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Evaluating the Effect of Planting Pattern and Herbicides on the Yield of Grain and Rapeseed Oil

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Abstract: *To investigate the effect of planting pattern and herbicides on the grain yield and rapeseed oil, an experiment with 18 treatments in three replications was carried out within the format of split-plot design during two farming years of 2011 and 2012, in agricultural fields belonging to Safi Abad agricultural research center. The main treatment included three levels: 61-centimeter furrows with two planting rows, 75-centimeter furrows with respectively three and two planting rows and the herbicide treatment including six levels of trifluralin (trifluralin +clopyralid), (trifluralin + clopyralid +haloxyfop-r-methyl), (clopyralid + haloxyfop-r-methyl). The control group included with and without weeds. The results indicated that the 75-centimeter furrows with three rows along with herbicides (trifluralin+clopyralid+haloxyfop) followed by 75-centimeter furrows with two planting rows besides herbicides (trifluralin+clopyralid+haloxyfop) were the most appropriate treatments hence they were recommended due to grain yield enhancements, grain weight, oil yield and biological yield of rapeseed.*

Keywords: Rapeseed, Planting Pattern, Trifluralin, Clopyralid, Haloxyfop-R-Methyl

INTRODUCTION

Rapeseed (brassica napus L.) is one of the most important oil plants worldwide that plays a substantial role in supplying the cooking oils. To achieve a potential yielding in rapeseed, optimum agricultural management methods are of particular importance. The existence of weeds is one of the most major problems in increasing the surface area under cultivation and enhancing rapeseed performance. Determination of the proper rapeseed planting pattern and their row spacing plays a significant role in weeds control. Thus, the determination of the herbicide and the proper planting pattern as well as the mutual effects of these two is of great necessity and importance in controlling the rapeseed weeds and augmentation of rapeseed yielding.

Background of the study:

Reduction in the rapeseed row spacing causes the reduction in the stem diameter, its delicateness and also the reduction in the amount of grain falls (Ahmadi, 2000). The highest rapeseed grain performance has been found in 38-centimeter row spacing (Xie et al, 1998). Rapeseed yielding has been controld to be higher in 20-centimeer row spacing than in 30-centimeter row spacing (O'Donovan et al, 2001). The highest yielding of rapeseed grain occurred in the lowest rate of grain amount which was higher in 15-centimeter rows than in 30-centimeters ones (Morrison et al, 1990).

The maximum rapeseed grain yielding pertained to two-row stacks and the minimum grain yielding pertained to three-row stacks (Akhavan et al, 2006). It was concluded in an investigation of the effect of row spacing and grain amount on rapeseed yielding that the highest grain yielding belonged to the treatment including six kilograms grain/hectare and 12-centimeters row spacing (Bagheri, 2006). Rapeseed grain yielding is a function of density, number of sheath per plant, number of grains per sheath and the grain weightt. The number of sheath per plant has been found most reactive to the density rate as compared to the other components (Diepenbrock, 2000).

Study Methodology

The present study has been carried out in the form of split-plot experiments within the format of complete random block design with 18 treatments and three replications during the 2011 and 2012 farming years in Safi Abad Agricultural Research Center fields in Dezful. The land preparation operation included initial irrigation, tillage and disking. The fertilizers were used based on soil test and the corresponding recommendations (table B). In the abovementioned experiments, the main factor was planting pattern that was implemented in three levels: two-row 61-centimeter furrows, three-row 75-centimeter furrows and two-row 75-centimeter furrows; the secondary factor was herbicide application that was conducted in six levels: trifluralin (48% EC) for 2.5l/ha before sowing in combination with soil; trifluralin for 2.5l/ha plus clopyralid (SL300) for 0.8l/ha after germination; trifluralin for 2.5l/ha plus clopyralid for 0.8l/ha plus haloxyfop-r-methyl herbicide (10.8% EC) for 0.75l/ha after germination; clopyralid for 0.8l/ha plus haloxyfop for 0.75l/ha. The control group included with and without weeds. Each secondary plot contained four furrows respectively 12.2m^2, 15 m^2 and 15 m^2 in size and each primary plot contained furrows reaching in size to 88.45 m^2, 108.75 m^2 and 108.75 m^2. After spraying the soil with trifluralin during November, rapeseed grains, RGS003 variety, were sown. Following the required irrigations and rapeseed germination along with weeds, post-germination herbicides were utilized. Spraying was done using a thin roundup backpack sprayer featuring a line spray nozzle with the use of 300 liters of water per hectare. Evaluating the research included the investigation of the rapeseed grain yield and oil, grain weight and biological yielding. The data obtained from the aforementioned evaluations were subjected to variance analysis in SAS and the mean comparisons were undertaken in 5% probability level.

