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REVIEW

Effect of Nitrogen and Potassium on Yield, Yield Components and Essential Oil of Black Caraway (Bunium Persicum L.)

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ABSTRACT

Fertilization is the main factor stimulating yield of plants, nitrogen and potassium are among must important essential nutrients. An experiment was conducted to investigate the effect of different rates of nitrogen and potassium on yield and yield components of Black caraway (Bunium persicum L.). The experiment was on the base of randomized complete block design with three replications for 3 years in Torogh agriculture and natural resources research station, iran. Plow, disc, leveling, creating planted rows and making plots was performed in mid-September. All potassium fertilizer and half of the nitrogen were applied at planting. The rest of the nitrogen was applied in the form of top-dressing at flowering stage in the second week of April. The size of each experimental plot was 4 × 3 meters in 6 rows and 12 lines. Treatments were 4 levels of nitrogen (0,40,80and120 kgN/ha in the form of urea), and three levels of potassium (0, 40 and 80 kg k2O/ha in the form of sop). The results showed that the effect of nitrogen and potassium on grain yield, yield components, straw yield and essential oil content was significant ($P<0.05$). Nitrogen rate of 40 kg/ha increased grain yield and some yield components and essential oil. Whereas the higher rate decreases grain yield and yield components, and increases straw yield. Interaction of nitrogen and potassium on grain yield, straw yield and number of umbels per plant, was significant($P<0.05$).

1. Introduction

Black caraway (Bunium persicum L.) Perennial plant, herbs with corm, from the Umbelliferae (Apiaceae), is endemic restricted area of West Asia which also includes the eastern half of Iran[1].

The black cumin seed has been widely used in folk medicine for the treatment of a number of diseases such as diarrhea, jaundice, amenorrhea, helminthiasis, ophthalmic, paralysis and osthema[4]. Black caraway is a wild

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plant that grows in natural habitat, mainly in mountainous area of kerman province, but efforts has been done to domesticate this valuable medicinal plant. Studies showed that black cumin has good ability to be planted in the field to enhance production of this valuable plant in Iran, especially in Khorasan province [8]. There are also a sight for black caraway in the future as a new plant to be cultivated in the world. The annual production of medicinal plants such as black caraway is increasing due to increase of acreage. Black caraway market in India and Pakistan is expanding .Due to suitable climatic conditions in Iran for cultivation of black caraway in the field, this medicinal plant must be introduced to the farmers. The role of nutrients, especially nitrogen and potassium are very important in the yield and quality of caraway. A research has shown that black caraway needs 20-30 kg N /ha for a suitable production in India . But Khalid[6] suggested that application of 100kg/ha nitrogen in the form of ammonium sulfate ($(NH_4)_2SO_4$) increased essential oil of black cumin in compare to control.For the production of one ton of seed, this plant absorbs about 72 kg/ha nitrogen, and 80 kg/ha of potash from the soil .It has been proved that nutrients have a great role in increasing yield of caraway[5] . Use of 50 to 80 kg per hectare K2O has positive effect on the growth of black Cumin (Omidbaigi,2004) . Bagheri [3]reported that use of 100 kg Nitrogen per hectare made the highest number of umbels per plant and number of seed in umbels. But in terms of dry matter yield no significant difference between application of 100 kg and 200 kg of nitrogen fertilizer reported. Weglars [10] stated that nutrient uptake in caraway is low .He reported that application of 85 kg nitrogen, 39 kg P2O5 and 94 kg K2O per hectare increased seed yield to 1.2 ton per hectare and root (tuber) to 4.2 ton per hectare. Moreover today there is little available information pertaining to agronomic practices including optimum dose of nitrogen and potassium fertilizers. There for this calls for initiative study to determine the optimum rate of N and K fertilizers to solve the existing problem of yield and quality of black cumin under the agro-climatic condition of Mashhad, Khorasan razavi province north east Iran.

The purpose of this study was to evaluate the effect of different levels of nitrogen and potassium on yield , yield components and essential oil in Black caraway.

