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Effect of nitrogen fertilizer and boron spray on growth and yield of black mustard (*Brassica nigra* L.).

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ABSTRACT

The experiment was carried out during the season 2022-2023 in the field of Agricultural Research Station (2) affiliated to the College of Agriculture, Al-Muthanna University (located in Samawah city, southern Iraq) , to study the response of the black mustard (*Brassica nigra* L.) for three different levels of nitrogen it is 0, 60 , 120 kg N ha^{-1} and spraying boron in 0, 2 , 4 mg B L^{-1}, and its reflection on its growth and seed yield. The results of the study showed that fertilization levels significantly affected the studied traits, the level of nitrogen fertilizer 120 kg N ha^{-1} was unique and gave highest values for plant height, fruiting branches number, siliquaes number, seed number in siliquae, 1000 seed weight and total seed yield (124.17 cm, 23.88 branch $plant^{-1}$, 184.1 siliquae $plant^{-1}$, 14.88 seed $plant^{-1}$, 4.43 g and 3691 kg ha^{-1}) respectively. The results also showed a significant effect of boron on all traits, as the plants that were sprayed with a concentration (4 mg B L^{-1}) gave the highest values in plant height (112.26 cm) , number of fruiting branches (22.21 number of fruiting branches) , siliquaes number (172.5 siliquae $plant^{-1}$), seeds number in siliquae (14.69 seed $plant^{-1}$) , 1000 seed weight (4.16 g) and total seed yield (3376 kg ha^{-1}) .Also, the overlap between the two experimental factors had a significant superiority in all the traits studied except for the one 1000 seed weight.

KEYWORDS: Black mustard; Brassica nigra L; Nitrogen fertilizer; Boron.

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تأثير السماد النتروجيني ورش البورون في نمو وحاصل نبات الخردل الأسود *Brassica nigra* L.

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الملخص

نفذت التجربة خلال الموسم 2022-2023 في حقول محطة البحوث الزراعية (2) التابعة الى كلية الزراعة / جامعة المثنى (الواقعة في مدينة السماوة جنوب العراق) لدراسة استجابة نبات الخردل الأسود **Brassica *nigra* L**. لثلاث مستويات مختلفة من النتروجين هي 0، 60، 120 كغم **N** هكتار$^{-1}$ ورش البورون بـثلاثة تراكيز مختلفة (0، 2، 4 ملغم **B L^{-1}**)، وانعكاس ذلك على نموه وحاصل بذوره . أظهرت نتائج الدراسة أن مستويات النتروجين أثرت معنوياً في جميع الصفات المدروسة، وكان مستوى التسميد النتروجيني 120 كغم **N**/هكتار قد تفوق معنويا وأعطى أعلى القيم لارتفاع النبات، عدد الأفرع الثمرية، عدد الخردلات، عدد البذور في الخردلة الواحدة، وزن 1000 بذرة وحاصل البذور الكلي (124.17 سم، 23.88 فرع نبات$^{-1}$، 184.1 خردلة نبات$^{-1}$، 14.88 بذرة خردلة$^{-1}$، 4.43 غم و3691 كغم هكتار$^{-1}$) على التوالي. كما أظهرت النتائج ايضا التأثير المعنوي للبورون في جميع الصفات، حيث أعطت النباتات التي تم رشها بالتركيز (4 ملغم **B** لتر$^{-1}$) أعلى القيم في ارتفاع النبات (112.26 سم) وعدد الأفرع الثمرية (22.21 فرع/نبات). عدد الخردلات (172.5 خردلة / نبات) وعدد البذور في الخردلة الواحدة (14.69 بذرة خردلة$^{-1}$) ووزن 1000 بذرة (4.16 غم) وحاصل البذور الكلي (3376 كغم هكتار$^{-1}$). كما كان للتداخل بين عاملي التجربة تأثيرا معنوياً في جميع الصفات المدروسة ماعدا وزن الألف بذرة.

الكلمات المفتاحية: الخردل الأسود، الأسمدة النيتروجينية، البورون، ***Brassica nigra* L**.

INTRODUCTION

Black mustard (Brassica nigra L.) is one of the crops known to man since ancient times. It is one of the well-known spices that belong to Brassicaceae family. It is one of the annual herbs and is native to the southern Mediterranean region (Thomas et al, 2012). The plant contains many effective compounds with medicinal and nutritional effect, it is one of the most important secondary

