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Effects of Nitrogen and Sulphur Fertilizers on Yield, Yield Components and Oil Content of Oilseed Rape (*Brassica napus* L.)

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Abstract: Present experiment was carried out to investigate the influence of nitrogen (150 and 300 kg ha^{-1}) and sulphur (0, 100 and 200 kg ha^{-1}) fertilizers on yield, yield components and oil content of two cultivars of oilseed rape (*Brassica napus* L.), Hyola 308 and PF7045. The experiment was factorial, laid out in Randomized Block Design with three replicates. Biological and economical yield were significantly different between cultivars. The higher grain weight of Hyola 308 was due to bigger size of pods and heavier seed weight. Application of nitrogen did affect biological yield positively but it did not affect grain weight. The increase in dry matter production or biological yield was 14% when the amount of nitrogen fertilizer increased from 150 to 300 kg ha^{-1}. Sulphur application affected neither dry matter production nor grain weight. Two cultivars were significantly different for oil contents. Nitrogen affected the oil content negatively and decreased it by 3.3%. Increasing the amount of sulphur fertilizer from zero to 200 kg ha^{-1} resulted in an increase in oil content.

Key words: Fertilizer, oilseed rape, sulphur, nitrogen, biological yield

INTRODUCTION

Oilseed rape (*Brassica napus*) is an important crop in northern Europe because of its varied utilizations (oil and biofuel). However, yields remain highly variable. As a consequence, oilseed rape has been extensively studied to identify key components of yield and to improve them by more effective nitrogen (N) application with the target of reducing environmental impacts[1]. Recently this crop as an oil crop has received special attention in different parts of Iran. But due to lack of existence of enough information concerning its nutritional requirements, yield production has been low. Hence, carrying some experiments to increase yield and oil production was necessary.

Nitrogen has the most profound effect on plant structure and seed yield. Oilseed rape requires large inputs of nitrogen (200-250 kg ha^{-1}) for maximum grain yields[2,3] but application rates need to be matched with the crop requirements which vary according to a number of factors which include the yield potential of the site and the soil nitrogen index[4]. Excessive nitrogen application results in over production of protein, causing a reduction in oil content[5]. It has been shown that the crop growth rate of spring oilseed rape increased with increasing nitrogen (N) uptake[3]. For winter oilseed rape, Bunting[6] reported on average optimum of 450 kg ha^{-1}, while others reported 200 kg ha^{-1}[7], 120 kg ha^{-1}[8] and in the presence of sulphur 160 kg ha^{-1} nitrogen[9]. Scott *et al.*[10] found maximum yield of 2098 t ha^{-1} by application of 200 kg ha^{-1} nitrogen for spring oilseed rape. Trials in the UK have shown 187 kg ha^{-1} N as optimum for spring oilseed rape[2].

Oil contents of oilseed rape crop is generally adversely affected by nitrogen application, but since the effect of nitrogen on seed yield is larger and positive; the oil yield is usually increased by nitrogen up to a maximum and declined thereafter. Fernandez *et al.*[11] reported that nitrogen rates of 0-150 kg ha^{-1} had no appreciable effect on oil content but rates higher than 200 kg ha^{-1} reduced oil contents by 8-9%.

Plants absorb sulphur as sulphate, which is present in the soil or absorbed directly from the atmosphere by the leaves. Inadequate sulphur supply has been recognized as an important factor limiting the production of crops in many parts of the world[12,13].

Oilseed rape yield response to applied sulphur has been reported by Nyborg *et al.*[14] and Wetter *et al.*[15]. Nitrogen fertilization has been reported to influence the response to sulphur application[16]. Numerous experiments, using a variety of crops have demonstrated a nitrogen and sulphur interaction with respect to yield[17], nutrient uptake[18] and crop quality[19]. Sulphur deficiency has become a yield limiting factor for rape seed production due to decreased input of sulphur containing fertilizers and a reduction in sulphur dioxide level in the

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atmosphere. This experiment was carried out to investigate the effect of nitrogen and sulphur on yield, yield components and oil content of oilseed rape.

