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Response of caraway (*Carum carvi* L.) to salicylic acid and planting spaces

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ABSTRACT

The study was conducted during 2022/2023 in the fields of the College of Agriculture, Hawija, University of Kirkuk, to study the effect of salicylic acid (0, 25, and 30 mg L⁻¹), planting spacing (0.15, 0.2, 0.3 m) and interaction on caraway. Randomized complete block design with three replications was applied. The distance of 0.2 m gave the highest plant height (85.27 cm), number of branches (10.3 branch/plant), number of inflorescences in main flower reached 95.10 inflorescences/flower, and wet and dry (280.3 and 38.13 grams/plant), respectively. The 50 mg L⁻¹ gave the highest plant height (64.86 cm), number of branches, (4.22 branch/plant), and the wet and dry weight and weight of a thousand seeds (278.6, 35.46, and 6.72), respectively. The interaction between planting spacing 15 cm and 50 mg L⁻¹ led to an increase gave the highest plant height (73.18 cm) and number of flowers per plant (15.92 flower/ plant) and increased the rest of the characteristics. The interaction between 0.3 m and 50 mg L⁻¹ was superior in the number of flowers per plant (17.66). The interaction between 0.3 m and 25 and 50 mg L⁻¹ was superior in wet and dry weight (198.70 and 201.77 g/plant), respectively. As for the interaction between 50 mg L⁻¹ and 0.2 m gave the highest value of 1000 seeds (6.36 g).

KEY WORDS:

Caraway, salicylic, Apiaceae

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استجابة نباتات الكراوية (*Carum carvi* L.) للرش بحامض الساليسيليك والمسافات بين النباتات وتفاعلها في النمو وحاصل البذور

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الخلاصة

أجريت الدراسة خلال 2023/2022 في حقول كلية الزراعة الحويجة جامعة كركوك لدراسة تأثير الرش بحامض الساليسيليك (0 و 25 و 30 ملغم/ لتر) وثلاثة مسافات بين النباتات (0.15، 0.2، 0.3 م) وتداخلهما في نمو وحاصل بذور الكراوية بتصميم القطاعات العشوائية الكاملة بثلاث مكررات. وأعطت المسافة 0.2 م أعلى الارتفاع نبات بلغ 85.27 سم وعدد فروع بلغ 10.3 سم فرع/ نبات ولم تختلف معنوياً عن باقي مسافات الزراعة. ويلاحظ أن مسافة الزراعة 0.2 م عدد ازهار في الزهرة الرئيسية بلغ 95.10 نورة مزهرة / زهرة و زادت الوزن الرطب والجاف، و أعطت متوسط وزن جاف ورطب (280.3 و 38.13) جرام/ نبات على التوالي. الرش بتركيز 50 ملغم/ لتر أعطى أعلى معدل ارتفاع للنبات بلغ 64.86 سم، و عدد الفروع حيث بلغ 4.22 فرع/نبات والوزن الرطب والجاف ووزن الألف بذرة (278.6، 35.46 و 6.72) على التوالي. التداخل بين مسافة الزراعة 15 سم والرش بالساليسيليك بتركيز 50 ملغم/ لتر أدى إلى زيادة ارتفاع النبات وأعطى أعلى ارتفاع نبات بلغ 73.18 سم و عدد النورات الزهرية/ النبات بمقدار 15.92 والرش بالساليسيليك بتركيز 50 ملغم/ لتر أدى إلى زيادة معنوية مع باقي معاملات التداخل وأعطى متوسطاً بلغ (4.88 فرعاً/ نبات). وتفوقت معاملة التداخل بين مسافة الزراعة 0.3 م ورش الساليسيليك بتركيز 50 ملغم / لتر في عدد الأزهار في النبات (17.66). و تفوق التداخل بين مسافة الزراعة 0.3 م والرش بالساليسيليك بتركيز 25 و 50 ملغم/ لتر في الوزن الرطب والجاف للنبات، وأعطوا متوسط وزن رطب للنبات قدره (198.70 و 201.77) جم/نبات ومتوسط وزن جاف (39.67 و 42.19) جم/نبات على التوالي. اما التداخل بين الساليسيليك 50 ملغم / لترو 0.2 م أعطت أعلى قيمة لوزن 1000 بذرة بلغ 6.36 غم. الكلمات الافتتاحية: الكراوية، الساليسيليك، العائلة الخيمية

