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Effects of different tillage system, seeding method and rates on yield and seed oil percentage of rapeseed

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Abstract

Rapeseed as one the most crops is the basic needs of human feeding in order to produce oil. A field experiment was conducted to study the effects of different tillage system, seeding method and rates on yield and its components, as well as, seed oil percentage of rapeseed (*Brassica napus* L. cv. Hyola-401) during 2011-12 growing season at Rice Research Institute of Iran-Department of Mazandaran (Amol). The study was carried out in a split-split-plot experiment based on a randomized complete block design with four replications. The treatments included three tillage methods (no tillage, minimum tillage, and conventional tillage) as main plots, two seeding methods (hand-sowing and row planter) as sub plots and three seeding rates (6, 9, and 12 kg/ha) as sub sub plots. The results showed that the highest grain yield was obtained by applying minimum tillage method. The seeding methods had no significant effect on seed yield. The mean squares of oil seed percentage and 1000 seed weight in any of applied treatment were no significant, which was suggesting the stability of this trait in relation to applied treatments. Consequently, minimum tillage method by use of row planter and seed rate of 9 kg/ha was suggested for the best result in rice fields of Mazandaran for canola seed.

Key words: Canola, tillage, seeding method, seed rates, yield, oil seed.

Introduction

Soil preparation and making a sufficient seed bed is so important in canola cultivation because of small and sensitive seeds. Suitable seed bed is one of the efficient factors on exceeding yield and decreasing production coasts. About 60 percent of mechanical energy in agricultural procedure is used for preparing

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soil and seed bed (Jacobs and Harrel, 1983). Zumbach, 1982, studied different methods of seed bed preparation in wheat, barley, canola, corn, sugar beet, and potato in a period of six years. The results showed that canola had the most sensitivity to the quality of seed bed and insufficient bed would result to unwilled germination and reduce the bushes density per acre. So, canola could have the same yield for a variety of seed rate (Azizi et al, 1999). In another research done in dry cultivation in Canada, the effect of soil compaction before and after cultivation on germination and yield was studied for canola and flax seeds. The results showed that the compaction in soil surface to a certain extent could increase the percentage of germination and yield. The results also indicated that the clod and aggregate size had a significant effect on seed germination and canola seed germination was most in aggregate size of 4 mm (Domier et al, 1992). Increasing hard pan compaction, root dry weight was decreased even upper than hard pan (Steen and Hakansson, 1987). According to Ball and Robertson researches, 1994, was done on canola yield and soil physical properties in weak drainage lands with Abundant rainfall, the yield and germination of canola was more in moldboard tillage than no tillage with direct seeding. The percentage of soil pores was significantly less in direct seeding than the moldboard tillage. Experiments done on a clay loam soil indicated that canola yield was more in land with use of chisel plow than moldboard plow (Vez, 1974). Plant density is one of the most important factors in quality and quantity of agricultural crops. The amount of seed, type and quality of seed, and seed bed condition are among the important factors that determine the plan density. However the desirable amount of seed is 4-8 kilogram for winter cultivation in Britain, the yield was the same for 3-12 kilogram of seed and the difference of yield was less than 10 percent (Ogilvy, 1984). Other researches done with different amount of seed indicated that there was no significant difference in canola yield (Rudi, 2001; Khoshnazar Pareshokuhi, 2001).

Studies done in Sweden and French showed that direct seeding of autumn canola had the same result with common tillage and cultivation (Cedell, 1983; Merrien and Pouzet, 1983). Tillage operations could be better in soil with weak structure and organic matter because root penetration and drainage is weak in this kind of soil for the absence of deep tillage. Direct seeding in this condition would increase the risk of nutrient deficiency and crop sensitivity to drought (Kimber and Mc Gregor, 1995). Conventional tillage and the amount of 8 kilogram seed per hectar for canola had better yield and bushes density than other tillage methods and amounts of seed (Pirdashty & et al., 2003). A research done in Canada surveyed the costs, net incomes, and economic impacts of land management for three crop rotations under three tillage systems at the watershed scale in a period of 20 years. For canola, the greatest net income was generated in the conventional tillage (CT) system, which is attributed to the yield response to the tilled seedbed. As tillage frequency decreased, net income for canola declined (Khakbazan and Hamilton, 2012). Another study done in Saskatchewan, Canada showed that tillage system had the greatest impact on crop yields with higher yield more often under zero tillage than conventional tillage, most likely as a result of improved soil moisture under the zero tillage system (Kutcher and Malhi, 2010).