2. Materials and Methods

A factorial experiment was conducted to Investigate the effect of different rates of nitrogen and potassium on yield and yield components of Black caraway. The experiment was on the base of randomized complete block design with three replications runned for 3 years in Torogh agriculture and natural resources research station north east of Iran. Treatments were 4 nitrogen levels as(0,40,80and120 kgN/ha), and three potassium levels as(0, 40 and 80 kg P2O5/ha). The sources of fertilizer treatments were urea($CO(NH_2)_2$) for nitrogen and potassium sulfate(K_2SO_4) for potassium. Before starting the experiment, soil samples were taken from 0-30 cm depth. Physical and chemical property analysis were made in the laboratory of soil and water research department of the soil and water research institute in khorasan razavi agriculture and natural resources research and education center, Mashhad (table 1).

Table 1. Physical and chemical characteristics of the soil

Depth of sampling (cm)	EC (Ds/m)	pH	SP %	TNV %	OC %	N (mg/kg)	P (mg/kg)	K (mg/kg)	Soil texture
0-30	0.9	8.1	31	14.9	0.23	0.04	11.2	219	Silty loam

Plow, disc, leveling, creating planted rows and making plots was performed in mid-September. All potassium fertilizer and half of the nitrogen were applied at planting. The rest of the nitrogen to form of top-dressing were used at flowering stage in the second week of April. The size of each expriment plot was 4 × 3 meters in 6 rows and 12 lines. Distance between planted rows was 50 cm. Plant spacing in the lines after weeding was 10 cm. caraway seeds were planted in October. The seeds After mixing with fine sand were planted in the lines at a depth of 3 cm soil. 15 kg of seeds per hectare was used for planting. Irrigation was performed 3 times each year as furrow. Amount of irrigation water was measured about 3,000 m^3 / ha in each year. Black caraway in the first and second years has vegetative growth but in the third year it enters the reproductive growth stage and produce seed. The grain yield, yield components, biological yield and essential oil content in each plot was measured. Yield components was cotain umbels per plant, umbelets in the umbrel and thousand seeds weight.

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Seed yield(kg/ha): Grain yield was determined by harvesting plants from the net middle plot area of 2.5*2.5 m2 to avoid border effects, Seeds which were obtained from the corresponding net plot were cleaned manually, after drying around 8.0% moisture weighed using sensitive balance and recorded as seed yield

Biological yield: At maturity the whole plant parts including leaves,stems and seeds from the net plot area were harvested and dried for three days. Finally weight of dried

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plants were recorded.

Plant height was measured in centimeter at physiological maturity from the ground level to the tip of plant from ten randomly selected plants in each plot. The values are expressed as mean values. Harvesting was carried out by hand following at full maturity. The harvested plants were dried in the open air for five days and weighted

The experimental data were analyzed with MSTAT-C and EXCEL softwares and comparisons of mean on each of the characteristics was performed using Duncan test.

3. Results and Discussion

The results of this study showed that the effects of nitrogen and potassium on grain and straw yield, yield components and content of essential oil of black caraway was significant the interaction effects of nitrogen and potassium only on seed yield , straw yield , umbels per plant and umbellate per plant were significant (Table 2).

Effect of nitrogen levels: As Table 3 shows the effect of nitrogen on all studied traits was

significant in compare to control, So that the application of 40 kg nitrogen per hectare increased seed yield (19.6%) , and 1000 seeds weight (45.6 %) compared to the control, this treatment also increased umbels per plant and umbellate per plant in compare to control and other nitrogen levels. While other levels of nitrogen had reveres effect on seed yield and 1000seeds weight. Nitrogen is a macro nutrient that has a major physiological role in the development of plants especially in prophyrin structure which has various metabolic activities in photosynthetic pigments and cytochromes that are basic in respiration. Nitrogen enhances vegetative growth so more application of nitrogen may have negative effect on seed yield. As is seen plant height in response to more application of nitrogen significantly increased but seed yield did not increased.

