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Effect of Seed Rate on Agronomic and Technologic Characters of *Nigella sativa* L.

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ABSTRACT

The effects of seed rate (10, 20, 30, 40 & 50 kg ha^{-1}) on seed yield and some yield components of *Nigella sativa* were evaluated under semi arid conditions in Diyarbakır, Turkey during 1999-2000 and 2000-2001. Seed rate significantly affected plant height, number of branch per plant, number of capsule per plant, seed yield per plant and seed yield. High seed rates (40 & 50 kg ha^{-1}) reduced number of branch, number of capsule per plant, seed yield per plant and seed yield. Seed rate did not affect thousand seed weight, number of seed per capsule, essential oil and fatty oil rate. The highest seed yield (828 kg ha^{-1}) was obtained from 10 kg ha^{-1}.

Key Words: *Nigella sativa;* Seed rate; Seed yield; Essential oil; Fatty oil; Medicinal plants

INTRODUCTION

Nigella (*Nigella sativa* L.) is an annual herbaceous plant belonging to the family *Ranunculacea*. It is grown in Trachea, North Anatolia, Mediterranean region of Turkey and Cyprus (Davis, 1965). Nigel is widely cultivated throughout South Europe, Syria, Egypt, Saudi Arabia, Iran, Pakistan, India and Turkey (Riaz *et al.,* 1996). The seeds are known as black cumin. Mature seeds are consumed for edible and medical purposes. The seeds are used as seasoning for vegetables, legumes and different types of baked products (Atta, 2003). It has been used as a herbal medicine for more than 2000 years. It is also used as a food additive and flavour in many countries. *N. sativa* volatile oil has recently been shown to possess 67 constituents, many of which are capable of inducing beneficial pharmacological effects in humans (Aboutabl *et al.,* 1986). In various studies, the volatile oil has been shown to have insecticide, bronchodilator, immunomodulative (El Kadi & Kandil, 1987), antibacterial (Hanafy & Hatem, 1991), hypotensive (Zaoui *et al.,* 2000), choleretic, antitumoral (Salomi *et al.,* 1992), antifungal, antelmentic and antiastmatic (El-Tahir *et al.,* 1993). Its seeds contain thymoquinone and monoterpenes, and a variety of therapeutic effects on digestive disorders, gynecological diseases and the respiratory system (Boskabady & Shahabi, 1997). In Turkish folk medicine *Nigella* seeds are used as a natural stimulant of immunity, antiallergic, asthma, treatment of neurologic and skin diseases, cough, anti-inflammatory, analgesic, diuretic, antidiabetic, digestive disorders, carminative, anthelmintic and appetitive (Baytop, 1984). The principal active ingredient isolated from the volatile oil of *N. sativa* is thymoquinone (Mahfouz & El-Dakhakhany, 1960). *N. sativa* seeds contain a variable amount of oil, with linolenic generally recognised as the more abundant fatty acid; relevant amounts of saturated acids such as palmitic, myristic and stearic were found in some cases, as well as the presence of unusual unsaturated c20 (PUFA) acids (D'Antuono, 2002).

To realize the full yield potential of *Nigella* agricultural practices will have to be optimised for its production. Seed rate is the key factor determining effecting the yield and yield components. The objective of the present study was to clarify the influence of seed rate under semi-arid conditions on seed yield and growth characters of *Nigella sativa.*

MATERIALS AND METHODS

The field experiment was conducted during the rabi seasons 1999-2000 and 2000-2001 at field Crops Department, Faculty of Agriculture, Dicle University, Diyarbakır, Turkey.

The soil of experimental area was argillaceous having low organic matter and phosphorus with neutral pH (7.12) (Anonymous, 1999). The experimental location has a long-term (70 years) average precipitation of 485.4 mm, air temperature of 8.8°C and relative humidity of 58.7%. Climatic data for the two year study period indicated an average temperature of 14.0 and 13.4°C for first and second year, respectively and growing season precipitation of 235.3 for first year and 537 mm for second year (Anonymous, 2002). However, most of the precipitation fell in winter and early spring. Late spring rains were very limited and erratic.

Seeds of *Nigella sativa* were obtained from the herbal market in Diyarbakır, Turkey. The experiment was laid out in randomised complete block design with three replications. The crop was sown at seed rate of 10, 20, 30, 40 and 50 kg ha^{-1} Sowing was done by hand in 30 cm apart rows. Each plot included 4 rows, and plot size was 4.8 m^2.

In fertilization; nitrogen was applied 30 kg ha-^{1} in the form of ammonium nitrate [$(NH_4)_2NO_3$] as split in two application; half as basal dose and the remaining half at the beginning of stem elongation. All plots received phosphorus at 60 kg ha^{-1} as triple super phosphate as basal dose in both years. Nigel seeds were sown on 29 October 1999 in first year (1999-2000), on 14 November 2000 in second year (2000-2001) and were harvested on 16 June 2000 in first year, on 25 June 2001 in second year. Weeds were controlled by hand when needed. Harvesting was done manually by pulling the dry plant out of the soil, and removing the roots. The crop was attended as per routine cultural practices. The isolation of the essential oils from the 30 g of powdered seeds was done by hydro distillation for 3 h using Clevenger type apparatus according to European Pharmacopoeia (1975). Seed oil content (% dry matter) was determined using Soxhlet apparatus.