The main aim of this study was determine the best tillage system, seeding method and rate to achieve the higher yield and yield components for rapeseed (Hayola- 401) in rice field of north of Iran.

Materials and Methods

This research was done in rice fields of Rice Research Institute of Iran located in Amol, Mazandaran Province, Iran (52˚22 ′E, 39˚28 ′E, 19.5 m asl). The canola seed type (*Brassica napus* L.) was Hayola 401 hybrid, which was a spring hybrid that could be planted in autumn in temperate regions. Some physical and chemical properties of field soil were determined shown in Table 1. The experimental design was split- split plot in a randomized complete block design with four replications.

The main plot was three different tillage types (NT: no-tillage, MT: minimum tillage and CT: conventional tillage), the sub plot was two seeding methods (manually and row-planter) and sub- sub plot was three amounts of seed (6, 9, and 12 k ha^{-1}). Tillage operation was done in early October with using once moldboard plow for CT, once disk plow for MT, and without any tillage operation for NT treatments. Twice disk plow for CT and once disk plow for MT treatments were fulfilled in late October, and before planting. Fertilization included 180 kg ha^{-1} of potassium sulfate and 130 kg ha^{-1} of ammonium phosphate, which added to soil along with tillage operations. The used row planter manufactured by Taka that was special for grain. N fertilization was applied by urea at 100 kg ha^{-1} (½ at planting and ½ after rosette). Weeds were controlled with treflan.

The pants were harvested after the physiological ripening in each plot with eliminating marginal effect (0.5 m from each side). The seed weight was measured based on 13 percent moisture content (DB). To determine the yield parameters, 10 samples of each plot were randomly selected and number of pods per main stems, number of pods per plant, number of seed per pods, and thousand-grain weight were measured. The percentages of seed oil were measured by nuclear magnetic resonance (NMR) method. Statistical analysis was done by MSTATC, SAS, and Excel software and mean comparisons was performed based on Duncan's multiple range tests in probability level of 5%.

Results and Discussion

The analysis of variance showed that the effect of tillage methods on number of pods per main stem (NPMS) was significant in probability level of 1% (Table 2). The averages of this attribute in no-tillage, minimum tillage and conventional tillage were 37.42, 57.83, and 52.79 respectively (Table 3). The correlation of this attribute with grain yield in different applied treatments was positive and significant (Table 4). The effect of seeding methods and the amount of seed on the NPMS was not significant (Table 2). The NPMS for manually and by using row planter were 48.28 and 50.42, respectively. The average of this parameter for the amount of seed 6, 9, and 12 kg per hectare were 48.46, 49.71, and 49.87, respectively (Table 3). Interaction of tillage methods and seeding methods on the NPMS was significant in the probability level of 5% (Table 2). Figure 1 showed that only in conventional tillage the NPMS was significantly more in row planter than manually seeding method and in two other tillage methods this parameter did not change by altering seeding methods. The figure also showed that the most NPMS related to minimum tillage for every seeding method. The results showed that the number of pods per main stem (NPMS) had a positive correlation on the grain yield that meant every change in farm management that increased this attribute would increase the grain yield.

