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EVALUATING THE EFFECT OF HERBICIDES AND PLANTING METHOD ON WEED CONTROL AND SEED YIELD OF CANOLA (BRASSICA NAPUS L.)

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ABSTRACT

In order to control canola seed growth and production inhibiting factors, an experiment, including 18 treatments and three replications, was conducted within split plot design during 2011 and 2012 farming years in the farmlands of Safi Abad Agricultural Research Center in Dezful. The main planting treatment included three levels: two-row 61-centimeter furrows as well as two-row and three-row 75-centimeter furrows. The herbicide treatment included six levels, namely trifluralin, trifluralin+clopyralid, trifluralin+clopyralid+haloxyfop-r-methyl, clopyralid+haloxyfop-r-methyl and evidence group with and without herbicide. The results indicated that spraying with trifluralin+clopyralid+haloxyop could control 81% of the weeds until about a month after the exertion of experimental treatments. The lowest density and dried weight of weeds was evidenced for complete weed control treatment, trifluralin+clopyralid+haloxyfop treatment and trifluralin+clopyralid treatment in all of the sampling stages. The highest seed performance belonged to complete weed control treatment followed by to the two-row 75-centimeter furrow planting method along with the use of trifluralin+clopyralid+haloxyfop, with a value of 3.1tons/ha.

Keywords: *canola, trifluralin, clopyralid, haloxyfop-r-methyl.*

INTRODUCTION

Canola (Brassica Napus L.) is one of the most important agricultural plants worldwide and plays a substantial role in the supply of edible oils. To obtain canola's potential performance, optimum management practices in application of production factors is of a great importance and weed control in canola is one of the most important cropping management factors (Shahidi et al, 1996). The existence of the weeds is one of the most challenging problems in increasing the surface area under cultivation as well as enhancing canola performance. The determination of an appropriate canola planting method plays a critical role in weed control. Thus, the determination of the suitable herbicide and planting method is significantly important and necessary in weed control and performance enhancement of canola plants.

Study Background:

The studies performed in this regard indicated that row spacing and the amount of seed required for planting are effective on weed control and canola sensitivity to dye-weed (Azizi et al, 2000). The highest performance is obtained in the shorter transverse distances, to wit 10cm and 20cm (Dosdall et al, 1998). In another investigation, the highest seed performance was found occurred in 38-cm row distances (Teasdale and Frank, 1983). Terflan and Sonalan have been found with

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the best weed control effects when used in 2l/ha and 4l/ha before sowing (Jamali, 2002). Use of Butisan Top for 1.5l/ha has been recommended for canola weed control (Hosseini and Shimi, 2005). The reduction in the inter-row spacing causes increase in canola performance enhancement (Christensen and Drabble, 1984). The maximum canola seed performance has been found obtained in two-row furrow planting method and the minimum seed performance has been found belonging to three-row furrow planting method (Akhavan et al, 2006). The plants grown on 30-centimeter row distances were found with higher performance in comparison with the centrifuge-based planting method in which the amount of used seed ranged from 2.5kg/ha to 20kg/ha (Clarke et al, 1978). The determination of an appropriate planting method plays a considerable role in weed control. Thus, the determination of the suitable herbicide and planting method enjoys a great necessity and importance in canola weed control and performance enhancement.

