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Annals of Biological Research, 2012, 3 (5):2074-2077
(http://scholarsresearchlibrary.com/archive.html)

Annals of Biological Research
Scholars Research Library
ISSN 0976-1233
CODEN (USA): ABRNBW

Study of yield and yield components of black mustard (*Brassica nigra*) in condition of sulphur application and water stress

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ABSTRACT

In order to Study of yield and yield components of black mustard (Brassica nigra) in condition of sulphur fertilizer application and water stress, a field experiment was conducted at research farm of Payame Noor University of Zahedan during crop season of 2010-11. The treatments consisted of three levels of irrigation: no irrigation, one irrigation at 45 days after sowing (DAS) and two irrigations at 45 DAS and 90 DAS, in main plots and four levels of sulphur: 0, 15, 30 and 45 kg.S/ha, in sub-plots. The results showed that application of two irrigations than one and no irrigation significantly enhanced seed and biological yield, and harvestindex.The increasing level of sulphur increased dry matter accumulation, seed and biological yield and harvest index.

Key words: Black mustard, Yield, Water stress

INTRODUCTION

The term “mustard” is used to describe several plants in the *Brassica* and *Sinapis*genera which are used as sources of food. There are a number of different types of mustard which are cultivated for different products, including greens and leaves. The incredible diversity and flexibility of mustard plants can cause them to pop up in a wide variety of places, from traditional American Southern cuisine to fiery Indian curries. *B. nigra*produces black seeds with a very strong and distinctive flavor. Black mustard is often used in Indian and Southeast Asian cooking, where it is incredibly popular; you may have encountered whole mustard seeds in marinades and curries if you eat a lot of Southeast Asian food. Black mustard can also be ground into condiment form. As a condiment, mustard is incredibly diverse. Mustard can be ground into a smooth puree or mixed with whole seeds for more texture. It can also be blended with things like horseradish for spicy mustard, which can be quite fiery, or sugar, for sweet mustard. Some cultures have a tradition of making mustard with beer or wine, creating a very distinctive, complex flavor which complements a range of foods.

In relation to mustard cultivation,Irrigation and fertilizer management are important agronomic practices for higher yield (Ahmadian et al. 2011). Irrigation influences favorably the growth and yield attributes of mustard by supplementing the water need of the crop. It also enhances availability of different nutrients to crop plants. Chauhan et al. (2001)reported thatirrigation applied at branching, flowering and grain filling stages significantly increased seed yield of Indian mustard over that of pre-flowering, pod formation and grain filling stages. Bharati and Prasad (2002) found that seed yield of mustard increased significantly to increasing irrigation levels.Babaeian et al (2011) reported similar results on sunflower.

Sulphur is very important in growth stages mustard and its deficiency caused a significant reduction in yield of it. Jat et al. (2003) concluded that application of 90 kg.S.ha^{-1}lead to significantly increase in seed and biological yield. Singh et al. (2000) reported that application of 45 kg.S.ha^{-1} significantly increased the seed yield.

The aim of our study was to investigate the effect of sulphur fertilizer application and water stress on seed and biological yield of mustard in Zahedan region, Iran.

MATERIALS AND METHODS

This experiment was conducted during seasons of 2010-11 at research farm of Payame Noor University of Zahedan, Iran. The site lies at longitude 61°53´, and latitude 25°28´ and the altitude of the area is 1370 m above sea levelThe climate ofthis area is arid with dry and hot summer. The mean annual rainfall is about 70 mm. The soil characteristics of research farm isclayloam in texture (Tables 1).

Table 1. The result of some soil chemical characteristic before planting (depth 0-30)

Absorbent sulphur (ppm)	Absorbent potassium (ppm)	Available phosphorus (ppm)	total N (%)	organic carbon (%)	pH	EC (Ds/m)
0.4	1.7	3.9	4.6	0.35	7.7	2.9

The experimental design was split plot, using randomized complete block design with three replications. The treatments consisted of three levels of irrigation: no irrigation, one irrigation at 45 days after sowing (DAS) and two irrigations at 45 DAS and 90 DAS, in main plots and four levels of sulphur: 0, 15, 30 and 45 kg.S.ha^{-1}, in sub-plots. In this experiment distances of main plots from each other was 200 cm and the distances of sub plots from each other was selected 100 cm. Sub plots are established of 8 rows in the long term of 6 m and with distances of 45 cm, and there was about 10 cm distance between every plant.

