Survey the influences of relay cropping on yield and yield components, growth length, light interception and solar radiation depreciation of different species of Brassica

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Abstract

In order to evaluate the effects of relay cropping on yield and yield components, growth length, light interception and solar radiation depreciation of 12 varieties of winter canola, an experiment was conducted in 2006-2007 at Isfahan Agricultural Research Station as a split plot layout within a randomized complete block design with three replications. Main plots were two planting dates (27 September was normal cropping and 27 October was relay cropping), subplots were inclusive of species B. napus (Option 500, Hyola 330, Hyola 401, Sargol, Modena, SLM 046, Opera, Zarfam and RGS003), two varieties of B. rapa (Echo and Park land) and one variety of B. juncea (Land race). The highest seed yield, biological yield, harvest index and oil yield was obtained by Zarfam and Opera at normal planting date and the maximum seed yield and oil yield was related to Slm046 at relay cropping. Oil yield in Zarfam, Opera and Slm046 was 1662, 1587 and 1578 kg/ha. Planting date also had significant effect on all experimental parameters, expect of the number of days from stem elongation to ripening. The effects of cultivars were significant on the number of days from planting date to stem elongation, the number of days from stem elongation to ripening, light interception, light depreciation and LAI. The interaction between planting date and cultivar had significant effects on the number of days from planting to stem elongation, light interception, light depreciation and LAI. The best cultivar in normal planting date were Zarfam and Opera and in relay cropping was SLM046 that these cultivars with suitable growth length, could provide appropriate conditions to intercept light.

Keywords: Relay cropping, growth length, light interception, solar radiation depreciation, Brassica, Isfahan.

Introduction

In many parts of the world, many species of the genus Brassica are consumed as vegetable (Thomson et al., 2007; Ahmad et al., 2007), or use up as for its oil (Pass et al., 2001). Yield response of rapeseed varies with different environmental variables, including planting date, plant density, cultivars, soil type, N feritilizer, residual fertility and etc. Laaniste et al. (2008) reported that the optimal sowing date of winter oilseed rape under Nordic climate conditions was mid August. In their study, those plants also gave higher yield (1748 kg ha^{-1}), compared with the plots sown early pr later in August. There is considerable yield variation among species, namely, Brassica Camperstirs, Brassica Juncea, Brassica Napus and Brassica Carinata (Nada et al., 1995). Richter et al., (2010) reported that rapeseed (Brassica napus) oils differing in cultivars and sites of growth. The

relationship between planting date and yield potential was reported (Nielsen et al., 2002). Sowing date can play a major role in determining the seed yield and quality in region. Numerous research studies for different climates have shown that sowing date influences the growth, seed yield and quality of some oil crops such as rapeseed (Taylor and Smith, 1992; Hocking, 2001; Miralles et al; 2001). Degenhardt and Kondra (1981) suggested that delayed seeding resulted in significant decrease in seed yield, harvest index. So, the aim of this study was to Study the effects of relay cropping on yield and yield components of different species of Brassica under semi arid climatic condition of Isfahan province, Iran.

Materials and Methods

In order to evaluate the effects of relay cropping on yield and yield components of 12 varieties of winter canola, an experiment was conducted in 2005-2006 at Isfahan Agricultural Research Station (32^{o} $30^{/}$ S, 51^{o} $49^{/}$, 1541 meter above the sea surface) as a split plot layout within a randomized complete block design with three replications. Main plots were two planting dates (27 September was normal cropping and 27 October was relay cropping), subplots were inclusive of species B. napus (Option 500, Hyola 330, Hyola 401, Sargol, Modena, SLM 046, Opera, Zarfam and RGS003), two varieties of B. rapa (Echo and Park land) and one variety of B. juncea (Land race).). Long term average precipitation was 150 mm and this area is semi arid. Soil analysis was done before beginning of study at two depths (0-30 cm and 30-60 cm). Electrical conductivity of soil at 0-30 and 30-60 cm was 1.7 and 1.6 dS m^{-1}, respectively. The nitrogen fertilizer was used from urea (50 percent before planting and 50 percent in the beginning of reproductive phase). At ripening stage with Lutron-101, solar radiation absorption was evaluated. The objectives of this study were (1) to determine the effects of relay cropping on seed yield and oil content of different species of Brassica, and (2) to determine the sutability of Brassica as industrial crops under semi arid climatic condition of Isfahan province, Iran 3) survey the influence of relay cropping on solar radiation absorption and light interception of different cultivars. Means were separated by Duncan ,s Multiple Test at $p \leq 5\%$. All statistics was performed with MSTAT-C program

