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Response of Black Cumin (*Nigella sativa* L.) to Different Seed Rates Growth, Yield Components and Essential Oil Content

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Abstract: This research was carried out to determine some important agronomical properties of the black cumin in Van, Turkey. The experiments were designed in a Randomized Complete Block Design with three replications. In the study, four different seed rates 5, 10, 15 and 20 kg ha^{-1} were applied. The seeds were sown as main crop in 3 April and 10 May in 2001 and 2002, respectively in 25 cm apart and given 30 and 60 kg ha^{-1} of N and P_2O_5, respectively. Data were tabulated on mean plant height, the number of branch, the number of capsule, the number of seeds in the capsule, thousand-seed weight, seed yield (kg ha^{-1}), essential oil content (%) and essential oil yield (kg ha^{-1}) in both years. It was showed that the analyzed features were generally affected by seed rate applications. Averaged over years, the highest seed yield 701.2 kg ha^{-1} and essential oil yield 3.5 kg ha^{-1} obtained from the 15 kg ha^{-1} seed rate application. It was concluded that the 15 kg ha^{-1} application were considered the optimum seed rate, having high essential oil and seed yield in the black cumin.

Key words: Black cumin, seed rate, yield, essential oil content

INTRODUCTION

The black cumin (*Nigella sativa* L.), belonging to the family Ranunculaceae, is a very ancient crop which originated in the Eastern-southern Europe. It is particularly grown in Southern Europe, The Balkans, North African and Hindistan. The Black cumin is generally short-lived annual, typical of disturbed soils or natural communities of semiarid areas, with a dominance of therophytes. In the natural form, flowers are bluish, with a variable number of sepals and characterized by the presence of nectarines. The gynoecium is composed of a variable number of multi-ovule carpels, developing into a follicle after pollination, with single fruits partially connected to form a capsule structure. Seeds, of generally small size (1-5 mg), dark grey or black color and with corrugated integuments, represent the useful product[1]. The black cumin is extensively used in traditional medicine, for healing various respiratory and gastrointestinal diseases in the various countries, particularly Turkey. The whole seeds or their extracts have antidiabetic, antihistaminic, antihypertensive, anti-inflammatory, antimicrobial, antitumor, galactagogue and insect repellent effects[2]. Another use of black cumin seeds is as seasoning for foodstuffs like bread and pickles, especially widespread among Turkish people[3]. The black cumin therefore appears to be potential multi-purpose crops of possible interest. Agronomic experiments of seed yield have been extensively investigated on black cumin[4-9]. In addition, only research on seed production of black cumin has been carried out in Turkey. However, the combined effects of growing factors on yield and essential oil quality have not been examined in Van (Turkey). In the present study, the potential of black cumin seed production and some quality characters of the seeds such as essential oil content were evaluated.

MATERIALS AND METHODS

Two year experiment was carried out at the farm located in Van, Eastern Anatolia region (38°55'N and 42°05'E, 1725 m elevation) during the seasons 2001 and 2002. The soil at the experimental site was sandy clay loam texture and consists of 1.21 % organic matter, 7.16 ppm phosphorus, 0.081% total salt and 20.4% total lime content. The soil pH was 7.7[10]. The typical rainfall pattern of Van is characterized with high rainfall in winter and spring and low rainfall from June to August. Accumulated rainfall during the crop cycle (April-September) was 116.0 and 252.5 mm in 2001 and 2002, respectively and these values were lower than the long-term average, which was 326.4 mm. The precipitation occurred mainly towards the beginning of the cycle in

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2001. Thus it was caused a better soil water status at sowing and a better first vegetative growth. The mean temperature for 2002 (17.4°C) was higher than that observed in 2001 (11.1°C) and long-term average (14.6°C). Monthly mean relative humidity were also 45.4, 58.9 and 61.7% in 2001, 2002 and the long-term average, respectively[11].

The experimental design was a Randomized Complete Block Design with three replications. In the study, seed rates of 5, 10, 15 and 20 kg ha^{-1} were tested in the commercial black cumin (*Nigella sativa* L.) obtained from the seller of medicinal herbs in Van. Seeds were sown as main crop in 3 April and 10 May in 2001 and 2002, respectively, in 25 cm apart. All plots received nitrogen at 30 kg ha^{-1} as ammonium sulfate and phosphorus at 60 kg P_2O_5 ha^{-1} as triple super phosphate at sowing in both years. The plots were applied to common cultural practices for the area where the experiments were conducted. Harvest was performed on mid-September in both years.