MATERIALS AND METHODS

The experiment was carried out at Agricultural College farm of Bahonar University of Kerman, Iran, in 2004. The soil was a calcareous soil with pH 8. The site was ploughed after being followed for several years and a basal dressing of 100 kg ha^{-1} of P applied. Oilseed rape Cultivars Hyola 308 and PF 7045 were drilled in 50 cm rows in mid March 2003 using a seed rate of 4 kg ha^{-1}. Each plot included 5 rows and measured 8.0×2.5 m long. The experiment was factorial, laid out in Randomized Block Design with 3 replicates. The treatments were combinations of the two levels of nitrogen (150 and 300 kg ha^{-1}), three levels of sulphur (0, 100 and 200 kg ha^{-1}) and the two mentioned cultivars. When the third true leaf was exposed and the establishment was complete, the plants were thinned to obtain the optimum density, about 45 plants m^{2-1}. Irrigations during growth period were applied whenever soil water potential as determined by tensiometers located at the 30 cm soil depth in three replicates averaged between –0.07 and –0.09 MPa. Weeds were controlled with mechanical cultivation and hand weeding (no herbicides were used). The nitrogen from urea source and sulphur from ammonium sulphate source were broadcasted manually in early May. To control aphid (*Brevicorynae brassica*) attack, Metasistox was sprayed in a 1.5 l ha^{-1} rate and was repeated two weeks afterwards. Removing the two border rows of each plot, five meter long from remained rows and hence 7.5 m^2 were harvested by hand as final harvest. One m^2 of this harvested area were bagged separately to measure the number of plants, number of pods and one thousand grain weight. The biological yield was recorded from the above mentioned area while grain yield was only recorded for 1 m^2 of this area. A grain sample of 50 g was oven dried at 80°C for 48 h to establish moisture content. Yield data (grain weight m^{2-1}) were then adjusted to 9% moisture content. One thousand grain weight was determined from a 10 g dried sub sample. A sample of 250 g was sent to Food Chemistry Laboratory at Agricultural Research Organization, to measure oil percentage. The Soxhlet method was used to measure the amount of oil[20]. The procedure was as follow. The dried sample was transferred to an extraction thimble and placed in the extractor connected to a weighed flask containing 100 mL petroleum ether. The extractor was connected to a reflux condenser. The sample was extracted, under reflux, on a steam bath for 3 h and then the extract was evaporated to dryness and 2 mL acetone was added. Air was gently blown into the flask and the last traces of solvent were removed. The flask containing the oil residue was dried in an air oven at 100°C for 5 min. and weighed after cooling in a desiccator. The extractable oil (%) was calculated using the following formula:

Extractable oil (%) =[(W3-W2)/W1] × 100, Weight (g) of sample before drying (W1), weight (g) of flask without fat (W2) and with fat (W3). Data were analyzed using SAS package. Duncan Multiple Range and LSD test at the 5% level was used to compare treatments mean.

