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Maize residue management effect on nitrogen fertilizer and canola grain yield

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Canola is an oilseed that is a member of the Brassicaceae family. It has 27% protein and 38% oil in its grains. The purpose of this study was to determine the effect of various nitrogen fertilizer rates applied to the canopy of the Canola crop on the direct and indirect elements of grain and the production of oil. In that regard, a trial with canola was conducted in succession to maize cultivation using the hybrid Hyola 61, under a no-tillage scheme, in a soil categorized as Eutrophic Red Latosol located at 53°16'44" W 24°49'06" S, in the investigational site of Dezful Agricultural Farm in northern Khuzestan, Iran. The experimental method utilized random blocks with four replications and seven treatments, totaling 28 plots on an 882 m2 region. 50 kg ha^{-1} of P2Os, 50 kg ha^{-1} of K20 and 28 kg ha^{-1} of N, were administered as base fertilization. 25 kg ha^{-1} N, 50 kg ha^{-1} N, 75 kg ha^{-1} N, 25 kg ha^{-1} N + 27 kg ha^{-1} S, 50 kg ha^{-1} N2 + 54 kg ha^{-1} Sand, 0.45 L ha^{-1} N + 0.1 L ha^{-1} S (foliar fertilizer Micro Xisto HF) were applied to the covering 42 days following the appearance of Canola seedlings. No statistically significant changes in production components were found across treatments except oil content.

Keywords: canola, fertilization, Khuzestan

INTRODUCTION

The pursuit for alternate and economically viable oil-producing plants is a constant in Brazilian agriculture, particularly in the aftermath of utilizing vegetal oils to create biodiesel. In that regard, Canola culture, whose grains contain an average of 38% oil, could be an agronomically viable option (Johnston, Lafond et al. 2001, Gholamin and Khayatnezhad 2020, Bi, Dan et al. 2021, Guo, She et al. 2021). Canola accounts for 15% of global oil production. Its oil, which is low in glucosinolates and erucic acid and rich in vitamin E and omega-3 fats, is among the healthiest oils for human nutrition, having been recognized as a functional food by healthcare (Brown, Davis et al. 2008, Khayatnezhad and Gholamin 2020, Si, Gao et al. 2020, Li, Mu et al. 2021). This oilseed was already well-known in India three thousand years ago. In 13th-century Europe, its oil has been used to illuminate towns and lubricate ships. Its cultivation gained global prominence during World War II due to its efficacy in lubricating ships and its resistance to high temperatures and water steam (Shahidi 1990, Gholamin and Khayatnezhad 2020, Sun, Lin et al. 2021, Tao, Cui et al. 2021). According to Zonin, Winck et al. (2010), canola production started in Brazil in 1974 by Tritfcola Serrana Ltda - Contrijuf as a fallow crop and in crop rotation with wheat throughout the winter; at the time, it was called Colza. Crops initially appeared in Parana in the early 1980s. The cultivation area was expanded in 2001 under canola, which means "Canadian Oil Low Acid," due to the oil containing less than 2% erucic acid and approximately 30 micromoles of glucosinolate (Gholamin and Khayatnezhad 2021, Ren and Khayatnezhad 2021). With the continuous advancements in agriculture, the pursuit of sustainable alternatives, food production for animals and people, and renewable energy sources, canola provides producers with another alternative. Due to its agronomic features and climatic requirements, it is a winter culture that fulfills the requirements for incorporation into Brazil's grain production system during the cold season (CASÃO JUNIOR, Araújo et al. 2012, Gholamin and Khayatnezhad 2020, Ma, Ji et al. 2021). The advancement of the no-tillage method, along with the need to cover the soil with straw throughout the year and practice crop rotation, establishes canola as a viable alternative in seasons and places when wheat cultivation is economically unviable fallow lands.Canola cultivation effectively suppressing weeds, pests, and diseases, as well as recycling nutrients for increased crop rotation and sustainable grain production (Franchini, da Costa et al. 2011, Huang, Wang et al. 2021, Khayatnezhad and Gholamin 2021). White mold, induced by the fungus Sclerotinia sclerotiorum (Lib.) de Bary, has sparked widespread concern among the productive sectors, particularly in the coldest regions of Brazil, where soybean, beans, and canola are grown. Sclerotiorum sclerotiorum (Lib.) de Bary is a global pathogen in temperate, subtropical, and tropical zones. In addition to being a polyphagous fungus, it is known for infecting and hosting 408 species and 278 types of plants (Huang, Wang et al. 2021, Rodríguez 2021). Canola needs good climatic conditions, acceptable soils, and macro and micronutrients in the soil solution for absorption to properly grow and yield grains. When nitrogen and sulfur are given to the cover crop during planting, canola reacts favorably (Franchini, da Costa et al. 2011, Khayatnezhad and Gholamin 2021). The purpose of this study was to determine the impact of various nitrogen fertilizer rates applied to the cover under a no-tillage system on the direct and indirect elements of oil and grain production in canola.