In the study, the black cumin was evaluated for plant height, the number of branch, the number of capsule, the number of seeds in the capsule, thousand-seed weight, seed yield (kg ha^{-1}), essential oil content (%) and essential oil yield (kg ha^{-1}). The essential oil analysis of black cumin seeds was done by hydrodistillation using Clevenger-type apparatus for 3.

Analysis of variance and Duncan's Multiple Range test were applied to experimental results to determine the significance of differences between treatments (MSTAT-C statistical package, version 2.1[12]).

RESULTS AND DISCUSSION

Plant growth: The results of the study showed that plant height was strongly influenced by the seed rates and increased seed rates tended to increase plant height. Averaged over years, the highest plant height (40.68 cm) was obtained from the 15 kg ha^{-1} seed rates and the lowest value (34.68 cm) was observed in the 10 kg ha^{-1} seed rate (Table 1). The present study with the literature reporting that increasing seed rates markedly increased plant height[5,8,13]. The plant height findings obtained from the study are in accordance with Özel *et al.*[14], while it lower than Ertuğrul and Özgüven[15], Telci[8] and Karaman[16].

The number of branches per plant varied with each year and seed rates and this component was less in 2002 (8.31), ranging from 6.20 to 7.93, than in 2001 (7.95) which it ranged between 6.66 and 11.20 according to the seed rates (Table 1). The differences between years probably reflect the influence of environmental conditions that much of the year to year variability is associated with rainfall during the vegetative stage of the season. Averaged over years, the highest number of branches per plant (9.56) was obtained from the 5 kg ha^{-1} seed rates and the lowest value (6.46) was observed in the 20 kg ha^{-1} seed rates (Table 1). It is known that the number of branches per plant is increase in which plant density is decrease and an increase in the number of branches per plant in reverse relation with plant density was also reported by Karaman[16]. However, the genotype, environmental conditions and agricultural practices also had an influence on this yield component. In the study, the numbers of branches per plant results are in accordance with Karaman[16], while it higher than Ertuğrul and Özgüven[15], Telci[8] and Geren *et al.*[7].

Yield components: The number of capsule per plant differed significantly in both years. The number of capsule/plant in 2001 (9.86) was higher than those in 2002 (9.10) (Table 1). The differences between years probably reflect influence of environmental conditions. The number of capsule per plant varied with seed rates. The number of capsule per plant ranged from 9.86 to 18.06 in 2001, whereas it ranged from 9.10 to 11.96 in 2002 (Table 1). Averaged over years, the highest number of capsule per plant (14.65) was obtained from the application of 5 kg ha^{-1} and the lowest value (9.48) was observed in the 20 kg ha^{-1}. In the study, the year x seed rates interactions were found to be statistically significant at 1% level of probability. The highest number of capsule (18.06) was obtained from the application of 5 kg ha^{-1} in 2001 (Table 1). It is known that the number of capsule partly depended on the number of branches per plant. However there is positive relation between the number of capsule and the numbers of branches, it was also reported by Telci [8], Karaman[16] and Özel *et al.*[14].

The effect of seed rate was found to be statistically significant at 5% level of probability for the number of seeds per capsule in the study. Averaged over years, the highest number of seeds (71.12) was obtained from the application of 10 kg ha^{-1} and the lowest value (66.45) was observed in the 20 kg ha^{-1}, whereas it were not found significant differences between both 10 and 15 kg ha^{-1} seed rates (Table 1). The findings differ from Özel and Demirbilek[17], Özel *et al.*[14] and Karaman[16]. These differences were probably related to variations in environmental conditions.

In the study, the effect of seed rate was found not to be statistically significant for 1000 seed weight. Averaged over years, it ranged from 2.40 to 2.65 g (Table 1). 1000 seed weight results are in accordance with many researchers.[7,8,16].

Table 1: Variation in yield and some agronomic characters of black cumin grown at Van in 2001 and 2002