A uniform dose of 80 kg.N.ha^{-1} as urea, 60 kg.P_2O_5.ha^{-1} as DAP and 40 kg.K_2O.ha^{-1} as KCl was applied to each plot. Half dose of nitrogen and full dose of P_2O_5 and K_2O were applied as basal application. The sulphur was applied as per treatments from source of Cosavet. The desired quantity of fertilizer was drilled 5 cm below the seedling depth in crop rows before sowing of seed. Rest of the dose of nitrogen was applied at flowering stage. Thinning was done to maintain a uniform plant population in each plot at three weeks after sowing. Crops were sown after a pre-sowing irrigation. The seeds of black mustard were hand drilled at about 3-4 cm depth in first week of October. Rows were spaced 45 cm apart and 5.0 kg seed per ha was used for sowing. The Irrigation as per treatment was given at 45 and 90 days after sowing. The crop from the net plot area was harvested by cutting the ground level and allowed for drying in Aven with 70□C temperature for 48 hr. After drying, the weight of the biological yield (seed+ stalk) from the net plot was recorded. The seeds were collected, cleaned and the seed yield was recorded. Harvest index (HI) was calculated as following:

$$HI = \frac{\text{seed yield (kg/ha)}}{\text{biological yield (kg/ha)}} \times 100$$

The data were analyzed using SAS statistical packages; mean comparison was done using Duncan at 5% probability level.

RESULTS AND DISCUSSION

Seed yield

The effect of water stress and sulphur application treatments was significant on seed yield. But interaction effect of these two factors weren't significant on seed yield (P<5%). Application of two irrigation recorded significantly higher yield than one and no irrigation (Table 2). The percent increase in seed yield due to two irrigations was 9.9percentover one irrigation and 21.2percent over no irrigation. Similarly, one irrigation increased seed yield over no irrigation by 12.5 (Table 2).The significant improvementin the mustard seed yield might be the cumulative effect of significant improvement in the value of yield attributes like number of siliquae per plant, number of seeds/siliqua and test weight. Ehsanullah et al. (1991) and Bharati and Prasad (2002) reported an increase in seed yield of mustard due to irrigation.Babaeian et al. (2011) reported similar results with this research on sunflower.

The seed yield of mustard increased significantly with the successive increase in the level of applied sulphurin. Application of 15, 30 and 45 kg.S.ha^{-1} increased seed yield of mustard over control by 3.5, 10 and 15.5 percent respectively(Table 2). These values indicate that response of mustard to sulphur was positive. Increase in seed yield with an increase in the rate of sulphur application has also been reported by Bhagat and Soni (2000).

Table 2. Effect of water stress and sulphur application on seed yield(kg/ha)

Treatments	seed yield(kg/ha)
Water stress	
No irrigation	1200.1 c
One irrigation	1400.9 b
Two irrigation	2000.5 a
Sulphur application (kg.S.ha^{-1})	
0	1400.8 d
15	1500.9 c
30	1800.1 b
45	2000.2 a

Mean followed by similar letters in each column, are not significantly different at the 5% level of probability.

Total biomass

The effect of water stress and sulphur application treatments was significant on total biomass. But interaction effect these two factors weren't significant ontotal biomass(P<5%). Application of two irrigations significantly enhanced total biomass production overone and no irrigation (Table 3).It is clear from the data on seed and straw yield which increased with increasing level of irrigation. Prassad (1995) reported an increase in total biomass of mustard with increasing irrigation frequency.

Application of 45 kg.S.ha^{-1} significantly enhanced total biomass of mustard. And wasn't see any significant different between this treatment with 30 kg.S.ha^{-1} treatment.But there was significant different among these treatments with other treatments(Table 3). Enhance in seed yield due to application of sulphur attribiuted to the increase in total biomass of the crop with increasing level of sulphur. Jat et al. (2003) reported similar results with this experiment.

Table 3. Effect of water stress and sulphur application on total biomass (q/ha)

Treatments	total biomass (kg/ha)
Water stress	
No irrigation	5400.2 c
One irrigation	6100.1 b
Two irrigation	7900.2 a
Sulphur application (kg.S.ha^{-1})	
0	6100.5c
15	6600.2b
30	6800.9ab
45	7000.7 a

Mean followed by similar letters in each column, are not significantly different at the 5% level of probability.

Table 4. Effect of water stress and sulphur application on Harvest index(%)

Treatments	Harvest index (%)
Water stress	
No irrigation	22.3 b
One irrigation	24.3a
Two irrigation	25.8 a
Sulphur application (kg.S.ha^{-1})	
0	24.0 b
15	24.0ab
30	26.2 a
45	28.8 a

Mean followed by similar letters in each column, are not significantly different at the 5% level of probability.

Harvest index

The effect of water stress and sulphur application treatments was significant on harvest index.But interaction effect these two factors weren't significant on harvest index(P<5%). Mean comparison data showed that application of two irrigation being on par with one irrigation, significantly increased harvest index over control. And between these two treatments (two and one irrigation) there isn't any significant different (Table 4).Availability of more moisture to plants might have resulted in production of more photosynthates which might have helped in translocation of more photosynthates to seeds and increased harvest index. Jadhav (1988) reported similar results with this experiment.Among fertilizer treatments the highest amount of harvest index obtained from 40 kg.S.ha^{-1}. And there wasn't any significant different between this treatment with treatments of 30 and 15 kg.S.ha^{-1}. Also application of

40, 30 and 15 kg.S.ha^{-1}significantly enhanced harvest index of mustard than no sulphur(Table 4)**.**The higher harvest index with sulpur application may be due to higher increase in seed yield. Ali et al. (1996) reported similar results with this experiment.

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