Table A: Physicochemical properties of the soil and water of the farm under investigation 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 (%)
7.65	1.9	0.65	32	42	26

Table B: Chemical properties of the soil of the farm under investigation in Dezful (according to soil testing of 0-30cm depth)

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) The grain weight

The results related to the combined analysis indicated that the effect of planting pattern × herbicide on the grain weight was significant in 99% level (table 1). The mutual effect of planting pattern × herbicide during two years of experiments showed that the highest grain weight, 3.64g, was obtained for two-row 75-centimeters furrow planting pattern along with the use of trifluralin+clopyralid+haloxyflop. The control group of without weed was ranked below the abovementioned treatment in terms of the grain weight (table 3).

Table 1: Combined analysis of the rapeseed grain yielding and the grain weight (mean value of the farming during the years of 2011 and 2012)

*Mean squares			
Variation source	Degree of freedom	Grain performance (kg/ha)	Grain weight (g)
Year	1	^{ns}32818284/72	^{ns}5/22
Replication	4	68602.89	0.087
Planting pattern	2	3402513.23**	0.03^{ns}
Planting pattern×year	2	373196.82 ^{ns}	0.07 ^{ns}
Error	8	45658.61	0.315
Herbicide	5	3482867.27**	0.77 ^{ns}
herbicide×year	5	684447.27 ^{ns}	0..45 ^{ns}
Planting pattern×herbicide	10	244194.99**	0.102**
Planting pattern×herbicide×year	11	216469.81 ^{ns}	0.122 ^{ns}
Error	60	88300.93	0.092
CV (%)	---	11.74	9.48
*and ** indicates significance in 95% and 99% probability level; ns designates insignificance			

B) Grain yielding:

The results of the combined analysis of the experiments indicated that the effects of planting pattern and herbicide as well as the mutual effects of planting pattern × herbicide were significant in 99% level (table 1). The mean comparison results indicated that the grain yielding rate was higher in three-rows of 75-centimeter furrow planting pattern, with a value of 2817.62kg/ha, in comparison to the other planting patterns. Also, the mean comparisons demonstrated that the grain yielding has been higher in the treatment including trifluralin+clopyralid+haloxyflop, with a value of 2810.68kg/ha, coming next to the control group with no weed (table 2). The mutual effects of planting pattern×herbicide indicated that the highest grain yielding (3404.06kg/ha) belonged to three-row 75-centimeter furrow planting pattern and control group without weed. The next rank in terms of the grain yielding was found belonging to two-row 75-centimeter furrow planting pattern along with trifluralin×clopyralid×haloxyfop treatment with a value equal to 3114.26kg/ha (table 3). The better controlling of the weeds in the aforesaid treatments caused the reduction of the competition between the agricultural plants and weeds. This result was consistent with the findings of the study by Bastawesy who expressed that the appropriate controlling of the weeds caused an increase in the performance and grain weight (Bastawesy et al, 1991).

Table 2: Comparing the mean values of the treatments' effects on the rapeseed grain yielding and the grain weight (the mean values of 2011 and 2012 farming years)

Treatment	Grain weight (g)	Grain performance (kg/ha)

Planting pattern		
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+haloxyflop	3.32 [a]	2574.3 [c]
Control group with no weed	3.27 [a]	2964.56 [a]
Control group with weed	2.8 [b]	1702.68 [d]
*Based on Duncan test, the mean values with at least one common letter in each column do not have significant difference in 5% level.		

Table 3: Comparing the mean values of the mutual effects of planting pattern×herbicide on rapeseed grain yielding and grain weight (mean values pertain to 2011-2012 farming years)

Planting pattern	Herbicide	Grain weight (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]
	Control without weed	3.24 [abc]	2470.64 [cd]
	Control 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]	30.44.37 [ab]
	Trifluralin+clopyralid+haloxyflop	3.3 [abc]	3072.01 [ab]
	Clopyralid+haloxyflop	3.35 [ab]	2810.69 [bc]
	Control without weed	3.36 [ab]	3404.06 [a]
	Control 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]
	Control group without weed	3.21 [bc]	3018.99 [b]
	Control group with weed	2.71 [d]	1822.06[e]
*Based on Duncan test, the mean values with at least one common letter in each column do not have significant difference in 5% level.			

Biological Yielding

The results obtained from combined variance analysis indicated that the effect of herbicide and the mutual effect of the planting pattern×herbicide on biological performance were significant in 99% level (table 4). The mean comparisons showed that the biological performance was the highest in the trifluralin+clopyralid+haloxyfop treatment with a value of 10026.04kg/ha. The next rank in terms of the biological performance was found belonging to trifluralin+clopyralid herbicide treatment with a value of 9853.89 kg/ha. Due to the fact that both of the abovementioned treatments were found grouped in a single statistical class, no significant difference was controld between them (table 5). Mean comparisons related to the mutual effects of planting pattern×herbicide during the two

farming years are reflective of the idea that, after the control group without weed, the highest biological performance (13398.46kg/ha) pertained to three-row 75-centimeter furrow planting pattern along with clopyralid+haloxyflop herbicide treatment (table 6).