Plant height and straw yield were significantly affected by nitrogen application rate. Tallest

plants received maximum nitrogen rate while minimum plant height recorded at control

treatment(without nitrogen application). Tallest plants have enjoyed adequate nitrogen for

vegetative growth. In other plants this trend has been reported but ozguven and sekeroglu[9] stated that there were no statically differences among the different nitrogen doses in black cumin. Yimam et.al[12] suggested that growers can use of 45-60 kg N / ha to obtain maximum production of black cumin in Duka konta district Ethiopia.

Content of essential oil of seed of black caraway was not increased by using nitrogen significantly. Weglars[10] stated that unbalanced use of nitrogen fertilizer on caraway may cause a decrease in yield, and high use of nitrogen could hurt plant.

Effect of potassium level: Table 4 shows the effect of potassium on grain yield, straw yield ,umbels in plant and content of essential oil at Black caraway. Potassium had significant effect on traits. As use of 80 kg Potassium per hectare Increased seed yield (56.1%) , straw yield (54.3%) and umbels in plant (41.5%) compared to the control. But application of 40 kg of potassium per hect-

Table 2. Analysis of variance effect of N and K on yield ,yield components and essential oil of caraway

Soures Of Variation	Degree Of Freedom	Mean of Squares						
		Seed yield	Straw yeild	Plant height	Umbels per plant	Umbellate per plant	thousand seeds weight	Essential oil content
Rep.	2	2429.6*	19339.9*	19.4 $^{n.s}$	4.26 $^{n.s}$	0.72 $^{n.s}$	2.39 $^{n.s}$	1.25 $^{n.s}$
N	3	2437.7*	85136.1*	268.9*	30.05*	45.16*	12.08*	4.12 $^{n.s}$
K	2	11548.6*	156169.4*	26.0 $^{n.s}$	22.09*	4.51 $^{n.s}$	6.5 $^{n.s}$	9.25*
NK	6	6772.0*	66739.8*	30.4 $^{n.s}$	11.58*	49.55*	5.57 $^{n.s}$	3.12 $^{n.s}$
Error	10							
C.V.		18.61	23.78	11.93	24.97	13.72	19.87	13.12

Table 3. Effect of Nitrogen Fertilizer on the studied traits

Levels of Nitrogen	Seed yield(Kg/ha)	Straw yeild(Kg/ha)	Plant height(cm)	Umbels per plant	Umbellate per plant	thousand seeds weight	Essential oil content(%)
N_0	186.91 ^{b}	331.9 ^{bc}	63.94^{a}	5.889 ^{a}	62.11 ^{a}	1.03 ^{b}	3.85 ^{a}
N_1	232.2 ^{a}	448.8 ^{a}	61.39^{a}	6.833 ^{a}	67.28 ^{a}	1.5^{a}	4.12 ^{a}
N_2	204.5 ^{b}	286.4 ^{c}	55.67^{b}	4.611 ^{b}	41.19 ^{b}	1.09 ^{b}	3.25 ^{a}
N_3	196.5 ^{b}	370.0 ^{b}	56.89^{b}	3.944 ^{b}	48.0^{ab}	1.15 ^{b}	3.12 ^{a}

Note: In each column treatments of at least one common letter, no statistically significant difference.

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are increased essential oil. Highest content of essential oil Was obtained %4.82 that increased 54.9% compared to the control. This result was similar to many researchers study. Research of Naseripoor [7] showed the highest yield of cumin was obtained by 50 kg/ha of potassium. Fagaria et al[5] in a sandy loam soil and in a three-year experiment observed significant difference between yield of the different levels of 0 to 80 kg per hectare potassium in cumin. Azza et. al.[2]investigated the effect of nitrogen and potassium fertilizers on growth, yield and essential oil of caraway and stated that adding .potassium fertilizers improved some of growth characters and yield component of caraway plants. Potassium as an important nutrient in plant metabolism, enhancing carbohydrates synthetic, positively affecting water transport in the xylem and cell elongations. Potassium activates many enzymes in plants and accelerate secondary metabolite production in plants such as essential oil production in medicinal plants.