MATERIALS AND METHODS

The experiment was conducted in the Dezful Agricultural Farm's research property in northern Khuzestan, Iran, on a soil categorized as typical Eutrophic Red Latosol by Franchini, da Costa et al. (2011). The farm is situated at longitude 53°16'44" W, latitude 24'49'06"S, and elevation 682 m above sea level. According to Koppen's categorization, the climate is categorized as Cfa - subtropical (Karasakal, Khayatnezhad et al. 2020). Soil fertility was determined in the research region by collecting two compound soil samples at depths of 0 to 10 cm and 10 to 20 cm, as recommended by Gao et al. (2010), and analyzing them at the Sol-Analise Soil Analysis Laboratory. Table 1 summarizes the findings of the soil analysis based on the samples.

The experiment was conducted in 2011 using seven lines with a 45 cm spacing between lines and a 10 m length, using Canola hybrid Hyola 61, totaling an area of 882 m2 in a no-tillage system (Apr,19). In terms of base fertilization, 280 kg ka-1 of chemical manure NPK was utilized, equating to 28 kg ha^{-1} of nitrogen, 50 kg ha^{-1} of phosphorus, and 50 kg ha^{-1} of potassium (Tomm et al., 2010).To maintain the standards of desired plants, the pests Diabrotica speciosa and Elasmopalpus lignosellus were managed by ground pulverization using a bar sprayer and the pesticides Novalurom 15 g La ha^{-1} + Esfenvalerate 10 g i.a ha^{-1} in a 130 liters ha^{-1} syrup 11 days since canola's onset (May, 07) in principal growth Stage (Werner, Santos et al. 2013, Gholamin and Khayatnezhad 2020, Xu, Ouyang et al. 2021). Sulfur and nitrogen were applied manually to the line 5 cm from the Canola crops; foliar fertilizer also was applied using an electric backpack sprayer in syrup at an application rate of 80 L ha^{-1} 42 days after the onset of seedlings with damp soil, on June 7, when the plants were in principal growth Stage 1, with the fourth leaf unfolded (e Silva and de Azevedo 2009, Khayatnezhad and Gholamin 2020, Zhu, Saadati et al. 2021). Seven different nitrogen fertilizer concentrations were used in the treatments: T1: Control; T2: 25 kg ha^{-1} of nitrogen; T3: 50 kg ha^{-1} of nitrogen; T4: 75 kg ha^{-1} of nitrogen; T5: 25 kg ha-1 of nitrogen + 27 kg ha^{-1} of sulfur; T6: 50 kg ha^{-1} of nitrogen + 54 kg ha^{-1} of sulfur (both solid); T7: 0.45 L ha^{-1} of nitrogen + 0.1 L ha^{-1} of sulfur (liquid). The following commercial fertilizers were employed in the study: urea CO (NH2J2, as a source of nitrogen; ammonium sulfate (NH4J2 S04, as a source of nitrogen and sulfur; and foliar fertilizer Micro Xisto HF, as a supply of liquid nitrogen and sulfur. The experimental design employed in this research was random blocks with four replications and seven treatments, resulting in 28 plots, each measuring 31.5 m2 (Pimentel-Gomes 2009, Karasakal, Khayatnezhad et al. 2020, Zhang, Khayatnezhad et al. 2021).The following parameters were analyzed: productivity, in kg ha-1 (PDH), determined by manually harvesting the entire plot and converting it to kg ha-1; mass of a thousand grains (MTG),