Results and Discussion

Planting date had significant effect on all experimental parameters, expect of the number of days from stem elongation to ripening. The effects of cultivars were significant on the number of days from planting date to stem elongation, the number of days from stem elongation to ripening, light interception, light depreciation and LAI. The interaction between planting date and cultivar had significant effects on the number of days from planting to stem elongation, light interception, light depreciation and LAI (Table 1). The highest number of days from planting to stem elongation (165.5), from 50% of flowering to 100% flowering (15.8), from beginning of stem elongation to ripening (29.14), from stem elongation to ripening (62.17) and from planting to ripening (227.7) was obtained by 27th Sep. light interception was decreased significantly, when plantation was changed from 27th Sep to 27th Oct. The highest light depreciation was related to 27th Sep (0.621), and the lowest one was related to 27th Oct (0.544). The maximum LAI was related to 27th Sep (3.07). Wang et al., (2001) reported that the amount of radiation that may be absorbed by a plant canopy is strongly related to the

vegetative cover or LAI.. There was significant difference in LAI, between 27th Sep and 27th Oct (Table 2). Light interception is a function of the leaf area (Collino et al., 2001). The highest light interception was obtained by RGS003 (96.2). The light interception in Zarfam was 95.1%. The maximum and minimum LAI, was related to Zarfam and Parkland, respectively (Table 2).

Table 1- Analysis of variance for the number of days from planting to stem elongation, 50% of flowering to complete flowering, beginning of stem elongation to ripening, planting to ripening, maximum percentage of light interception, light depreciation and Effective LAI.

S.O.V	d.f	planting to stem elongation	50% flowering to 100% flowering	beginning of stem elongation to ripening	Stem elongation to ripening	planting to ripening	light interception	Light depreciation	LAI
Replication	2	40.5	113*	1.0	100.3*	2.4	104.4**	0.004**	2.39*
Planting date	1	8712**	475.3*	25.7*	3.1	9054.1**	783**	0.106**	16.38**
Error (a)	2	45.8	35.3	1.4	38.8	0.3	0.1	0.0001	0.08
Cultivar	11	441.6**	24.4	93.4	259.6**	55.1	24.9**	0.003**	0.47**
Planting date× Cultivar	11	64.1**	110.6	54.2	72.4	23.8	24.3**	0.002**	0.35**
Error (b)	44	12.9	98.6	63.4	39.5	42.4	3.7	0.00005	0.005

*significant at 0.05 significance in F-tests

**significant at 0.001 significance in F-tests

Table 2- Mean comparison for the number of days from planting to stem elongation, 50% of flowering to complete flowering, beginning of stem elongation to ripening, planting to ripening, maximum percentage of light interception, light depreciation and Effective LAI..

Treatment	planting to stem elongation	50% flowering to 100% flowering	beginning of stem elongation to ripening	Stem elongation to ripening	planting to ripening	light interception	Light depreciation	LAI
Planting date								
27 September	165.5a	15.8a	29.14a	62.17a	227.7a	96a	0.621a	3.07a
27 October	143.5b	10.7b	27.94a	61.75a	205.3b	89.4b	0.544b	2.11b
Cultivar								
Option500	150.7de	13.7a	33.5a	67abc	217.7a	91.1cd	0.614a	2.34d
Hyola330	152.3cd	15.0a	31.5a	63.2abcd	215.5a	94.8ab	0.597b	2.84b
Hyola401	153.5cd	15.3a	24.7a	63.8abcd	217.2a	90.8d	0.566de	2.62c
Sargol	150.0de	11.3a	30.2a	63.8abcd	213.8a	92.2bcd	0.565e	2.58c
Modena	166.5a	13.0a	25.8a	53.8d	220.3a	90d	0.571de	2.33d
Sim046	163.2ab	11.3a	30.0a	54.5d	217.7a	94.6abc	0.571de	2.86b
Opera	165.0a	11.2a	23.3a	52.3d	217.3a	91.8abc	0.554f	2.39d
Zarfam	157.7bc	13.3a	29.2a	58.8dbc	216.5a	95.1ab	0.568de	2.90b
RGS003	149.2de	17.7a	26.8a	68.8ab	218.0a	96.2a	0.619a	2.09a
Park land	138.3f	11.7a	23.5a	70.0ab	208.3a	90.6d	0.589bc	2.20e
Echo	145.5e	13.8a	35.8a	70.8a	216.3a	92.1bcd	0.596b	2.35d
Land race	162.2ab	11.5a	28.3a	56.7cd	218.8a	92.6bcd	0.579cd	2.20c

Common letters within each column do not differ significantly.

