Economic Assessment and Effectiveness of Sulfur and Organic Matters on the Qualitative and Quantitative Yield of Canola (Brassica napus L.) in the calcareouse Soil

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Abstract: For economic assessment of Sulfur application, the present research has applied Thiobacillus Bacterium and organic matter, during 2009 - 2011 for three years, in the calcareouse soil of the Research Field of Agricultural station of Gachsaran-Iran as the split- split plot experiment in the randomized complete blocks design with 18 treatments on a Varity of Hiyolo 401 Canola in three replications. The treatments were: Sulfur (0, 400, 800 kg), Thiobacillus (0, 2, 4 kg) and organic matter (0, 20 tons) in hectare. The combine analysis of variance for three years mentioned factors on some properties as harvest index, biologic yield, seed yield, protein percentage, oil percentage and oil yield showed that the factors alone and together have a significant effect on the qualitative and quantitative economic yield of Canola plant. mean Comparisons of the main and interaction effects between factors showed that the most average of the seed and oil yield has been produced by treatments $O_2T_3S_2$ which increased, in comparison to the control treatment, the seed and oil yield respectively 154% and 180%. Also, the economic consideration of the project results revealed that exerting this treatment will increase 5320000r (266$) profit in per hectare.
[Jafar Gohargani, Meruzhan Galstyan, Abdolamir Moezzi. **Economic Assessment and Effectiveness of Sulfur and Organic Matters on the Qualitative and Quantitative Yield of Canola (Brassica napus L.) in the calcareouse Soil.** *Life Sci J* 2012;9(4):736-740] (ISSN:1097-8135). http://www.lifesciencesite.com. 115

Keywords: Canola, Sulfur, Organic matter, Thiobacillus bacterium and yield.

Introduction

After the cereals, the oil seeds are the second food source of the world. These crops contain both the oil source of Fate Acid and protein. Among the oil plants, Canola is the plant with the high level in term of quality, quality and nutrition indexes. Also, it has been recognized as one of most important oil plants of the world and it is, according to the last published static by FAO, the third source of herbaceous oil in the world after Soya and Palm (Malakouti, et al. 2003). Capitation of the oil consumption in the world has been, differently, reported based on the nutrition habits of people. However capitation of edible oil of Iran has been estimated about 16(kg) and the internal need of the country is more than one million tons in which about 90% is imported. In term of agriculture, the oil plants are in a particular position (Malakouti, et al. 2003).

Sulfur plays an important role in increasing the yield and oil quality of Canola. In other words, it plays a significant role in the yield of Canola oil (for its participation in the product process of oil) as well as a modifier in the soil (Besharati Kalaye, 1999). Importance of this element in our country soil, which is dominantly limy, will be represented more than other elements. By participation in the structure of Amine Acides, Proteins, Vitamins and Anzims within the plant, Sulfur is one of elements with high consumption for plant, after Nitrogen, Phosphorous and Potassium., Canola plant has been regarded as one of the most important oil plants. Because of containing more than 40% proteins in its meal, Canola is taken into account as one of the most significant oil seeds of the world. Increase in the oil percentage of Canola plant is because of Sulfur consumption and its function in many fate Acides (Asghar, et al. 2004). In comparison with the cereals and legume, Canola needs more Sulfur because of the more protein in its seed (Malakouti, et al. 2003). The result of the different fertilizer experiments showed that the density of Glucosinolate and oil in seed as well as general yield of Canola in the applied varieties were increased noticeably (Lakhincni, et al. 1992).

The Sulfurous fertilizers not only increase the yield and quality of oil products but also improve the consumption efficiency of the other fertilizers as Nitrogen and Phosphorus; consequently, reduce the production costs and increase the economic return for the producer. Based on the results of all farm data, per kilogram of the consumed Sulfur by fertilizers increased the yield of ground nut, Soya and Canola, respectively, 13/3, 8/9 4/5 kg (Lin, 1998).

In our country, only 8-10 percent of the necessary oil seed is produced. If we continue the current trend, we should import about 1/3-1/4 million tons to provide the annual edible oil (assuming the percent capitation: 17-18 kg). This estimation has been regarded by assuming 200000 tons as the minimum

local product; therefore, we need, minimally, 1/5 to 2 milliard dollars to import the raw oil, with regard to the price of 1000 dollar for per tons of edible oil within 10 to 20 years in the future. (Malakouti, et al. 2003).