metabolites are glycosinolates, which are thioglycosides)Veliek et al,1995). Sinigrin (potassium myronate) is one of the important compounds belonging to the thioglycosides found in black mustard seeds, which can be hydrolyzed by the enzyme myrosin (myrosinase) to produce the allyl isothiocyanate compound responsible for the flavor and the sharp, pungent taste of the seeds of the plant, which is estimated at 1%. Also, seeds of plant also contain fixed oil (25-37%), sinapic acid and sinapine (Leung and Foster, 1996). Black mustard plant is one of the medicinal crops that is widely cultivated in Asia, central and southern Europe, as well as in Africa for its therapeutic value, as it is used in the treatment of many diseases, like skin diseases (due to its high sulphur conten), arthritis and rheumatism, in addition to its nutritional value as a leafy vegetable (Thomas et al,2012 ; Kakabouki et al, 2020). Rahman (2018) referred to the expected significant increase in the production of black mustard in coming years due to the increased use of plant seeds in medicines, food, beverages and cosmetics. Wanasundara (2011) stressed that adding ground black mustard seeds to animal feed is ideal, especially for poultry, because it contains a high percentage of protein, as well as the quality of its oil. Studies indicate that deficiency of nutrients is one of the most important factors responsible for the decline in crop productivity and quality. Nitrogen is considered one of the essential nutrients for plants due to it participates in the synthesis of protein molecules and enzymes, which gives it an important role in biosynthesis of plants (Khalid, 2013). In their study, Keivanrad and Zandi (2012) confirmed that all growth characteristics and yield of mustard seeds were significantly affected when nitrogen fertilizer was increased. Bani-Saeed (2001) noted in his study that nitrogen fertilization reduced the flower abscission of mustard, thus increasing number of siliquae per unit area, increasing thousand-seed weight (TSW), and decreasing number of seeds per siliquae, which led to an increase in total yield of seeds per hectare. Cheem et al (2001) confirmed that increased amounts of nitrogen added to the mustard plant led to a significant increase in TSW and number of seeds per siliquae. Boron is one of the essential trace mineral elements needed for the growth and production of plants, which is needed in very small quantities. Boron plays an important role in glucose transport, cell wall formation, carbohydrate metabolism, RNA metabolism, IAA metabolism and respiration (Ahmad et al., 2009), In addition to boron helps in completing the pollination process through the germination of pollen grains, and thus the fertilization process and fruits development and seed production (Al-Molla, 1985).Yang et al. (2009) found that the addition of boron leads to an increase in seed yield and an improvement in quality of mustard oil, and its addition led to an increase in the number of siliquae per plant and the number of siliquae seeds as a result of the effect of this element on the absorption of water and the metabolism of carbohydrates and the increase in their accumulation in the seeds and because it affects the activity of enzymes responsible for the synthesis of oil and protein. The aim of this experiment is to improve the cultivation and production of black mustard by studying the effect of adding nitrogen fertilizer and boron spraying and the interaction between them.

MATERIALS AND METHODS

The study was carried out in fields of Agriculture College, Al-Muthanna Univ., Iraq, in the winter season 2022-2023 , to know the reaction of black mustard plant with addition of of nitrogen fertilizer (0, 60 , 120 kg N ha^{-1}) and boron spray with (0, 2 , 4 mg B L^{-1}), and its reflection on the studied characteristics . The soil properties of the experimental field were determined before planting and were: silt-loam (silt 53 %, sand 26%, and clay 21%) with pH (7.4), O.M (1.4%), EC (4.5 dsm^{-1}), available nitrogen, phosphorous and potassium (14 , 12 and 190 ppm), respectively. The experiment was designed as a factorial experiment according to a randomized complete block design (RCBD) with three replications. The field of study was divided into three sectors, each sectors containing 9 experimental units; area of each was 6 m2 (2×3m). Seeds were planted inside each experimental unit in 5 lines, with a distance of 40 cm between one line and another, and 10 cm between one plant and another. Nitrogen fertilizer levels were added in the form of urea (46% N) in two batches. The first was added two weeks after the date of sowing seeds in the field, one month later, and the second batch was added. A fixed amount of triple super phosphate fertilizer (20% P) was added at a rate of 55 kg P/ha during planting seeds. Boron concentrations were sprayed in the form of boric acid (17% B) in two batches, 30 days after the seedlings emerged on the soil surface, the first batch was sprayed, the second batch was sprayed after the appearance of flower buds on the plants. After the plants reach physiology maturity represented by siliquae yellowing in beginning early April, the plants were harvested. The growth and yield characteristics of the plant were measured: plant height, number of branches $plant^{-1}$, number of. siliquae $plant^{-1}$, seed number of siliquaess, and total seed yield. The data were analyzed statistically using the GenStat software, and the means were compared using least significant difference (LSD) with a probability level of 5%.

RESULTS AND DISCUSSION

Effect of nitrogen fertilizer levels:

Different fertilizer levels a significant effect on all the studied parameters (Tables 1-6), the nitrogen level (120 kg N ha^{-1}) exceeded the rest of the levels and gave significant values in plant height (124.17 cm), fruiting branches number (23.88 branch $plant^{-1}$), siliquaes number (184.1 siliquae/ plant), seed number in siliquae (14.88 seed/ plant), 1000 seed weight (4.43 g) and total seed yield (3691 kg ha^{-1}), in comparison with the lowest values for those traits that appeared at the control treatment. The increase in the characteristics of the studied black mustard plant associated with the increase in nitrogen levels may be due to the vital role of nitrogen in the construction of amino acids, proteins and enzymes and in the production of chlorophyll, which leads to an increase in the growth rate and the number of branches and the leaves number, which led to an increase in the efficiency and activity of the photosynthesis process and thus an increase in the production of carbohydrates , which

reflects positively on the productivity of the plant from seeds (Lawlor *et al*, 2004). These results are consistent with what was reached by Keivanrad and Zandi (2012) in their study on the Indian mustard plant. It's also agreed with the findings of Rajput *et al*, (2018) in their study on the Indian mustard as well.