All characters measured (plant height, number of branch per plant, number of capsule per plant, number of seeds per capsule, seed yield per plant, 1000-seed weight, seed yield, fatty oil rate & essential oil rate) were subjected to the analysis of variance, including the seed rates. All data obtained were analysed statistically, using MSTAT-C program, and mean values of seed rates and lines were grouped, using LSD values at a significance level of 5%.

RESULTS AND DISCUSSION

Variance analysis results are given in the Table I. According to results; different seed rates significantly affected the plant height, number of branch per plant, number of capsule per plant, seed yield per plant and seed yield while significant effect of years was found on the plant height, number of branch per plant, number of capsule per plant, seed yield and fatty oil rate. The effect of interaction was highly significant on plant height and number of branch per plant.

Year and seed rate interaction was significant for plant height (Table I). Highest plant height was obtained from 50 kg ha^{-1} as 78.8 cm in first year. The lowest plant height was 57.0 cm and 57.1 cm from 20 and 30 kg ha^{-1} in second year. The average plant height for first year (73.4 cm) was higher than that observed (61.5 cm) in second year. Arslan (1994a) and Kırıcı (1999) showed that the plant height increased with increasing seed rate.

Interaction was observed for number of branch per plant (Table I). Generally, number of branch per plant was greater in 1999-2000 than it was in 2000-2001. 10 kg ha^{-1} had the highest number of branch with 9.1 pieces/plant in first year. The lowest number of branch was observed in 40 kg ha^{-1} in second year. Similarly, some researches (Degenhardt & Kondra, 1981; Roy & Paul, 1991; Kızıl, 2002) reported that as seed rate increased, number of branch per plant decreased. Also this is probably because high seed rate created higher interplant competition.

Despite interaction were not significant, the main effects year and seed rate were significant for number of capsules per plant (Table I). The differences between the years were largely caused by weather conditions, particularly rainfall. In the first year of the study, different seed rates produced high number of capsule per plant than second year (9.0 pieces/plant in first year; 7.3 pieces/plant in

Table I. Analysis of variance for the agronomic traits of *Nigella sativa* grown in Diyarbakır during 1999 and 2001

Variation Source	Plant height (cm)	Number of branch per plant (pieces/plant)	Number of capsule per plant (pieces /plant)	Number of seeds per capsule (pieces/cap.)	Seed yield per plant (g)	Thousand seed weight (g)	Seed yield (kg ha^{-1})	Fatty oil rate (%)	Essential oil rate (%)
Year	1072.81**	29.601**	22.707*	681.633	0.118	0.002	6859.037*	658.945*	0.000
Error	24.103	1.303	1.370	345.963	0.054	0.018	355.047	34.779	0.003
Seed rate	53.509**	4.493**	8.955**	25.615	0.071*	0.009	549.385*	28.795	0.003
Int.	67.855**	3.895*	2.115	100.710	0.007	0.019	49.217	29.289	0.002
Error	10.586	0.906	1.851	56.338	0.020	0.015	152.792	15.492	0.002
C.V. (%)	4.82	17.96	16.80	8.23	20.84	6.75	17.29	13.13	13.40

*, **: Significant at the 0.05 and 0.01 probability levels, respectively

Table II. Effect of seed rate on plant height, number of branch per plant and number of capsule per plant of *Nigella sativa*

Seed Rate(kg ha^{-1})	Plant height (cm)			Number of Branch per Plant (pieces/plant)			Number of Capsule per plant (Pieces/plant)		
	99-00	00-01	Mean	99-00	00-01	Mean	99-00	00-01	Mean
10	65.9 c*	63.3 c	64.9	9.1 a	4.5 bcd	6.8	11.6	8.7	10.2 a
20	72.1 b	57.1 d	64.6	6.1 b	4.1 cd	5.1	8.5	7.0	7.8 b
30	76.7 ab	57.0 d	66.8	5.5 bc	4.8 bcd	5.2	8.1	8.3	8.2 b
40	74.0 ab	64.8 c	69.4	5.8 b	3.6 d	4.7	8.1	5.9	7.0 b
50	78.8 a	64.5 c	71.5	5.0 bcd	4.5 bcd	4.7	8.5	6.3	7.4 b
Mean	73.4 a	61.5 b		6.3	4.3		9.0 a	7.3 b	
LSD	Year x seed rate int.: 5.632			Year x seed rate int: 1.648			Year:1.149, Seed rate:1.665		

*Means followed by the same letter are not significantly different at P= 0.05 level

Table III. Effect of seed rate on number of seeds per capsule, thousand seed weight and seed yield per plant of *Nigella sativa*

Seed Rate(kg ha^{-1})	Number of seeds per capsule(pieces/capsule)			Thousand seed weight(g)			Seed yield per plant (g)		
	99-00	00-01	Mean	99-00	00-01	Ort.	99-00	00-01	Mean
10	98.3	87.3	92.8	1.97	1.80	1.89	0.91	0.74	0.83 a
20	101.0	83.5	92.2	1.77	1.89	1.83	0.85	0.65	0.75 ab
30	99.1	86.0	93.0	1.79	1.81	1.80	0.70	0.64	0.67 abc
40	93.0	82.6	87.8	1.88	1.79	1.84	0.61	0.57	0.59 bc
50	88.6	92.9	90.7	1.77	1.80	1.79	0.64	0.49	0.57 c
Mean	96.0	87.0		1.84	1.82		0.74	0.61	
LSD	ns			ns			Seed rate:0.1731		

Means followed by the same letter are not significantly different at P= 0.05 level.