Table 1: Chemical soil analysis, at depths 0 to 10 cm and 10 to 20 cm from the experimental area

Depth	PH	H+ AL	Ca	Mg	K	CTC	P	S	M.O %	V%
0-10	5.4	4.96	6.79	2.08	0.23	14.06	10.80	1.50	4.66	64.72
10-20	5.0	6.21	4.88	1.85	0.20	13.14	3.80	3.90	3.58	52.74

Source: Solanalise Soil Analysis Laboratory.

determined by weighing two samples of 125 grains randomly selected from the volume harvested from the plot and multiplying by four; grain oil content, determined by extracting oil from each sample using a direct extractor Soxhlet.

To determine the yield of individual plants and their estimated components, eight plants were randomly selected from the plots to provide the averages for the following determinations: a) number of siliquas per plant, as determined by counting siliquas inside each plant; b) grain mass per plant, as determined by tracking each plant on an analytical scale.

To determine the statistical significance of the differences between treatments, the F test (analysis of variance) was used, and a posterior test (Tukey's), which sought to compare averages at a level of 5% significance for both tests (Cheng, Hong et al. 2021, Hou, Li et al. 2021, Khayatnezhad and Nasehi 2021, Wang, Shang et al. 2021, Zheng, Zhao et al. 2021, Zhu, Liu et al. 2021). The model's assumptions were validated using Hartley's maximum F test for variance homogeneity and Shapiro-Wilk's test for normality. ASSISTAT 7.6 beta was utilized to evaluate the data (e Silva and de Azevedo 2009).

RESULTS AND DISCUSSION

One can see that the total of pluviometric precipitations in the experiment region during ten days from March to September 2011 (Table 2) indicated a greater concentration during the filling stage of the Canola grains. The analysis of variance revealed a major impact for only the oil content at a 5% level of significance for the parameters: number of siliquas per plant, grain mass per plant, MTG, GOC, productivity in kg ha^{-1}, and plants with sclerotinia symptoms (Table 3). The variance coefficients found varied from 1.27 to 26.13 % for plants exhibiting sclerotinia symptoms. These findings are consistent with those of Rigon, Cherubin et al. (2010), who examined canola's reaction to sulfur and nitrogen applied to coverage plots and found no increase in production at a 5% level of significance.

According to Osório Filho, Rheinheimer et al. (2007), canola's lack of reaction to sulfur applied to the soil may result from rainfall absorbing ambient sulfur. The current study's findings contrast with those of Rigon, Cherubin et al. (2010). They reported a statistical response at a 5% level of significance for the interaction of 60 kg ha^{-1} N + 16 kg ha^{-1} S concerning the quantity of siliquas. Jia, Khayatnezhad et al. (2020) confirmed a 45 % increase in siliquas output and a 22 % increase in grain mass per plant. Additionally, Ma, Khayatnezhad et al. (2021) discovered that nitrogen fertilizer enhanced the quantity of siliques and yield substantially. The results of this experiment differ from those of Peng, Khayatnezhad et al. (2021), who conducted research under five distinct experimental settings to test Spring Canola's reaction to various concentrations of Nand S and discovered statistically significant variations. Öztürk (2010)obtained a 47 % increase in grain production for the treatment that received 150 kg ha^{-1} of Borsoi, Cereda et al. (2010) validated the influence of Nand S application on the hybrid Hyola 43, and obtained statistically significant differences from the witness in comparison to the treatments with 38 kg ha^{-1} of N (ur). Karamanos, Goh et al. (2007), (Sun and Khayatnezhad 2021) reported a 23.7 % increase in Canola grain yield when Nand S were added to soils deficient in these nutrients. There were no statistically significant reactions in soils with high levels of N, and S. Gao, Thelen et al. (2010)found no increase in Canola grain output when they applied 84 and 168 kg ha^{-1} of nitrogen in two locations in the years 2007 and 2008. By examining the sclerotinia-infected plants (Table 3), it is clear that the treatments had no statistically significant impact. The results contrast with those of Yin, Khayatnezhad et al. (2021), who found a statistically significant response in the interaction between nitrogen and sclerotinia disease incidence at nitrogen concentrations of 80 and 120 kg ha^{-1}. The regression curves produced for the average values of siliquas per plant, grain mass in thousand grains, canola output in kg ha^{-1}, and canola oil content in kg ha^{-1} may be seen concerning the nitrogen fertilizer given to the covering.