	Plant height (cm)			No. of branch			No. of capsule			No. of seeds per capsule		
Seed rates (kg ha^{-1})	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
5	36.53ab	37.70	37.11ab	11.20a	7.93	9.56a	18.06a	11.23ab	14.65a	68.30b	68.33a	68.31ab
10	34.40b	34.96	34.68b	9.46ab	7.86	8.66ab	12.93b	11.66a	12.30b	74.66a	67.56ab	71.12a
15	43.20a	38.16	40.68a	8.33bc	7.36	7.85bc	13.06b	11.96a	12.51b	70.53ab	70.23a	70.38a
20	41.73a	36.43	39.08ab	6.66c	6.20	6.46c	9.86c	9.10b	9.48c	66.60b	66.30b	66.45b
Mean	38.96	36.81		8.91a	7.35b		13.48	10.99		70.02	68.10	
CV (%)	6.29	Ns	4.59	2.66	1.65	1.44	2.69	2.21	1.60	5.1	3.72	2.90
Analysis of variance												
Year (Y)			Ns			**			**			Ns
Seed rate (S)			*			**			**			*
Y x S			Ns			Ns			**			Ns
	1000 seed weight (g)			Seed yield (kg ha^{-1})			Essential oil content (%)			Essential oil yield (kg ha^{-1})		
Seed rates (kg ha^{-1})	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
5	2.66	2.40	2.53	375.3d	353.3d	364.3d	0.51	0.50	0.51	1.9a	1.8d	1.8c
10	2.63	2.66	2.65	517.0c	471.3c	494.1c	0.46	0.50	0.48	2.4a	2.3c	2.4b
15	2.73	2.53	2.63	743.6a	658.6a	701.2a	0.48	0.52	0.50	3.5a	3.4a	3.5a
20	2.36	2.43	2.40	617.6b	558.3b	588.0b	0.58	0.52	0.55	3.6a	2.8b	3.3b
Mean	2.60	2.51		563.4a	510.4b		0.51	0.50		2.9	2.6	
CV (%)	Ns	Ns	Ns	4.36	3.90	2.90	Ns	Ns	Ns	0.06	0.03	0.03
Analysis of variance												
Year (Y)			Ns			**			Ns			Ns
Seed rate (S)			Ns			**			Ns			**
Y x S			Ns			Ns			Ns			Ns

*,**: Significant at the 0.05 and 0.01 level, respectively; CV: Coefficient of Variation; Ns: Non-significant

Seed yield: As seen in Table 1, there were significant differences between the growing seasons. The seed yield (510.4 kg ha^{-1}) of the first year were superior to those (563.4 kg ha^{-1}) of the second and year. The higher seed yield of the first year was partly due to more favorable environmental conditions, particularly total rainfall. Similarly, the differences between the seed rates was observed and found to be statistically significant. The study data showed that seed yields increased linearly with application of seed rate up to 15 kg ha^{-1}, whereas it led to declines in seed yield with application up to 20 kg ha^{-1} (Table 1). Averaged over years, the highest seed yield (701.2 kg ha^{-1}) was obtained from the 15 kg ha^{-1} seed rate application, while the lowest yield (364.3 kg ha^{-1}) was obtained from the 5 kg ha^{-1} (Table 1). The increases in yield with increasing seed rate applications can be explained partly by increasing the plant density in the area. It is known that it was a close relationship between seed yield and plant density. Arslan[13] and Telci[8] also reported that seed yields were increased by increasing seed rate application. On the other hand, this response can also be accounted for the positive response of agronomic characteristics associated with yield such as number of branch, capsule and seed per capsule. However, the yield decreases with application of 20 kg ha^{-1} seed rate can be explained by probably decreased yield components due to excessive increasing of plant density. In the study, seed yield results are in accordance with Arslan[13] and Geren *et al.*[7], while it higher than Ertuğrul and Özgüven[15], Özel *et al.*[14] and it lower than Das *et al.*[6], Karaman[16] and D'Antuano *et al.*[18]. These differences among the studies were probably related to variations in environmental conditions and soil properties.

Essential oil content and yield: The effect of seed rate was found not to be statistically significant for essential oil content. Averaged over years, it ranged from 0.48 to 0.51% (Table 1). In the study, essential oil content results are in accordance with Karaman[16], while it found lower than Ertuğrul and Özgüven[15] and Geren *et al.*[7]. However, the seed rates effects were found to be statistically significant at 1% level of probability for the essential oil yield. Averaged over years, the highest essential oil yield (3.5 kg ha^{-1}) was obtained from the 15 kg ha^{-1} seed rate and the lowest value (1.8 kg ha^{-1}) was observed in the 5 kg ha^{-1} seed rate application (Table 1). In fact, essential oil yield was associated directly with seed yield. This agrees with Geren *et al.*[7] who reported that essential oil yields were increased by increasing seed yield and essential oil yield values obtained from the study are in accordance with this researcher finding.

To date, management practices required for optimal yield of black cumin have been described for neither Van nor eastern Anatolia. However, it is the first to be detailed seed rate study on black cumin. It is concluded that the black cumin could be grown successfully under Van conditions. In this study, seed rate of 15 kg ha^{-1} has been shown to be adequate for the high seed yield and essential oil yield of black cumin under the region conditions. The information provided by the experiment might be helpful for recommending the optimum seed rate in black cumin production in similar climatic and soil conditions.

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