Effect of boron spraying

The results presented in the Tables (1-6) show that there are significant differences in spraying boron concentrations, plants treated with boron (4 mg L^{-1}) outperformed significantly in plant height, fruiting branches number, siliquaes number, seed number in siliquae, 1000 seed weight and total seed yield (112.26 cm, 22.21 number of fruiting branches, 172.5 siliquae/ plant, (14.69 seed/ plant, (4.16 g) and (3376 kg ha^{-1}) respectively. The reason for this may be due to the role of boron in stimulating cell division and the speed of transmission of the products of the photosynthesis process (Marschner, 1995) and its role also in increasing the rate of flowering and the growth of the pollen tube, which leads to an increase in pollination and fertilization (Nadian *et al*, 2010). These results of the study agreed with what was found by Rana *et al*, (2020) and Rajput *et al*, (2018) in their study on the mustard.

Effect of the interaction

The results of Tables (1,2,3,4,6) showed that the interaction between nitrogen levels and boron concentrations was significant, as the interaction exceeded (120 kg N ha^{-1} × 4 mg B L^{-1}) on rest of the characteristics of plant height, number of fruiting branches, siliquaes number, seed number in siliquae, and total seed yield. While the interaction between the experimental factors did not have any significant effect on the weight of 1000 seeds (Table 5).

Table (1) Effect of adding nitrogen and spraying boron in the height of black mustard (cm.)

Nitrogen levels (kg ha^{-1})	Boron concentrations (mg L^{-1})			Mean
	0	2	4	
0	70.76	88.27	94.00	87.35
60	100.81	105.83	114.16	106.93
120	120.00	123.87	128.63	124.17
Mean	100.19	105.99	112.26	
L.S.D. 0.05	N. levels	B. conc.	B. conc.× N. levels	
	3.57	3.57	6.18	

Table (2) Effect of adding nitrogen and spraying boron in fruiting branches number of black mustard (branch plant^{-1})

Nitrogen levels (kg ha^{-1})	Boron concentrations (mg L^{-1})			Mean
	0	2	4	
0	10.33	13.00	17.00	13.44
60	16.25	18.30	20.99	18.52
120	20.00	23.00	28.65	23.88
Mean	15.53	18.10	22.21	
L.S.D. 0.05	N. levels	B. conc.	B. conc.× N. levels	
	3.00	3.00	5.21	

Table (3) Effect of adding nitrogen and spraying boron in the number of black mustards siliquaes (siliquae plant^{-1})

Nitrogen levels (kg ha^{-1})	Boron concentrations (mg L^{-1})			Mean
	0	2	4	
0	49.0	82.9	113.3	81.7
60	71.0	115.5	151.2	112.6
120	119.7	179.8	252.8	184.1
Mean	79.9	126.1	172.5	
L.S.D. 0.05	N. levels	B. conc.	B. conc.× N. levels	
	17.21	17.21	29.81	

Table (4) Effect of adding nitrogen and spraying boron in number of seeds in siliquae of black mustard (seed siliquae^{-1})

Nitrogen levels (kg ha^{-1})	Boron concentrations (mg L^{-1})			Mean
	0	2	4	
0	10.85	12.78	13.83	12.48
60	12.84	13.62	14.75	13.74
120	14.13	15.00	15.50	14.88
Mean	12.60	13.80	14.69	
L.S.D. 0.05	N. levels	B. conc.	B. conc.× N. levels	
	1.00	1.00	1.74	

Table (5) Effect of adding nitrogen and spraying boron in1000 seed weight of black mustard (g)

Nitrogen levels (kg /ha)	Boron concentrations (mg L^{-1})			Mean
	0	2	4	
0	2.50	2.90	3.60	3.00
60	3.16	3.80	14.20	3.72
120	4.10	4.50	4.70	4.43

Mean	3.25	3.73	4.16
L.S.D. 0.05	N. levels	B. conc.	B. conc.× N. levels
	0.34	0.34	N.S

Table (6) Effect of adding nitrogen and spraying boron on total seed yield of black mustard (kg ha^{-1})

Nitrogen levels (kg ha^{-1})	Boron concentrations (mg L^{-1})			mean
	0	2	4	
0	1724	2090	2565	2126
60	2432	2927	3352	2904
120	3197	3662	4212	3691
Mean	2451	2893	3376	
L.S.D. 0.05	N. levels	B. conc.	B. conc.× N. levels	
	267	267	463	

CONCLUSION

We conclude from our study that the black mustard plant responded well to nitrogen fertilization and foliar nutrition with boron, so it is preferable when growing the plant under the conditions of Al-Muthnna Governorate in southern Iraq, it is preferable to fertilizer at the level 120 kg N ha^{-1}, and spraying with boron at 4 mg B L^{-1} in order to obtain the highest seed yield for the plant.

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