The highest LAI was obtained by 27th Sep (4.29). There was significant difference in LAI between 27th Sep and 27th Oct. Zarfam had obtained the highest LAI (5.07). Seed yield was significantly changed, when plantation on 27th Sep was changed into 27th Oct. The maximum seed yield was related to Zarfam (3605 kg/ha), and the minimum one was obtained by Echo (1557 kg/ha). The highest number of seer per pod also was related to 27th September, but the maximum a thousand seed weight was obtained by 27th October. The number of seed per pod and a thousand seed weight in Zarfam was 16.51 and 3.89, respectively (Table 2). The highest biological yield and harvest index was related to 27th Sep and 27th Oct, respectively. Zarfam also had obtained the maximum harvest index. In the view of the sensitivity of rapeseed to climatic factors especially to photoperiod and temperature, it is essential that sowing should be done on time, so that there have enough time for vegetative growth. There was significant difference in oil yield and oil percentage between 27th Sep and 27th Oct. With changing planting date, each plant changed oil yield. The highest oil yield was related to 27th Sep (1337 kg/ha). The maximum oil yield was obtained by Zarfam (1662 kg/ha) (Table 4).

Table 3- Analysis of variance for experimental characteristics.

S.O.V.	d.f.	LAI	Seed yield	The number of seed per pod	A thousand seed weight	Biological yield	Harvest index	Oil percentage	Oil yield
Replication	2	4.4*	91083	13.1	0.139*	7381	0.001	13.3*	18463
Planting date	1	20.1**	4409935*	72.9	1.198**	347978142**	0.041*	9*	1092310*
Error (a)	2	0.07	184019	30.4	0.006	1598756	0.001	0.3	41174
Cultivar	11	1.3**	3300134**	42.2**	5.335**	11093274**	0.016**	80.3**	899676**
Planting date× Cultivar	11	0.6**	326046**	1.3	0.153*	3557811**	0.002	5.2	84928**
Error (b)	44	0.003	115536	2.6	0.072	1100731	0.001	6.9	26216

*significant at 0.05 significance in F-tests

**significant at 0.001 significance in F-tests

Table 4- Mean comparison for LAI, seed yield (kg/ha), the number of seed per pod, a thousand seed weight (g), biological yield (kg/ha), harvest index (%), oil percentage and oil yield (kg/ha).

Treatment	LAI	Seed yield	The number of seed per pod	A thousand seed weight	Biological yield	Harvest index	Oil percentage	Oil yield
Planting date								
27 September	4.92a	2966a	15.03a	3.09b	13773a	21b	44.3a	1337a
27 October	3.87b	2471b	13.02a	3.35a	9377b	26a	43.5b	1091b
Cultivar								
Option500	3.78h	2490d	14.01cde	4.24a	9893d	25bc	44.7ab	1117c
Hyola330	4.73c	3140abc	13.52cde	3.97ab	12320abc	26abc	47.2a	1485ab
Hyola401	4.46de	298abcd	14.35bcd	3.95ab	13110ab	24bc	46ab	1373abc
Sargol	4.51d	2550cd	14.88bcd	3.3cd	11870abc	22cd	45.7ab	1169c

Modena	4.02g	2655bcd	17.16ab	2.92d	10560cd	25bc	45.9ab	1222bc
Slm046	4.95b	3585a	17.84a	3.71bc	12930ab	29ab	44ab	1578a
Opera	4.28f	3445a	15.62abcd	3.61bc	11140bcd	31a	45.9ab	1587a
Zarfam	5.07a	3605a	16.51abc	3.89ab	13210a	28ab	46.1ab	1662a
RGS003	4.97b	3205ab	13.44de	3.72gc	12910ab	25bc	45.7ab	1464ab
Park land	3.72h	1658e	10.03f	2.07e	9650d	17de	41.9bc	698d
Echo	3.93g	1557e	9.56f	1.67ef	9753d	16de	39.4c	614d
Land race	3.37e	1748e	11.40ef	1.57f	11560abcd	15e	34.5d	599d

Common letters within each column do not differ significantly.

Conclusion

Delayed maturity and light interception to be the most important parameters for obtaining higher seed yields. The highest seed yield, biological yield, harvest index and oil yield was obtained by Zarfam and Opera at normal planting date and the maximum seed yield and oil yield was related to Slm046 at relay cropping.

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