Oil Yield:

The results of the combined analysis of the two experiment years showed that the effect of planting pattern, herbicide and planting pattern×herbicide on the oil yield was significant in 99% level (table 4). The mean comparisons' results were suggestive of the idea that the oil yield was the highest in the three-row 75-centimeter furrow planting pattern with a mean value of 1243.8kg/ha as compared to the other planting pattern. Furthermore, the results of mean comparisons indicated that the oil yield obtained for the trifluralin+clopyralid+haloxyflop, with a mean value of 1234.74kg/ha, was the highest next to control group without weed, 1302.85kg/ha, (table 5). The results obtained for the mutual effects of planting pattern×herbicide in the two foresaid farming years were indicative of higher oil yields (1517.19kg/ha) for three-row 75-centimeter furrow planting pattern and control group without weed (table 6). Trifluralin+clopyralid+haloxyflop treatment (with a mean oil yield of 1365.87kg/ha) did not differ significantly from the control group without weed (table 6).

Conclusion

In sum, it can be concluded based on the study experiments that amongst the various planting patterns and herbicide treatments, three-row 75-centimeter furrow along with use of herbicides (trifluralin+clopyralid+haloxyflop) followed by two-row 75-centimeter furrow along with application of herbicides (trifluralin+clopyralid+haloxyflop) have been the best treatments hence their use is recommended in line with increasing the weight of a thousand grain, oil yield and biological performance of rapeseed.

Table 4: Combined analysis of rapeseed oil yield and biological yielding (mean values of 2011-2012 farming years)

Variation source	Degree of freedom	Biological Yielding(kg/ha)	Oil yield
Year	1	33126236.3^{ns}	5825158.6^{ns}
Replication	4	2529610.44	5772.4
Planting pattern	2	1923660.57^{ns}	731793.97**
Planting pattern×year	2	67037.38^{ns}	64904.37^{ns}
Error	8	1019725.49	10974.46
Herbicide	5	31445503**	714775.77**
herbicide×year	5	292886.35^{ns}	13582.88^{ns}
Planting pattern×herbicide	10	4634670.58**	53510.9**
Planting pattern×herbicide×year	11	167498.59^{ns}	46306.57^{ns}
Error	60	1701332.12	18262.56
CV(%)	---	14.09	12.19
*and** indicate significance in 95% and 99% probability levels; ns designates insignificance			

Table 5: Comparing the mean values obtained for the effects of planting pattern and herbicide on rapeseed oil yield and biological yielding (mean values of 2011-2012 farming years)

Treatment	Oil yield (kg/ha)	Biological Yileding (kg/ha)
Planting pattern		

Two-row 61-centimeter furrows	959.55[c]	8992.65 [a]
Three-row 75-centimeter furrows	1243.8 [a]	9343.15 [a]
Two-row 75-centimeter furrows	1121.3 [b]	9428.99 [a]
Herbicide		
Treflan	1102.97[c]	9702.42 [ab]
Treflan+Lontrel	1152.23 [bc]	9853.89 [a]
Treflan+Lontrel+gallant super	1234.74 [ab]	10026.04 [a]
Lontrel+gallant super	1125.64 [c]	8438.96 [c]
Control group with no weed	1302.85 [a]	8832.4 [bc]
Control group with weed	730.87 [d]	8831.94 [bc]
*based on Duncan test, the mean values with at least one common letter in each column do not have significant difference in 5% level.		

Table 6: Comparing the mean values of the mutual effects of planting pattern×herbicide on rapeseed oil yield and biological yielding (mean values of 2011-2012 farming years)

Planting Pattern	Herbicide	Oil yield (kg/ha)	Biological Yielding (kg/ha)
Two-row 61-centimeter furrow	Treflan	951.94[d]	12266.06 [a-d]
	Treflan+Lontrel	1097.06 [cd]	12038.96 [b-e]
	Treflan+Lontrel+gallant super	974.27 [d]	10440.5 [f-i]
	Lontrel+gallant super	1025.74 [d]	9906.45 [g-j]
	Control group with no weed	1070.6 [cd]	13433.17 [ab]
	Control group with weed	637.7 [e]	9153.6hij
Two-row 61-centimeter furrow	Treflan	1227.4[bc]	11475.21 [c-f]
	Treflan+Lontrel	1341.59 [b]	13291 [ab]
	Treflan+Lontrel+gallant super	1365.87 [ab]	12837.64 [abc]
	Lontrel+gallant super	1235.74 [bc]	13398.46 [ab]
	Control group with no weed	1517.19 [a]	13673.61 [a]
	Control group with weed	775 [e]	8744.44 [j]
Three-row 61-centimeter furrow	Treflan	1129.58[cd]	10653.02 [e-h]
	Treflan+Lontrel	1018.06 [d]	10720.93 [efg]
	Treflan+Lontrel+gallant super	1364.08 [ab]	12397.35 [a-d]
	Lontrel+gallant super	1115.45 [cd]	11184.05 [d-g]
	Control group with no weed	1320.74 [b]	12299.3 [a-d]
	Control group with weed	779.91 [e]	9086.21 [ij]
*Based on Duncan test, the mean values with at least one common letter in each column do not have significant difference in 5% level.			

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