The effects of tillage methods, seeding methods, and seed rates on the number of pods per plant (NPP) were significant in the probability levels of 1%, 5%, and 5%, respectively (Table 2). The most and the least NPP was obtained in minimum tillage method (247.67) and no tillage method (84.83), respectively (Table 3). The averages of this attribute for different seeding methods were 193.63 for manual seeding and 163.27 for row planter (Table 3). According to results, the most NPP was gained for 9 kg seed per hectare and increasing seed rate to 12 kg would significantly decrease the NPP (Table 3). Correlation between this attribute with grain yield was significant and positive (Table 4). Increasing the seed rates, the bushes density would increase so the numbers of tributaries would decrease because of increasing the competition between plants and limiting the use of environmental resources and then the number of pods per plant would also decrease. Leach and et al. (1999) and Yazdifar (2003) obtained the same results. Since the correlation of the number of pods per plant (NPP) with the grain yield was significant and positive, increasing the NPP would increase the grain yield. The results showed that with increasing seed rates the NPP would decrease. Faraji (2001) and yazdifar (2003) founded that increasing the plant density would decrease the NPP.

The mean squares of tillage treatment and seed rate were significant for the number of seeds per pod (NSP) in the probability level of 1% (Table 2). The averages of this attribute were 19.54, 23.58, and 23.54 for no tillage, minimum tillage, and conventional tillage methods (Table 3). The NSP had not much variability for seeding methods and seed rates and there were no statistically significant difference (Table 2). The most NSP was for seed rate of 6 kg per hectare that was 21.54 (Table 3). Interactions between treatments had no significant difference on this attribute (Table 2).

The analysis of variance of 1000-grain weight (TKW) attribute revealed that the mean squares of no treatment had significant effect on 1000-grain weight and this showed the stability of the trait to the treatments (table 2). The means of TKW in different tillage methods were 3.83 (g) for no tillage, 3.96 (g) for minimum tillage, and 3.98 (g) for conventional tillage with no meaningful differences (table 3). The TKW did not vary a lot with different seeding methods (table 3). Study the effect of different seeding rates on TKW indicated that this treatment had no meaningful difference on TKW and the average of it for seeding rates of 6, 9, and 12 kg per hectare were respectively 3.92, 44.04, and 3.79 (g) (table 3). The interactions between treatments had no statistically significant effect on TKW (table 2). Correlating this attribute with yield was also non-significant (table 4). The seed rates did not have a significant effect on 1000-grain weight (TKW) that was also reported by Kazerani (2002) and Yazdifar (2003). According to the results, increasing TKW would not increase the grain yield because the correlation of TKW with grain yield was not significant.

Analysis of variance indicated that the effect of tillage methods on the grain yield was significant in the probability level of 1% (table 2). The averages of grain yield were 246.3, 2262, and 1874 kg/ha for no tillage, minimum tillage, and conventional tillage methods, respectively (table 3). The grain yield was not affected by the seeding methods and the average of it was 1478.42 and 1443.2 kg/ha for manually and row planter, respectively (table 3). The procedure of minimum tillage method in rice fields would improve the soil aggregation and produce small lumps and firm, warm, and ventilated seed bed that increased the grain yield. These results were in accordance with the reports of Givhan (2001) cited by Pirdashty (2003).

Different seed rates would vary the grain yield as the most yield was earned for seed rates of 9 kg/ha and the least one was for 12 kg/ha (table 3). The interaction of seeding methods and seed rates on the grain yield was significant in the probability level of 1% (table 1). Figures 2 showed that the grain yield in seed rates of 9 and 12 kg/ha of manually seeding were more than using the row planter but in seed rate of 6 kg/ha it was vice versa. Using row planter, the yield was decreasing when the seed rates increased. The different seed rates did not have a significant impact on the grain yield that was in accordance with the findings of Leach and et al. (1999) that the increasing the bushes density to a limit would increase the grain yield but in further plant density the yield would decrease. Faraji (2001) also reported that the excessive increase in seed rate would increase the crop lodging and decrease the grain yield.