RESULTS AND DISCUSSION

Analysis of variance carried out on the obtained data showed cultivars used were very highly significantly different in biological yield production ($p<0.0001$). PF7045 produced higher dry matter than Hyola 308 (Table 1). Since the number of plant per square meter were not statistically different between two cultivars (Table 1), it can be concluded that the higher biological yield of PF7045 was due to a larger crop size that was resulted from longer growth period compared with Hyola 308. Although both cultivars were spring ones but Hyola 308 was at flowering and physiological ripening 20 and 30 days sooner than PF7045, respectively. Therefore, the difference in biological yield appears to be related to a longer period of photosynthesis and dry matter accumulation. The two cultivars produced a highly significantly different number of pods ($p<0.01$). PF7045 produced higher number of pods per square meter than Hyola 308 (Table 1). In all other measured traits; Thousand Grain Weight (TGW), grain weight per square meter and pods weight per square meter; Hyola 308 showed higher values than PF7045 (Table 1). Calculating grain yield ha^{-1} using the mean grain weight per square meter showed there was a huge difference between two cultivars (1417 versus 620 kg ha^{-1}). The lower pod weight in PF7045 implies that pods size was much smaller than that of Hyola 308. Meantime, very low grain weight per square meter of PF7045 showed there could be a problem in fertilization or may be most zygotes has been aborted due to some unknown reasons. A likely problem could be aphid attack which was not controlled effectively in spite of two times Metasistox spraying. Meantime, it is worth mentioning the flowering and especially grain filling period of PF7045 was faced with the high temperatures occurred late in May and June that could be a reason for low grain yield production. TGW also was much lower in PF7045 than that of Hyola 308. From analyzed data shown in Table 1 specially the value recorded for biological yield

Table 1: Mean comparisons of different measured traits and the effects of different levels of nitrogen* and sulphur* on them, LSD (5%)

Treatments		BY* (kg ha^{-1})	No. of plant m^{-2}	No. of pod m^{-2}	Pod weight (g m^{-2})	Gram. Weight g m^{-2}	TGW* g
Cultivar	Hyola 308	2950.3a [1]	48.28a	2167.4a	183.55a	141.7a	3.53a
	PF 7045	4232.9b	44.61a	2622.5b	116.79b	62.1b	2.34b
Nitrogen	$N1_{(150)}$	3354.5a	45.66a	2402.9a	148.53a	101.3a	2.92a
	$N2_{(300)}$	3828.6b	47.22a	2387.1a	151.81a	102.5a	2.94a
Sulphur	$S1_{(0)}$	3619.7a	46.08ab	2530.6a	163.61a	108.8a	2.92a
	$S2_{(100)}$	3655.8a	48.75a	2436.3a	145.60a	109.9a	2.97a
	$S3_{(200)}$	3499.2a	44.5b	2218.1a	141.30a	87.1a	2.92a

[1]The values in each column followed by the same letter(s) are not significantly different

*Levels of nitrogen: 150 and 300 kg ha^{-1} *Levels of sulphur: 0, 100 and 200 kg ha^{-1}

*BY= Biological Yield *TGW= Thousand Grain Weight

Table 2: Mean comparisons between the effect of different treatments on oil production

	Cultivars		Nitrogen (kg ha^{-1})		Sulphur (kg ha^{-1})		
	Hyola 308	PF7045	150	300	0	100	200
Oil (%)	45.90a *	37.40b	42.34a	40.96b	40.73a	41.65b	42.57c
Oil content (kg ha^{-1})	650.4a	232.3b					

*The values in each row followed by the same letter(s) are not significantly different

it can be concluded that PF7045 has a good vegetative growth in the area and if the reasons of low economical yield production overcome by a better husbandry practices, it may have a good yield potential. However PF7045 produced lower oil percentage than Hyola 308 (Table 2). As this table shows there was also a profound difference between oil content. This low production of oil is also related to the very low grain yield production.

The effect of nitrogen application on oil percentage was very highly significant ($p<0.0002$). The oil percentage was decreased significantly ($p<0.05$) with an increase in nitrogen application (Table 2). This is in agreement with the findings of Scarisbrick[21] and Fernandes *et al.* [11] that reported nitrogen rates higher than 200 kg ha^{-1} reduced oil content by 8-9%. The minimum and maximum oil percentage was recorded for zero and 200 kg ha^{-1} sulphur, respectively and both were significantly different from 100 kg ha^{-1} (Table 2). These findings are in agreement with those of Nuttall *et al.*[22] who observed 1.8% increase oil content with up to 50 kg S ha^{-1} applied as ammonium sulphate, while it was in contrast to the 1.5% lower oil concentration obtained by Wetter *et al.*[15]. Sulphur application did affect none of the other measured traits while N application affected also biological yield very significantly ($p<0.007$).

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