Material and methods

The present research was conducted in the Research Field of the Agricultural station of Gachsaran, Iran.within 2009-2011.

At first we prepared composite soil samples from the field in the 0-30 cm depth and after drying the samples were analyzed for soil physical and chemical characters. Soil texture was determined using the hydrometric method, pH and electrical conductivity of the saturated paste, soil organic matters, total carbon and available P, K and neutralizing material were measured using standard methods. The experiment was performed was done with split-split plot experiment based on randomized complete blocks design with three replications.

Treatments in this research were different combinations of three factors namely: 1- organic matter with two levels of O_1=0, O_2=20 t ha^{-1}) as main factor, 2- Thiobacillus inoculants three levels of T1=0, T_2=2, T_3=4 kg ha^{-1} as sub factor and finally 3- three levels of Sulfur element with the three levels of S1=0, S_2=400, S_3= 800 kg ha^{-1} as sub-sub factor. Canola seeds were planted in 12 m^2 plots, in the 7 rows with 6 meters length and 30 cm space from each plot. To preventing of mixing and other problems two meter spacing was consider between replications. Before seed planting, the field was leveled carefully with tillage machinery in the all of plots. Nutrient elements based on the results of soil analysis were performed by triple super phosphate and urea, 50/50 kg ha^{-1} and mixed with the soil using disk harrow respectively (Klute, 1986). The Sulfur treatment (Sulfur element with the purity of 98%) and the organic matter as source of organic matter were used for each plot based on their treatments and mixed completely with soil. Canola seeds were inoculated with thiobacillus bacterium based on related treatment (0.5% applied Sulfur) before planting. During the different stages of plant growth, agronomic operations such as diseases, weeds and pests control were performed for all plots. During growing season, agronomic traits such as pods per plants, seed per pods, thousand seed weight and economic yield, oil, protein content and etc. were recorded (Naderi Arefi, et al.2006) . All data were analyzed with SAS and MSTAT-C software's.

The combine analysis of variance in triennial data of the experiment showed that the effect of year on the properties of biologic yield, economic yield, percentage of oil and oil yield were significant at1% probability level (Table 1).

The result showed that the effect of organic matter on the measured properties was significant and interaction between year × organic matter on the harvest index at 1% probability level and biologic yield at 5% probability level was significant but it did not significant of the other properties. The organic matters cause the improvement in the quantitative properties of plant by improving the physical properties of soil and possibility of growth and development of root as well as availability of the useful elements for plant (Azzizy, et al. 1994 and Malakouti, 2004).

The results showed that the effect of Thiobacillus Bacterium as well as interaction between year × Bacterium and Bacterium × organic matter on all properties were significant but the protein percentage.

The results showed that the interaction between year × organic matter × Bacterium on the properties of harvest index, biologic yield, economic yield and oil yield at 1% probability level were significant but it was not significant in the case of properties of protein and oil percentage. Some researchers concluded that Thiobacillus Bacterium eventually provides many static elements in the soil, through the mechanism of decrease in PH of soil, which increases the aerial organs of plant and, consequently, quantitative yield of plant (Jafarneijad 2006, Haghighi, et al. 2004 and Kalbasi, et al. 1988).
The results showed that the effect of Sulfur on all properties significant at 1% probability level and interaction between year × Sulfur on the biologic yield, economic yield and oil yield were significant.

The results showed that effect of interaction between Sulfur and organic matter on the properties biologic yield, economic yield, protein percentage and oil yield significant at 1% probability level. The results showed that interaction between the year × organic matter× Sulfur on the properties of harvest index, biologic yield, economic yield and oil yield at 1% probability level were significant. But it did not significant in protein and oil percentage. Moreover, the interaction between Sulfur ×Bacterium ×organic matter on all the measured properties were significant at 1% probability level.

Also, the results of combine analysis of variance showed that the interaction between year ×organic matter ×Bacterium ×Sulfur on the properties of harvest index, biologic yield and oil yield were significant at 1% probability level. The results of the research are agreement to the results of the other researches (Gohargani, et al. 2010 and Salimpour, et al. 2010).