INTROUCTION

Carum variety has 25 species, and *Carum carvi* or caraway is the main yearly and biennial conservative one as zest, aperitif, and carminative in food and drug enterprises. It is broadly utilized in food items because of its flavour and additive properties. Its organic products are utilized as a solution for heartburn and pneumonia, and as cumulative, canapé, and galactagogue in various conventional frameworks (Rasooli, 2016). It is much of the time utilized in veterinary medication, as in human medication, for the excitement of ap-unimposing and feed consumption, improvement of endogenous stomach related compound emission, actuation of resistant reaction and against bacterial, antiviral, cancer prevention agent and antihelminthic exercises (Hassan and Abdel-Raheem , 2013) and (Naseri *et al.*, 2012). Caraway natural products are utilized as well known solution for alcoholic breath, frailty, and as antitoxin specialist against venomous beats. Caraway natural products are utilized for seasoning of rye bread and its mixture is a solution for colic and stomach related messes, and to battle (Attokaran,2017) and (Maddonni *et al.*, 2001). Many examinations to the reaction of numerous restorative plants for treatment with salicylic corrosive (Al-Shabani, and Abdel-Ameer, 2013, and Popova *et al.*, 1997) saw that showering of dark cumin and salicylic corrosive at two concentrations 12 and 20ml L⁻¹ by two sprinkles. The initial three weeks subsequent to planting and, then the second following two months after the primary shower brought about a huge expansion in plant level, number of branches and leaves, and dry load for vegetative and root all out, blossom number and weight of

1000 seed and the seed content of nignon from the unstable oil removed from seeds. Plant hormones having phenolic qualities, such as salicylic acid, control several physiological functions in plant, including ion absorption, hormonal balancing, stomata movement, and flowering stimulation (Popova *et al.*, 1997).

Apart from controlling how the plant reacts to external stressors including heat, drought, and heavy metals. Additionally, it functions as a catalyst for the production of the pigments carotenes and chlorophyll as well as an aid in photosynthesis (Hayat and Ahmad, 2007). Utilizing ideal plant thickness, plants are totally adjusted in natural circumstances like water, air, light, soil, and bury or intraspecific contests will be at the base level (Sadeghi and Ashrafi, 2009), demonstrating that rising plant thickness found to create taller plants, but more slender stems and fewer branches in fennel. Management practices including row spacing, which determines the ideal crop stand and encourages intercultural, and appropriate herbicide use for weed control have an impact on crop output. In order to maximize light distribution, interception, penetration, and average light effectiveness of the canopy leaves since, according to Hussain *et al.*, (2003), all boost crop yield, the ideal row spacing is crucial. The architecture and development characteristics of each variety must be taken into consideration when determining the requirements for wheat row spacing. A smaller percentage of incoming radiation that is collected by canopy layers must be intercepted by the crop canopy (Eberbach and Pala, 2005). Similar to this, tight spacing can lower production because it increases plant competition for moisture and light nutrients (Das and Yaduraju, 2011). Typically, wheat is planted in rows that are spaced 22.5 cm apart, with no regard for the cultivar's size or ability to tiller, (Das and Yaduraju, 2001). Wheat cultivars respond variably to varying row spacing because to differences in height and tillering capacity (Hussain *et al.*, 2012 and Hussain *et al.*, 2013). By enhancing the absorption of enough solar light, plant density or seeding rates have a significant impact on agricultural output (Maddonni *et al.*, 2001).

The main impact of planting pattern and plant density on a crop is primarily caused by differences in how light would distribute through the canopy; increasing solar absorption would result in an increase in yield. The distribution of plants affected the amount of absorbed light across the canopy (Naseri *et al.*, 2010).

MATERIAL AND METHODS

A field experiment was carried out during the 2022-2023 agricultural season in Al- Hawija College of Agriculture Fields, Kirkuk University in a field that has blended residue soils. It was divided into blocks at a rate of one block per unit, covering a surface area of 1.5×1.5 m. The study comprised nine component coefficients that integrated the crossover between: The trial was designed with a (RCBD) and three replications, and included two factors.

A: planting spacing

1. 0.15 m
2. 0.2 m

3. 0.3 m

B: Salicylic acid

1. Without showering (examination treatment), splash it with water.
2. Shower using a grouping of 25 mg L⁻¹
3. Shower using a grouping of 50 mg L⁻¹

Seeds were sown on November 15, 2020, and salicylic concentrations (0, 25, and 50 mg L⁻¹) was applied to the plants on February 15, 2021, and returned fourteen days later. When the plant reached the flowering stage, the following estimates were made:

1. Plant height (cm)
2. Number of branches (branch/plant)
3. Fresh weight g/plant
4. Dry weight g/plant
5. Number of flowers per inflorescence
6. 1000 seed weight (g)

The outcomes were examined genuinely as per the plan utilized, and the midpoints were contrasted with the Duncan test at a 5% likelihood level.

RESULTS AND DISSCUSION

Table (1) demonstrated that there was tremendous variation in plant height at various planting spacings. It was noticed that 0.2 m gave the heights height of the plant reached to 85.27 cm. however, The lowest plant height was 69.41 cm at planting spacing of 0.15 m. The table likewise indicated that there were no significant differences in number of branches per plant, and planting space of 0.2 m gave the highest number of branches reached (10.3 branch /plant). As may be seen from the table that planting space of 0.2 m gave a critical expansion in two qualities of the quantity of flowers in the primary inflorescence and quantity of flowering the plant's inflorescences with the in establishing distance and the most elevated typical number of flowers in the main inflorescence recorded (95.10 flower/inflorescences). The table indicated that the planting space of 0.2 recorded the highest values of wet and dry weight, and gave a typical wet and dry weight of (280.3 and 38.13 g/plant), separately. Planting space of 0.2 m recorded the highest weight of 1000 seed reached (6.32 g) these results are in agreement with Hussain *et al.*, 2012 and Hussain *et al.*, 2003.