Analysis of variance revealed that the percentage of seed oil (PSO) was stable against variations of treatments and also interaction between them (table 2). The variations of this attribute were negligible according to different tillage methods. The averages of the PSO in tillage methods of no tillage, minimum tillage, and conventional tillage were 49.19%, 48.68%, and 48.16%, respectively (table 3). The mean of this attribute in different seeding methods were 48.47% and 48.89% for manually and row planter seeding (table 3), so this treatment did not cause a major changes in the PSO. The different seeding methods did not have a major impact on the percentage of seed oil that is consistence with the results of leach and et al. (1999) and Yazdifar (2003).

Studying the effect of seed rates on PSO showed that the changes in PSO due to changes of seed rates were very low as the averages of the PSO were 48.25%, 48.80%, and 48.99% for 6, 9, and 12 kg/ha, respectively (table3). The effect of interactions between treatments on the PSO was also non significant (table 2). The correlation between the PSO and grain yield was significant and negative (table 4).

Based on the general conclusion of this research, the minimum tillage operation was suggested in rice fields of Mazandaran for canola seed due to develop a suitable soil structure and lower cost than other tillage operations. Using row planter was preferred to manually seeding because of quick act, uniformity in planting, suitable depth for seeds, appropriate use of nutrients, and facilitating the maintenance and harvesting. The seed rate of 9 kg/ha was the best treatment due to decrease the plant lodging and rot the stem in Mazandaran weather conditions.

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Tables

Table 1- Soil characteristics of test field.

Depth (cm)	EC (dS m^{-2})	pH	Soluble materials TNV (%)	OC (%)	P (mg kg^{-1})	K (mg kg^{-1})	Clay (%)	Silt (%)	Sand (%)	soil texture
0-30	1.23	6.79	29.5	2.6	10.5	165	28	51	21	silt loam

Table 2- Analysis of variance of the studied attributes mean squares.

Source of Variation	mean squares						
	df	NPMS	NPP	NSP	TKW (g)	Grain Yield (kg ha^{-1})	Seed oil (%)
rep	3	149.13	607.53	35.3	0.09	34841.35	0.45
tillage (A)	2	2714.60**	169819.29**	129.35**	129.35 **	27452647.26**	6.35 ^{ns}
Error a	6	33.04	535.09	4.59	4.59	32386.43	2.47
seeding method (B)	1	82.35^{ns}	16592.35*	40.50 ^{ns}	40.50 ^{ns}	22295.68 ^{ns}	3.09 ^{ns}
AB	2	104.76*	6390.60 ^{ns}	7.04 ^{ns}	7.04 ^{ns}	578600.68 ^{ns}	0.52 ^{ns}
Error b	9	59.53	1124.46	14.09	14.09	67576.83	8.76
seed rate (C)	2	14.39^{ns}	2367.54*	22.60 ^{ns}	22.60 ^{ns}	433433.39**	3.56 ^{ns}
AC	4	55.65 ^{ns}	3396.27 ^{ns}	8.26 ^{ns}	8.28 ^{ns}	80686.05 ^{ns}	0.34 ^{ns}
BC	2	242.39 ^{ns}	8483.76 ^{ns}	1.79 ^{ns}	1.79 ^{ns}	1524713.72**	6.02 ^{ns}
ABC	4	89.93 ^{ns}	12169.57 ^{ns}	5.33 ^{ns}	5.33 ^{ns}	28360.26 ^{ns}	0.76 ^{ns}
Error	36	11.56	473.7	5.43	5.43	26176.38	2.17
CV%		6.89	12.19	10.49	10.49	11.07	3.02

*, ** probability levels of 5% and 1%, respectively. ns is non-significant

NPSM: number of pods per main stem; NPP: number of pods per plant; NSP: number of seeds per plant; TKW: thousand kernel weight.

Table 3- Comparison of means of the treatments for studied attributes.