The average of triennial yield showed that the interaction between Thiobacilus Bacterium and Sulfur powder was able to influence the measured properties

(Table 2). The results show that the interaction between Thiobacillus bacterium and Sulfur powder in the treatment with out organic matter and 4 kg bacterium in hectare and 800 kg in hectare Sulfur, in comparison to the control treatment, caused respectively increase in harvest index (2/79%), biologic yield (3149 kg/ha), economic yield (662 kg/ ha) and protein (%0.5), oil (2/24%) and oil yield (313 kg/ ha).

The results of table 2 show that the interaction between organic matter, Thiobacillus bacterium and Sulfur powder was able to affect the measured properties significantly and the treatments (O_2T_3 S_2), in comparison to the control treatment, had the most effect on the harvest index 4/91%, economic yield 1700 (kg/ ha), oil yield 817 (kg/ ha) and treatments (O_2T_3 S_3) had the most effect on the biologic yield 9058 (kg/ ha) and 0.68% on the protein percentage and 4/5% oil.

Some researchers (Morshedi, et al. 2007, Sayami, et al. 2006 and Gohargani, et al. 2010) reported that the simulations application of organic matter and Sulfur powder in the different Sulfur increased the yield and its components and oil quality in the different plants. Also, other researchers (Azzazy, et al. 1994, Malakoti, 2004 and Naderi Arefi, et al 2006) reported that the simultaneous treatments of bacterium and Sulfur powder fertilizer had a significant effect on the qualitative yield of Canola product because of the bacterium role in absorption of the various elements by plant.

Zhao, et al. (2001) and Matalebi Fard, et al. (2007), in their studies, reported that application of the pure Sulfur fertilizers increases the qualitative properties and yield of Canola plant. The above results corresponds to the experiments and results by Malaki, (2004), Kallbasi, et al (1988), Gohargani, et al (2010) and Jafarnejad, et al (2006).

Sulfur fertilizers and bacterium together not only increase the yield and quality of the oil products but also improve the consumption efficiency of the other fertilizers as Nitrogen and phosphorous; consequently, reduce the product costs and increase the economic return for the producers (Salimpour, et al. 2010).

Discussion

The absorption capability of the tiny nutritive element by the plant is reduced in the place of the experiment performing because of its limy and alkaline soil (pH=8). Application of Sulfur decreases the soil pH and, consequently, increases the absorption capability of nutritive tiny element by the plant. Thus, increase in the absorption capability of nutrition elements as well as its effect in increasing the oil percentage and protein in the seed cause an increase in the qualitative and quantitative yield of the Canola seed. Sulfur has an essential role on the oil percentage and yield in the oil seeds, in particular Canola, but it should be changed into the sulfate ion for absorption. Unfortunately, with regard to the intensive decrease in the percentage of organic matters in Iran's soils, the activity of this local bacterium also has been reduced; thus, application of animal manure increases the activity of this bacterium as well as Sulfur Oxidation.

In this research, the program of combination of Sulfur fertilizers and Thiobacillus bacterium with organic matter caused the effectiveness on the qualitative and quantitative yield of Canola; thus, the triennial average of the means show that treatments ($O_2T_3S_2$), in comparison to the control treatment, was accompanied by increase in the seed yield (154%) and oil yield (180%). By this increase, the yield in the calcareous soil with the same climate, like the place of experiment for Iran with 15000 ton in Canola seed will be 23100 tons in year.

In this project, the economic assessment method was performed based on the detailed budgeting method the results of which are in the following part:

$\partial GM = (R1+C2) - (R2+C1)$

R1= the income which is the result of performing the project.

C2= the income without any cost payment.

R2= the income which was lost by performing the project.

C1= the cost which is because of performing the project.

$\partial GM = (1960000+0)-(10780000+3500000) = 5320000$(r).

Application of Sulfur with Thiobacillus bacterium and animal manure in Canola cultivation is economic because ∂GM is positive. Also, the results of the project show that application of 400 (kg) Sulfur, 4 kg Thiobacillus and 20 tons Organic matter ((O_2T_3 S_2)) in hectare will increase the farmers benefit about 5320000 (r) (266$). As the result, the pure profit of the yield increase in the 15000 hectare cultivation will be 79/8 milliard (399000$) per year.

The result correspond to the those of Malakuti, et al (2003), Hamedi, et al. (2005), Salimpour, et al. (2010) and Gohargani, et al. (2010).

