	Yield loss	
				kg/ha	kg/ha/d	% per week
Saeedi 2002	Ahwaz	Hyola 401	18-Apr to15-Aug	470	-1.5	-2.2
Rahnama et al. 1999	Shiraz	RGS003	18-Jun to 25-Oct	232	0.0	0.0
		Olga	18-Jun to 25-Oct	409	-6.3	-10.7
Salehi	Dezfoul		22-Apr to 4-Jun	930	5.6	4.2
			22-Apr to 4-Jun	1570	-0.9	-0.4
Shoushi 2002		Mean 3 vars	3-Oct to 31-Oct	5020	-36.8	-5.1
Khajemoradi et al. 2001		early vars	1-Jun to 26-Aug	4200	-18.3	-3.0
		late vars	1-Jun to 26-Aug	3800	-7.8	-1.4
		early vars	11-Aug to 12-Oct	2100	-10.6	-3.5
		late vars	11-Aug to 12-Oct	1600	-6.2	-2.7
	Ahwaz	early vars	3-Aug to 10-Oct	3600	-9.8	-1.9
		late vars	3-Aug to 10-Oct	3600	-9.0	-1.7
Ahmadi 1992		Various	19-Apr to 1-Jul	2067 to 2691	-18.6 to -8.2	-4.8 to -2.8
Omidi 2003	Ilam	Various	21-Jun to 2-Aug	450 to 617	-9.1 to -6.5	-10.4 to -8.9
	heavy soil	Various		336 to 466	-7.2 to -3.8	-10.8 to -7.9
Roodi et al. 1998		Hyola308	20-Jun to 3-Oct	1830	11.0	4.2
			4-Jul to 19-Aug	1910	-23.3	-8.5
	Karaj	RGS003	16-Aug to 16-Oct	1240	-2.3	-1.3
	Sarablehe		15-Aug to 17-Oct	2650	-17.2	-4.5

Maximum yield is that measured at the earliest sowing date in each study. Yield loss is the slope of grain yield on sowing date, expressed either as kg/ha/d or as a percent of the maximum yield per week. A negative yield loss indicates that yield declined with delay in sowing date.

Table 2: Response of canola to sowing date recorded in the region of Iran in 1998 (unpublished).

Location	Variety	Sowing dates	Max yield	Yield loss	
			kg/ha	kg/ha/d	% per week
Sari (36.33°S 52.85°E)	Option500	21-Sep to 1-Oct	1947	-8.9	-3.2
	Oscar		2219	-10.4	-3.3
	RGS003		1885	-8.2	-3.1
	Syn-3		2469	-12.2	-3.5
Gorgan (36.33°S 53.01°E)	Hyola60	15-July to 26-Oct	3320	-50.0	-10.5
Amol (36.33°S 53.04°E)	Hyola 42	20-Aug to 26-Oct	3263	-23.2	-5.0
Gonbad (36.33°S 53.07°E)	PF	19-Jun to 28-Oct	3150	-39.5	-8.8

Table 3: response to sowing date at Ilam.

Sowing date	15^{th} Aug	15^{th} Sep	15^{th} Oct	15^{th} Nov
Grain yield (kg ha^{-1})				
Average	1686	1331	1068	1030
25% quartile	1163	781	583	585
75% quartile	2239	1851	1430	1330
Flowering date	19-Oct	3-Des	30-Des	18-Feb
Maturity date	11-Jun	9-Feb	26- Feb	9-Mar
Grain-filling temperature (°C)	14.1	18.9	20.8	22.4
Frost risk 2°C	1.00	0.68	0.26	0.02
0°C	0.86	0.14	0.01	0.00
-2°C	0.53	0.04	0.00	0.00
-4°C	0.12	0.00	0.00	0.00