Table 2: Pluviometric precipitation (mm) occurred during the experiment, at the meteorological station of Cascavel

10-day period	March	April	May	June	July	August	September
				Months			
1 st	10.8	7.0	1.8	27.0	66.0	6.4	39.8
2nd	2.4	17.8	11.4	0.0	36.8	187.4	15.6
3rd	53.6	29.8	0.0	18.8	24.0	36.4	22.2
Total	66.8	54.6	13.2	45.8	126.8	230.2	77.6

Table 3: Phenotypic average values for Canol a productivity and S. *sclerotiorum* (Lib.) de Bary symptoms according to different dosages of nitrogen and sulfur applied to the coverage

Treatments			**Variables**			
	NSP	**GMP**	**MTG**	**GOC**	**PDH**	**SCI**
kg ha^{-1} Nand S	**n plant^{-1}**	**g plant^{-1}**	**g**	**%**	**kg ha^{-1}**	**Pl . *w* /symp.**
Control	264.75	10.65	3.67	38.12a	2.171	1.45
25 N	283.50	11.27	3.69	35.32d	2.201	1.05
50 N	281.50	10.95	3.66	36.65bc	2.241	1.11
75 N	276.25	10.87	3.60	34.77d	2.186	1.67
25 N + 27 S	258.25	11.20	3.74	37.17ab	2.172	1.59
50 N + 54 S	273.00	10.74	3.68	35.60Cd	2.268	1.44
0.45N+0.1S1	257.25	10.27	3.70	37.00b	2.206	1.45
F value	0.31 n8	0.45n8	0.33n8	26.33*	0.41 ns	1 .60n8
P - value	0.9230	0.8387	0.9116	<0.001	0.8647	0.2032
C.v.	14.19	9.46	4.10	1.27	517	26.13
MSD	89.69	2.40	0.35	1.08	266.35	0.85

Averages followed by the same letter in the column do not differ significantly from each other by Tukey's test at 5% significance. * = significant at the level of 5% probability; 1 = foliar fertilizer; ns = non-significant; GV = coefficient of variation; MSD = minimum significant difference; NSP = number of siliquas per plant; GMP = grain mass per plant; MTG = mass of a thousand grains; GOG = grain oil content; PDH = productivity in kg ha''; SGL = Sclerotinia.

One can see that the number of siliquas per plant follows a quadratic relationship, peaking between 25 and 50 kg N ha^{-1} (the value 44.24 kg N ha^{-1} as displayed presents the regression graph for the mass of a thousand grains as a function of the nitrogen doses applied to the coverage;

One can see that the maximum mass point is achieved between 25 and 50 kg N ha^{-1}) (in the value 28.33 kg of N ha^{-1}). One may see that the productivity kg ha^{-1} is quadratic, peaking between 25 and 50 kg of N ha^{-1} (in the value 42.50 kg of N ha^{-1}).

Additionally, one may observe that the grain oil content falls as the coverage of nitrogen fertilizer rises. Ahmad, Jan et al. (2007) found comparable findings when examining canola's reaction to nitrogen fertilization. According to Johnston, Lafond et al. (2001), Canola seed oil content reduces with increased nitrogen application, perhaps owing to the crop's delayed maturity. Another possible explanation for the decline in oil content, according to Öztürk (2010), is that this nutrient is a major component of proteins, resulting in an increase in protein percentage and a decline in oil content.

CONCLUSION

There was no statistically significant difference in Canola productivity between treatments that received nitrogen and sulfur fertilizers to the coverage and treatments that did not receive nitrogen fertilizers. Canola grain oil content was reduced with nitrogen application to the coverage in all treatments except the one that received 25 kg ha^{-1} N + 27 kg ha^{-1} S. In this trial, no statistically significant difference in the incidence of symptoms or damage produced by the fungus Sclerotinea sclerotiorum (Lib.) de Bary was found between treatments.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Mani Alizadeh conducted, planned, Analyzed the data, wrote manuscript and interpreted the results and involved in manuscript preparation. All authors read and approved the final version.

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