Levels of factors	NPMS	NPP	NSP	TKW (g)	Grain yield (kg ha^{-1})	Seed oil (%)
Tillage Systems						
No tillage	37.42 c	184.83 c	19.54 b	3.83 a	1246.33 c	49.19 a
Minimum tillage	57.83 a	247.67 a	23.58 a	3.96 a	2262.04 a	48.68 a
Conventional tillage	52.79 b	203.87 b	22.97 a	3.98 a	1874.08 b	48.16 a
Seeding methods						
Manually	48.28 a	193.27 b	22.97 a	3.97 a	1478.42 a	48.47 a
Row planter	50.42 a	163.27 b	21.47 a	3.86 a	1443.22 a	48.89 a
Seeding rates						
6 kg ha^{-1}	48.46 a	174.96 b	23.33 a	3.92 a	1520.29 a	48.25 a
9 kg ha^{-1}	49.71 a	189.67 a	21.79b	4.04 a	1555.21 a	48.80 a
12 kg ha^{-1}	49.87 a	170.75 b	21.54 b	3.79 a	1306.96 b	48.99 a

Means with similar letter are not significant differed (Duncan 0.05).

NPSM: number of pods per main stem; NPP: number of pods per plant; NSP: number of seeds per plant; TKW: thousand kernel weight.

Table 4- Correlation coefficient of studied attributes.

attributes	1	2	3	4	5	6
NPMS	1					
NPP	0.84 **	1				
NSP	0.61 **	0.60 **	1			
TKW	0.1	0.11	0.17	1		
Grain yield	0.85 **	0.89 **	0.58 **	0.14	1	
seed oil	-0.18	-0.21	-0.19	0.16	-0.29 *	1

*, ** probability levels of 5% and 1%, respectively.

Figures

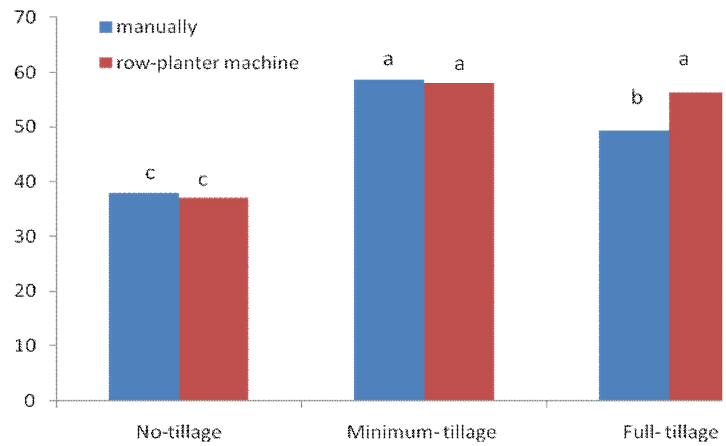

Figure 1- Interactions between seeding methods and tillage system.

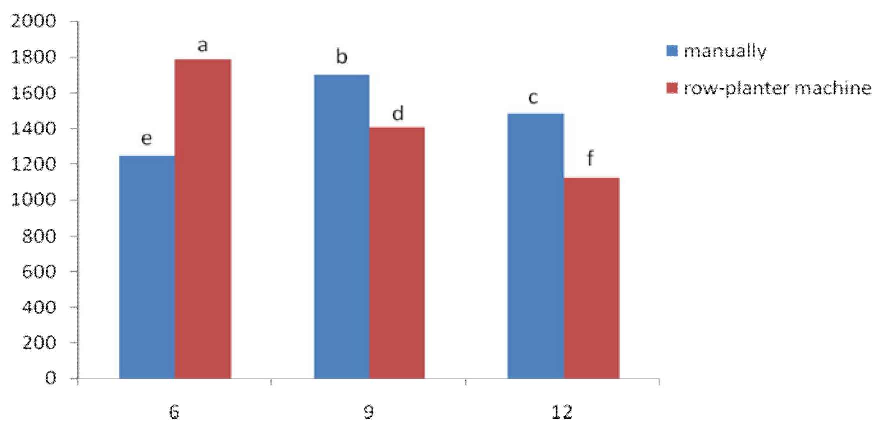

Figure 2- Interactions between seeding methods and seeding rates.