STUDY METHOD

The present study has been conducted based on split plot experiments within the format of complete random block design with 18 treatments in three replications during 2011-12 and 2012-13 farming years in farmlands belonging to Safi Abad Agricultural Research Center in Dezful. Land preparation operation included initial irrigation, tillage and disking. The fertilizers were applied according to soil tests and the related recommendations. In the aforementioned experiment, the main factor was planting method in three levels: two-row 61-centimeter furrow planting method, three-row 75-centimeter furrow planting method and two-row 75-centimeter furrow planting method. The secondary factor was herbicide application in six levels: trifluralin (48%EC) for 2.5l/ha before sowing in combination with soil, trifluralin for 2.5l/ha along with clopyralid (SL300) for 0.8;/ha after germination, trifluralin for 2.5l/ha along with clopyralid for 0.8l/ha and haloxyflop-r-methyl (10.8% EC) for 0.75l/ha after germination, clopyralid for 0.8l/ha plus haloxyflop for 0.75l/ha, an evidence group without weed and an evidence group with weed. Each secondary plot contained four furrows, 12.2m^2, 15 m^2 and 15 m^2 in size. Each primary plot, as well, contained furrows, 88.45 m^2, 108.75 m^2, 108.75 m^2 in size. During November, canola seeds (RGS003 varieties) were sown following spraying the soil with trifluralin. After performing the required irrigation and canola germination along with weed growth, post-germination herbicide treatments were undertaken. Spraying operation was conducted using backpack roundup sprayer with line spray nozzle with the use of 300 liters of water per hectare. The experiment evaluations incorporated the followings: investigation of the burning of canola plants based on EWRC Standard, counting and weighing the weeds (using fixed one square meter quadratic equation) in two stages: a) one month after the application of herbicides (02/10/2011 and 02/10/2012) and b) upon the termination of canola growth season (04/31/2012 and 04/31/2013); evaluation of the weight of a thousand grain and canola performance assessment. The obtained data were subjected to variance analysis in SAS. Mean comparisons were carried out in 5% probability level based on Duncan test.

Table A: physicochemical specifications of soil and water in farm place of experiment in Dezful

Soil acidity (PH)	Electric conductance (EC) of soil (desi Siemens/m)	Electric conductance (EC) of the irrigation water (desi Siemens/m)	Soil texture		
			Clay (%)	Silt (%)	Sand (%)
1.9	0.65	32	42	26	26

Table B: physicochemical properties of the soil in the farm place of experiments' implementation in Dezful (according to soil 0-30cm testing)

Nitrate (ppm)	Ammonium (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Azote (%)	Phosphorus (ppm)	Potassium (ppm)	Zinc (ppm)
33.06	7.31	5.60	15.60	1.30	0.37	10	131	1.44

RESULTS AND DISCUSSIONS

A) Weight of a Thousand Grain:

The results related to the combined analysis indicated that the effect of year and planting method×herbicide on the weight of a thousand grain is significant in 99% level (table 1). The high rate of the weight of a thousand grain during the first year, in comparison to the second year, can be ascribed to the longer growth period stemming from the earlier planting of the seeds as well as the resultant longer grain filling period. The results obtained for the mutual effects of planting method×herbicide during the two years were reflective of the idea that the highest weight of a thousand grain belongs to two-row 75-centimeter furrows along with the application of trifluralin+clopyralid+haloxyfop (table 3).

Table 1: combined analysis of the canola grain performance and the weight of a thousand grain (mean value of 2011-2012 farming years)

*Mean squares			
Variation source	Degree of freedom	Grain performance (kg/ha)	Weight of a thousand grain (g)
Year	1	32818284.72^{ns}	5.22*
Replication	4	68602.89	0.087
Planting method	2	3402513.23**	0.03^{ns}
Planting method×year	2	373196.82 ^{ns}	0.07 ^{ns}
Error	8	45658.61	0.315
Herbicide	5	3482867.27**	0.77 ^{ns}
herbicide×year	5	684448.27 ^{ns}	0..45 ^{ns}
Planting method×herbicide	10	244194.99**	0.102**
Planting method×herbicide×year	11	216469.81 ^{ns}	0.122 ^{ns}
Error	60	88300.93	0.092
CV(%)	---	11.74	9.48
*and ** indicate significance in 95% and 99% probability level, respectively; ns designates insignificance			

B) Grain Performance:

The results of the combined analysis indicated that the effects of year, planting method, herbicide and planting method×herbicide are significant. (table1) The results of the mean comparisons indicated that the grain performance rate has been higher in the first experiment year (3083.45kg/ha) in comparison to the second experiment year (1980.95) (table 2). The high performance in the first experiment year can be attributed to earlier sowing date in comparison with the second experiment year. The earlier planting date provides the enlargement of the growth and florescence periods that is followed by grain performance enhancement. On the other hand, the late flowering and sheath production stages coincided with severe winds and rainfalls in the second experimental year as a result of which the plots became full of dye-weeds. No grain was produced by the dye-weed stricken plants. That is because the amount of nutrient that has to be used for grain filling was used for producing ancillary branches and new flowers and this was followed by intense performance reduction during the second experiment year in comparison with the first experiment year. These results are consistent with what has been found by Scarisbrick and his colleagues. The mutual effects of planting method×herbicide indicated that the highest grain performance (3404.06kg/ha) belongs to two-row 75-centimeter furrow planting method and the evidence group without weed. Following the lead of the evidence group without weed, the same planting method along with trifluralin+clopyralid+haloxyflop application had the next highest grain performance (3114.26kg/ha) (table 3).

Table 2: comparing the mean values of the treatments' effects on the canola grain performance and weight of a thousand grain (the mean values of 2011 and 2012 farming years)

Treatment	Weight of a thousand grain (g)	Grain performance (kg/ha)
Year		
First year	3.42[a]	3083.45[a]
Second year	2.98[b]	1980.95[b]
Planting method		
Two-row 61-centimeter furrows	3.18[a]	2206.69[c]
Three-row 75-centimeter furrows	3.24[a]	2817.62[a]
Two-row 75-centimeter furrows	3.19[a]	2572.29[b]
Herbicide		
Trifluralin	3.19[a]	2499.21[c]
Trifluralin+clopyralid	3.25[a]	2641.77[bc]
Trifluralin+clopyralid+haloxyfop	3.38[a]	2810.68[ab]
Clopyralid+haloxyfop	3.32[a]	2574.3[c]
Evidence without weed	3.27[a]	2964.56[a]
Evidence with weed	2.8[b]	1702.68[d]
*based on multiple-range Duncan test, the mean values with at least one common letter in each column do not have significant difference in 5% probability level.		

Table 3: comparing the mean values of the mutual effects of planting method×herbicide on canola grain performance and weight of a thousand grain (mean values of 2011-2012 farming years)

Planting method	Herbicide	Weight of a thousand grain (g)	Grain performance (kg/ha)
Two-row 61-centimeter furrows	Trifluralin	3.29^{abc}	2170.43^{d}
	Trifluralin+clopyralid	3.22^{bc}	2521.79^{cd}
	Trifluralin+clopyralid+haloxyflop	3.2^{bc}	2245.78^{d}
	Clopyralid+haloxyflop	3.34^{ab}	2347.91^{d}
	Evidence without weed	3.24^{abc}	2470.64^{cd}
	Evidence with weed	2.79^{d}	1483.59^{e}
Three-row 75-centimeter furrow	Trifluralin	3.25^{abc}	2772.19^{bc}
	Trifluralin+clopyralid	3.25^{abc}	3044.37^{ab}
	Trifluralin+clopyralid+haloxyflop	3.3^{abc}	3072.01^{ab}
	Clopyralid+haloxyflop	3.35^{ab}	2810.69^{bc}
	Evidence without weed	3.36^{ab}	3404.06^{a}
	Evidence with weed	2.91^{cd}	1802.38^{e}
Two-row 75-centimeter furrow	Trifluralin	3.04^{bcd}	2555.01^{cd}
	Trifluralin+clopyralid	3.28^{abc}	2359.15^{d}
	Trifluralin+clopyralid+haloxyflop	3.64^{a}	3114.26^{ab}
	Clopyralid+haloxyflop	3.28^{abc}	2564.31^{cd}
	Evidence without weed	3.21^{bc}	3018.99^{b}
	Evidence with weed	2.71^{d}	1822.06^{e}
*based on multiple-range Duncan test, the mean values with at least one common letter in each column do not have significant difference in 5% probability level.			