Table 1 The results of analysis of variance for the important agronomic traits

Source of variation	Df	Harvest Index	Biologic Yield	Economic Yield	%Protein	%Oil	Oil Yield
		(ms) mean square					
Year	2	1.543^{ns}	53864381**	1732742**	0.679^{ns}	3.36**	335199**
Year× repetition	6	1.527^{ns}	1076283^{ns}	15987^{ns}	0.616^{ns}	0.534^{ns}	3260.89
Organic matter	1	159.01**	578060446**	29183102**	8.32*	71.76**	6315458**
Year× organic matter	2	22.83**	4781219.9*	36108^{ns}	0.006^{ns}	0.072^{ns}	6513.90^{ns}
Error	6	0.875	741458.4	25100.84	1.057	0.512	3961.06
Bacterium	2	14.522**	59250195.5**	2231406**	0.155^{ns}	14.70**	535848.9**
Year× Bacterium	4	7.017**	2150940.9**	82286.4**	0.004^{ns}	0.915*	16147.88**
Organic matter × Bacterium	2	11.909**	14142008**	166344**	0.835^{ns}	3.47**	58681.46**
Year× organic matter × Bacterium	4	4.275**	2493738.4**	34068.7**	0.002^{ns}	0.567^{ns}	7509.62**
Error	24	1.040	442515.8	5815.05	0.316	0.269	1157.86
Sulfur	2	6.625**	135528889.5**	4421596**	5.17**	26.82**	1016286**
Sulfur × year	4	1.728^{ns}	2875899.8**	160340**	0.0002^{ns}	0.044^{ns}	33123**
Organic matter ×Sulfur	2	1.841^{ns}	14819911.2**	441235**	0.816**	0.283^{ns}	107425.5**
Year× organic matter ×Sulfur	4	5.354**	1353899.9*	88856.5**	0.008^{ns}	0.263^{ns}	18725.15**
Sulfur ×Bacterium	4	13.529**	7137284.25**	95136.4**	0.577**	1.611**	24766.78**
Year ×Bacterium ×Sulfur	8	4.276**	2121619.9**	13767.5^{ns}	0.005^{ns}	0.114^{ns}	2992.5^{ns}
Organic matter ×Bacterium× Sulfur	4	3.874**	2642215.3**	94379.9**	0.590**	3.044**	28391.35**
Year× organic matter × Bacterium× Sulfur	8	4.658**	1930386.6**	24230.7^{ns}	0.002^{ns}	0.169^{ns}	4568.92**
Error	72	0.900	512812.97	14386.2	0.138	0.260	2885.90
CV%		5.54	6.42	6.25	1.64	1.18	6.43
ns, * and ** non significant and significant at the 5 and 1 percent level of probability respectively.							

Table 2. The effects of different treatments on the average of triennial yield components of canola

	Thiobacillus Kg ha^{-1}	sulphur	Harvest Index (%)	Biologic Yield (kg.ha^{-1})	Economic Yield (kg.ha^{-1})	Protein (%)	Oil (%)	Oil Yield (kg.ha^{-1})
Non- Organic matter	0	0	14.82	7692	1101.5	22.41	41.19	453
		400	16.54	9250	1421	22.21	42.09	598
		800	17.92	9162	1476	22.66	43.33	640
	2	0	16.66	7842	1297.6	21.87	42.03	545
		400	16.93	9985	1546.6	22.3	43.05	666
		800	17.98	10062	1705.3	22.78	43	732
	4	0	17.22	8580	1386.6	22.48	42.31	586
		400	16.49	10037	1603	22.26	42.73	679
		800	17.61	10841	1763.6	22.91	43.43	766
20 t ha^{-1} organic matter	0	0	18.59	10510	1794	22.48	43.05	772
		400	17.29	12823	2178.6	22.48	43.09	939
		800	20.76	11923	2245.3	23.04	43.62	979
	2	0	20.08	9687	1930.3	22.61	43.04	831
		400	18.43	14266	2447	23.38	43.95	1075
		800	20.6	13936	2651	23.16	44.09	1169
	4	0	17.01	11683	1985.6	22.37	43.21	858
		400	19.73	15876	2802	22.93	45.31	1270
		800	18.9	16750	2703.6	23.09	45.67	1235

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9/28/2012