Table (1) Response of caraway characteristics to planting space

Planting space (m)	Plant height-cm	Number of branches per plant	Number of flowers per inflorescence	Herb fresh weight per plant (gm)	Dry weight/plant (g)	1000 seed weight (g)
0.15	69.41 C	10.2 A	87.15 C	222.1 C	32.86 C	4.55 C
0.2	85.27 A	10.3 A	95.10 A	280.3 A	38.13 A	6.32 A

0.3	71.46 B	10.1 A	90.19B	252.9 B	33.29 B	5.20 B
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The coefficients bearing the equal alphabet are not considerably different from each other consistent with Duncan's polynomial check and the 5% probability level.

Table (2) Response of caraway characteristics to salicylic acid

Salicylic acid concentration mg L ⁻¹	Plant height(cm)	Number of branches / plant	number of flowers inflorescence	Herb fresh weight per plant (gm)	dry weight plant .g	1000 seed weight .g
0	63.46 A	3.79 A	15.28 B	232.9 C	33.77 C	5.13 C
25	63.83 A	3.98 A	15.92 A	278.6 A	34.81 B	6.11 B
50	64.86 A	4.37 A	15.80 A	256.7 B	35.46 A	6.72 A

The coefficients bearing the equal alphabet are not considerably different from each other consistent with Duncan's polynomial check and the 5% probability level.

Table (2) showed that the salicylic acid treatment did not significantly affect the attributes of plant height and number of branches per plant. Concentration of 50 mg L⁻¹ gave the most elevated plant (64.86 cm) and it did not significantly differ the other concentrations. The concentration of 50 mg L⁻¹ gave the highest number of branches per plant (4.37 branch/ plant), and there was no significant variation comparing to the other concentrations. The table indicated that salicylic acid at a concentration of 25 mg L⁻¹ recorded an expansion in the quantity of flowers in the inflorescences per the plant (15.92 flower/ inflorescence), (Hayat and Ahmad, 2007). It was noted from the same table that the concentration of 50 mg L⁻¹ gave the increment trademark in fresh weight, dry weight and thousand seed weight and it gave means of (278.6 g, 35.46 g and 6.72 g), respectively.

Table (3) Response of caraway characteristics to the interaction between planting space and salicylic acid

Salicylic acid concentration mg SA. L ⁻¹	Planting Space (m)	Plant height(cm)	Number of branches per plant	number of flowers per inflorescences	Herb fresh weight per plant (gm)	Dry weight per plant .g	1000 seed weight (g)
0	0.15	68.65AB	3.75 B	13.58 D	157.15 F	31.43 F	4.55 C
	0.2	65.18 B	4.07 AB	16.7 BC	162.13ED	32.42 ED	5.19 B
	0.3	58.72 C	3.57 B	16.05 BC	187.40 B	37.48 B	5.20 B
25	0.15	72.46 A	3.59 B	14.32 D	158.57 EF	31.71 EF	4.55 C
	0.2	62.10 C	3.72 B	16.42 BC	156.24 D	33.24 D	5.32 B
	0.3	59.30 C	4.2 AB	17.01 AB	198.70 A	39.47 A	5.20 B
50	0.15	73.18 A	4.08 AB	14.45 D	167.86 EF	31.56 EF	4.55 C
	0.2	57.44 C	3.82 B	15.78 B	173.52 C	34.70 C	6.36 A
	0.3	57.73C	4.88 A	17.66 A	201.77 A	40.12 A	5.20 B

According to Duncan's polynomial check and the 5% probability threshold, the coefficients with the same alphabet do not differ significantly from one another.

Table (3) results showed that the interaction between planting space of 0,15 m and salicylic acid concentration of 50 mg L⁻¹ recorded the highest plant height (73.18 cm). Results showed the significant impact of the interaction between planting space (0.3 m) a and salicylic acid concentration of (50 mg L⁻¹) and gave the highest: number of branches per plant (4.88

branch/plant), number of flowers per inflorescence in the plant (17.66 flower inflorescence), fresh weight (201 g), dry weight (40.12) and 1000 seed weight (5.20 g) (Maddonna *et al.*, 2001).

CONCLUSION

It can be concluded that applying the correct planting space and concentration of salicylic acid could increase vegetative and yield components characteristics of caraway. Planting space of (20 cm) the highest values of the studied characteristics mean. Salicylic acid concentration 50 mg L⁻¹ recorded the highest means of the most of the studied characteristics.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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