C) Weeds:

No burning effect was observed following the application of the various herbicides on the canola plants.

Number of Weeds:

In regard of the number of weeds in two stages, i.e. 30 days after spraying and upon the termination of growth season, no significant difference was evidenced between the various treatments of planting method and the mutual effect (planting method×herbicide). But, there was found a significant difference between the various herbicide treatments in 99% significance level (table 5). Because the mutual effects of year×herbicide was found significant, as documented in the foresaid table, the mean comparison results of the herbicide treatments have been summarized in tables (7) and (8) in separate for each farming year. During the first year of the experiment (2011-12), the mean comparison results of various herbicide treatments are indicative of the idea that the herbicide treatments (terflan+lontrel+gallant super), with 16.4

remaining weeds after spraying, have been the most optimum treatments following the lead of the evidence group without weeds hence they are both grouped in class c. Moreover, in regard of the number of weeds remained in the end of the growth season, terflan+lontrel treatment was considered as the best treatment along with the evidence group without weed both of which were grouped in the lowest statistical class (table 7). As for the second experiment year (2011-12), the mean comparison results of various herbicide treatments are suggestive of the idea that terflan+lontrel+gallant super herbicide treatment, with 3.56 weeds remained following spraying, has been the most suitable treatment following the lead of the evidence group with no weed hence they are both grouped in bc statistical class. Furthermore, in respect to the number of the weeds remained in the end of the growth season, terflan+lontrel herbicide treatment was found to be the best treatment hence grouped in statistical class b along with evidence group without herbicide (table 8).

Dry Weed Weight:

A significant difference was evidenced between planting method treatments in terms of dry weed weight after spraying in 95% level. In regard of the dry weed weight in both of the stages, i.e. after spraying and in the end of the growth season, a significant difference was found between various herbicide treatments applied in both of the stages in 99% level. The difference between the mutual effects of the various treatments (planting method×herbicide) was found insignificant (table 5). Considering the dry weed weights after spraying, the mean comparison results of the planting method treatments are indicative of the idea that the two-row 75-centimeter furrow planting method and the two-row 61-centimeter furrow planting method, both with lower weight of the weed remained after spraying, are grouped in a single b statistical class (table 6). But, the two-row 75-centimeter planting method, with a 8.820g dry weed weight, features the lowest dry weed weight hence it was pinpointed as the most superior treatment. Since the mutual effects of year×herbicide treatments were found significant as shown in table (5), the mean comparison results of the herbicide treatments have been summarized in tables (7) and (8) separately for each farming year. In the first experiment year (2011-12), the mean comparison results of the various herbicide treatments in regard of the dry weed weight demonstrate that terflan+lontrel+gallant super herbicide treatment, with a dry weed weight of 3.9g remained weeds, is the best treatment following the lead of the evidence group without weed hence grouped in bc statistical class (table 7). In the second experiment year (2012-13), the mean comparison results of the various herbicide treatments indicate that terflan+lontrel+gallant super treatment, with a dry weed weight of 3.14g weed remained after spraying, is the most suitable treatment following the lead of the evidence group without weed hence grouped in cd statistical class. In terms of the dry weed weight in the end of the season, terflan+lontrel herbicide treatment, with a value of 2.83g dry weed per every square meter, was found having the lowest dry weed weight hence grouped in statistical class b (table 8).

CONCLUSION:

In sum, it can be concluded from various parts of the present study that, amongst the various treatments of planting method and herbicide, two-row 75-centimeter furrow planting method along with a combination of terflan+lontrel+gallant super herbicides or terflan+lontrel herbicides gives the best treatment hence more appropriate and is recommended for the

reduction of the number of the weeds, dry weed weight and the canola performance enhancement.