Table IV. Effect of seed rate on seed yield, essential oil rate and fatty oil rate of *Nigella sativa*

Seed Rate(kg ha^{-1})	Seed yield (kg ha^{-1})			Essential oil rate(%)			Fatty oil rate (%)		
	99-00	00-01	Mean	99-00	00-01	Mean	99-00	00-01	Mean
10	993	665	828 a	0.34	0.29	0.31	29.8	32.6	31.2
20	917	621	769 ab	0.34	0.32	0.33	19.5	33.1	26.3
30	847	633	740 abc	0.30	0.35	0.32	26.4	33.4	29.9
40	827	457	642 bc	0.29	0.27	0.28	24.7	36.4	30.6
50	745	442	594 c	0.29	0.30	0.30	26.1	37.8	31.9
Mean	866 a	564 b		0.31	0.30		25.3 b	34.7 a	
LSD	Year:19.10, Seed rate:15.13			ns			Year: 5.979		

Means followed by the same letter are not significantly different at P= 0.05 level.

second year). The highest number of capsule per plant was obtained from 10 kg ha^{-1} (10.2 pieces/plant). The lowest (7.0 pieces/plant) was 40 kg ha^{-1}. This might explain the reduced branching and hence fewer number of capsule per plant for greater seed rate (Degenhardt & Kondra, 1981; Roy & Paul, 1991; Arslan, 1994a).

There were no significant differences for year, seed rate and year x seed rate for number of seeds per capsule (Table I). Despite the differences among seed rates was not important, generally lower seed rate produced higher results. Also, plants gave greater number of seeds per capsule in first year than second year. Our results for number of seeds per capsule was higher than Das *et al*. (1992) and Arslan (1994b).

Seed rates had no effect on thousand seed weight in both years (Table I). Thousand seed weight varied from 1.77-1.97 g. No variations in seed weight most likely resulted from same genotype. Thousand seed weight was lower than that of reported by literature (Das *et al.,* 1992; Arslan, 1994b).

Seed yield per plant was significantly affected by seed rates but not by year and, year x seed rate interaction (Table I). The highest seed yield per plant (0.83 g plant^{-1}) was obtained 10 kg ha^{-1}, the lowest one was 0.57 g in 50 kg ha^{-1}. On a per plant basis, all factors being equal, greater light interception leads to larger plants in less seed rates and this often translate into greater seed yield per plant (Gesch *et al.,* 2003).

Seed yield was influenced both seed rate and year (Table I). The highest seed yield was obtained from 10 kg ha^{-1} (828 kg ha^{-1}). 50 kg ha^{-1} seed rate had the lowest seed yield (594 kg ha^{-1}). Averaged over the years, the Nigel produced higher seed yield in first year (866 kg ha^{-1}) than in second year (564 kg ha^{-1}). When seed rate increased, plant population density increased, which might have caused greater competition for available water, nutrients and lights, thus leading to lower seed yield. Also, these variations in seed yield most likely resulted from annual prescriptions which rained in growing seasons and thus rainfalls were affected this character negatively. The seed yields were found to be gradually reduced considerably when the seed rates increased (Arslan, 1994b; Kizil, 2002). The results of present study are lower than of reported by Karaman (1999) and Telci (1995).

Essential oil content was not influenced by year and seed rate (Table I). Although it is not important essential oil rates varied from 0.27-0.35%. Some studies conducted on *Nigella sativa* showed that essential oil rate varied from 0.36-0.49% and 0.125% (İlisulu, 1992; Özgüven *et al.,* 1989; Geren *et al.,* 1997).

Fatty oil content was significantly influenced by years, but seed rate had no effect (Table I). The maximum fatty oil rate (34.7%) was obtained from second year, the first year gave the minimum one (25.3%). The results show that highly significant differences occurred between the years. İlisulu (1992) reported that Nigel has 30-35% fatty oil while Baytop (1984) reported 30-45% fatty oil rate of Nigel.

At the lower seed rates numbers of plant are fewer in per unit area than higher seed rates. When the seed rates increased, the competition among plants also increased. This might increase the competition among plants in terms of usage of light, water and nutritional elements. However, the low seed rates produced the highest quantity number of branch per plant, number of capsule per plant, seed yield per

plant and seed yield in comparison with high seed rates. Consequently, in order to obtain a high yield from unit area for Nigel, it can be suggest 10 kg ha^{-1} in semi arid conditions.

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