Table 4. Effect of different levels potash, on seed yield, straw yield and umbels per plant

Levels of potash	Seed yield (Kg/ha)	Strawyeild (Kg/ha)	Umbels per plant	Essential oil content(%)
K_0	165.23 ^{c}	290.2 ^{b}	4.5 ^{b}	3.11 ^{b}
K_1	212.1 ^{b}	339.7 ^{b}	5.1 ^{b}	4.82 ^{a}
K_2	258 ^{a}	447.9 ^{a}	6.4 ^{a}	4.43 ^{a}

Note: In each column treatments of at least one common letter, no statistically significant difference.

Interaction effect of nitrogen and potassium: The interaction effect of nitrogen and potassium was significant on the seed yield, straw yield and umbels per plant (Table 5). The highest seed yield and straw yield with the amount of 360.8 and 489.2 kg /ha, respectively, obtained from the second level and third level of nitrogen and potassium. This fertilizer treatment increased grain yield and straw yield by 86% and %85.2 respectively, compared to the control. The number of umbels per plant in the treatments of N1K1, N0K2 and N1K2 were not difference significantly. However, the highest number of umbels per plant(8.5) was obtained from N1K2 treatment, which increased 54.5% compared to the control. Studies of Naseripoor[7] showed that the highest yield of cumin have been obtained from 30 kg/ha N and 80 kg K/ ha K2O. Cumin, to produce one ton seed , absorbs, 72 kg nitrogen, 32 kg phosphorus oxide and 80 kg of potash per hectare from the soil. It has been proven that nutrient is effective in increasing the performance of cumin and yield of cumin. Both nitrogen and potassium are essential nutrients that affect plant growth differently, nitrogen increases vegetative growth while potassium is a quality element that has effect on byproducts of plants such as essential oil. Wiedenhoeft[11] stated that positive effects of potassium on growth and yield of medicinal plants is due to potassium is the primary osmolyte and ion involved in plant cell membrane dynamics, including regulations of stomata and maintenance of turgor and osmotic equilibrium.

Table 5. Interaction effect of nitrogen and potassium on grain yield, straw yield and number of umbel per plant

Treatments	Seed yield (Kg/ha)	Strawyeild (Kg/ha)	Umbels per plant	Umbellate per plant
N_0K_0	172.8 ^{de}	264.8^{ef}	5.5^{c}	15.0^{a}
N_1K_0	105.8 ^{f}	278.5^{ef}	4.0^{de}	12.0^{bcde}
N_2K_0	151.9 ^{e}	319.5^{def}	4.6^{cd}	11.7^{de}
N_3K_0	200.4 ^{de}	297.9 ^{def}	3.8^{e}	13.0^{abcd}
N_0K_1	150.5 ^{e}	303.3 ^{def}	4.3^{cd}	13.5^{abcd}
N_1K_1	221.8 ^{cd}	398.7^{bcd}	8.0^{a}	13.8^{abc}
N_2K_1	253.0 ^{bc}	320.4^{cdef}	4.2^{de}	13.7^{abcd}
N_3K_1	210.8 ^{cd}	336.7^{cde}	3.8^{e}	11.8^{cde}
N_0K_2	178.4 ^{de}	427.6^{bc}	7.4^{ab}	13.8^{abc}
N_1K_2	320.8 ^{a}	489.2^{a}	8.5^{a}	14.0^{ab}
N_2K_2	182.5 ^{de}	219.3^{f}	5.0^{c}	13.7^{abcd}
N_3K_2	284.3 ^{b}	445.5^{b}	4.2^{de}	10.8^{e}

Note: In each column treatments of at least one common letter, no statistically significant difference

4. Conclusion

In general, according to the results of this study Caraway in terms of the need to nutrient nitrogen, does not need a large amount of this element and with the least amount of nitrogen will reach to the optimal plant growth and development and expected yield. This plant showed appropriate response to potassium application and higher levels of potassium, increased yield and some yield components. The highest percentage of essential oil was observed in the first level of nitrogen and potassium (N_1 $K_{1)}$. Under experimental conditions, 40 kg N and 80 kg K_2O per hectare can be recommended for optimal seed yield and yield components and essential oil in Black caraway. Despite the fact that use of this fertilizer treatment decreased the essential oil content partially, but an increase in the yield was compensated a decrease.

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