Table 4: a list of weeds in canola experimental farm

Row	Common name	Scientific name
1	Sour clover*	Melilotus indica L.
2	Plantain*	Plantago Lanceolata L.
3	Mallow*	Malva Sylvestris L.
4	Wild clover*	Trifolium alexandrinum L.
5	Asteraceae	Cichorium intybus L.
6	Wild safflower	Carthamus oxyacantha M.B.
7	Persian speedwell*	Veronica Persica Poir
8	Scarlet pimpernel*	Angalis Arvensis
9	Milk thistle	Sonchus Oleraceus L.
10	Darnel*	Lolium Rigidum L.
11	Medicinal fumitory	Fumaria Officinalis L.
12	Field bindweed*	Convolvulus Arvensis L.
Prevalent weeds		

Table 5: combined analysis of the measured traits of the weeds (mean values of 2011-12 farming years)

Variations source	Degree of freedom	Mean squares			
		Number of weeds		Dry weed weight	
		After spraying	Season end	After spraying	Season end
Year	1	4.208**	3.041**	0.513**	1.261*
Replication	4	0.212ns	0.281 ns	0.163 ns	0.766
Planting method	2	0.120	0.018	0.419*	0.140
Year×planting method	2	0.026	0.029	0.037	0.280
Error	8	0.058	0.022	0.084	0.188
Herbicide	5	2.802**	1.229**	1.792**	3.615**
Year×herbicide	5	0.394**	0.367**	0.398**	0.550*
Planting method×herbicide	10	0.033	0.022	0.099	0.048
Year×planting method×herbicide	10	0.090	0.069	0.052	0.268
Error	60	0.070	0.055	0.091	0.196
CV (%)	------	23.54	26.80	31.87	40.65
*and** indicate significance in 95% and 99% level, respectively; ns designates insignificance					

Table 6: mean comparison of the dry weed weights following spraying in terms of the effects of planting method treatments (mean values of 2011 and 2012 farming years)

Planting method treatment	Mean dry weed weight (g/m²)
Two-row 61-centimeter furrow	8.953[b]
Three-row 75-centimeter furrow	19.136[a]
Two-row 75-centimeter furrow	8.820[b]
The mean values with common letters in each column are not significant according to multiple-range Duncan test in 5% probability level.	

Table 7: mean comparison of the weeds' measured traits in terms of the effect of herbicide treatments in 2011 farming year

Treatment	Weed number (per every square meter)		Dry weed weight (g/m²)	
	After spraying	End of season	After spraying	End of season
Trifluralin	52[ab]	19[ab]	27[a]	128.8[a]
Trifluralin+clopyralid	24.9[c]	4.4[d]	9.8[b]	105.9[ab]
Trifluralin_clopyralid+haloxyfop	16.4[c]	10[bcd]	3.9[bc]	92.8[ab]
Clopyralid+haloxyfop	32.4[bc]	17.3[abc]	7.2[bc]	118.9[a]
Evidence without weed	0[d]	0[d]	0[c]	0[b]
Evidence with weed	85.8[a]	28.4[a]	32.6[a]	111.1[a]
The mean values with common letters in each column are not significant according to multiple-range Duncan test in 5% probability level.				

Table 8: mean comparison of the weeds' measured traits in terms of the effect of herbicide treatments in 2012 farming year

Treatment	Weed number (per every square meter)		Dry weed weight (g/m²)	
	After spraying	End of season	After spraying	End of season
Trifluralin	5.78[b]	1.56[b]	3.47[cd]	3.32[b]
Trifluralin+clopyralid	4.44[bc]	1.11[b]	9.76[bc]	2.83[b]
Trifluralin_clopyralid+haloxyfop	3.56[bc]	1.78[b]	3.14[cd]	11.20[b]
Clopyralid+haloxyfop	19.56[a]	9.11[a]	19.33[ab]	57.92[a]
Evidence without weed	0[c]	0[b]	0[d]	0[b]
Evidence with weed	25.33[a]	6.89[a]	25.32[a]	55.60[a]
The mean values with common letters in each column are not significant according to multiple-range Duncan test in 5% probability level.				

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