International Journal of Plant & Soil Science

33(17): 116-123, 2021; Article no.IJPSS.71354
ISSN: 2320-7035

Effect of Foliar Application of Plant Growth Hormones on Yield and Quality Parameters in Ajowan (*Trachyspermum ammi L. Sprague*)

Y. Rajasekhara Reddy[1*], G. Ramanandam[1], P. Subbaramamma[1] and A. V. D. Dorajeerao[1]

[1]Dr. YSR Horticultural University, Venkataramannagudem, Tadepalligudem-534101, Andhra Pradesh, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2021/v33i1730556
Editor(s):
(1) Dr. Hon H. Ho, State University of New York, USA.
Reviewers:
(1) Elham Abd ELMoneim Badr ELSayed, Alexandria University, Egypt.
(2) Waleed Ahmed Elmadawy Abido, Mansour University, Egypt.
Complete Peer review History: https://www.sdiarticle4.com/review-history/71354

Original Research Article

Received 12 May 2021
Accepted 22 July 2021
Published 02 August 2021

ABSTRACT

Foliar application of plant growth regulators *viz*., GA_3 -50& 100 ppm, NAA- 50 ppm &100 ppm, Thiourea- 250 & 500 ppm, 28-Homobrassinolide- 0.1& 0.2ppm, Triacontanol - 2.5& 5 ppm and Control. All the treatments were applied as foliar sprays at 30 and 45 DAT. Days to 50% flowering (46 d) and days to harvest (100.20 d) were found earlier in ajowan with the foliar applications of triacontanol by 5 ppm (T_{10}).The same treatment had recorded the maximum number of umbellate umbel^{-1}(14.20). Foliar applications of thiourea by 250 ppm (T_5) had record the highest values with respect to yield, yield attributing characters *viz* number of umbels plant^{-1}(228.70), number of seeds umbel^{-1}(183.60), number of seeds umbellate^{-1}(13.50), test weight (1.56 g), seed yield plant^{-1} (28.50 g), seed yield plot^{-1} (1425 g), seed yield hectare^{-1}(1583.33 kg), harvest index (69.71%) and quality parameters *viz* essential oil (3.64%) and protein contents (19.26 mg 100 g^{-1}).

Keywords: Ajowan; essential oil; growth regulators; protein content; seed yield hectare-1; test weight.

**Corresponding author: E-mail: rajasekharreddyyarramreddy@gmail.com;*

1. INTRODUCTION

Ajowan or Bishop's weed (*Trachyspermum ammi L*. Sprague) is an annual herb; it belongs to the family Apiaceae. During the rabi season, it is a significant seed spice growed for seeds in rainfed vertisols in Andhra Pradesh. The crop must live with residual soil moisture content throughout the cropping period, and it frequently suffers from terminal moisture stress, resulting in low yield. This is the main constraint for ajowan production in Andhra Pradesh. [1]. Because of its distinctive herbal scent and pungent flavor, ajowan seeds are used as a seasoning. It's used as an antioxidant and a preservative in confectionary, drinks, and pan mixtures, and it's used in small amounts for flavoring food. Ajowan seeds are used as a household remedy for indigestion [2].

Plant growth hormones (PGRs) have great potential in increasing the production of horticultural crops by eliminating the many barriers executed either through genetical meansor through environmental factors. Plant hormones are essential in reducing stress and increasing flower bud initiation. Exogenous PGR application has been shown to increase crop growth and yield in a variety of crops. [3]. The main purpose of this study is to increase the seed yield by using plant growth hormones.

2. MATERIALS AND METHODS

During the Rabi 2018-2019 season, a field experiment was conducted at the College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari District, Andhra Pradesh. The soil of experimental field was red sandy loam in texture, having a pH of 6.5, available N (186 Kg ha^{-1}) is low, available P (32.5 Kg ha^{-1}) is medium, and available K (218 Kg ha^{-1}) is high. The experiment was laid out in a randomised block design with three replications and eleven treatments (including control (water spray) two concentrations each of NAA(50 and 100 ppm), GA_3(50 and 100 ppm), Thiourea (250 and 500 ppm), Triacontanol (2.5 and 5 ppm) and 28-Homobrassinolide(0.1 and 0.2 ppm)) and each replicated thrice. The treatments were imposed at 30 and 45 DAT as foliar spray. The crop was harvested after need-based cultural operations and plant protection measures were implemented. Five plants in each treatment and in each replication were selected at random to record the data at harvest on yield and quality attributing *viz* number of umbels $plant^{-1}$, number of umbellates $umbel^{-1}$, seed yield $plant^{-1}$, $plot^{-1}$ and $hectare^{-1}$. The essential oil content in ajowan seeds was estimated by steam distillation method and the protein content in ajowan seeds was estimated by Lowry's method [4]. The data recorded on yield, yield parameters and quality attributing characters in ajowan was tabulated and were statistically analysed by analysis of variance method as per the procedures out lined by Panse & Sukhatme [5].

3. RESULTS AND DISCUSSION

3.1 Days to 50% Flowering (d)

Table 1 shows the data on number of days to 50% flowering. Significant results were observed among the treatments for number of days taken to 50% flowering. The number of days taken to 50% flowering was (46.00 d) less in T_{10} treatment (Triacontanol by 5 ppm) which was on par (46.50 d) with T_4 (GA_3 by 100 ppm) treatment and it was significantly inferior (48d) to T_8 (28 homobrassinolide by 0.2 ppm) treatment. The number of days to 50% flowering was more (57 d) in T_1 (NAA by 50 ppm) treatment [2].

Application of TRIA and GA had results in early flowering it could be due to their influence on photo-morphogenetic effect. Similar results were reported by Sarada et al. [1] in coriander.

3.2 Days to Harvest (d)

For number of days to harvest in ajowan crop non significant results were found among the treatments.

3.3 Number of Umbels $Plant^{-1}$

The data on number of umbels $plant^{-1}$ was shown in table 1.Significant results were noticed among the treatments for number of umbels $plant^{-1}$. In between the growth regulating chemical sprays, foliar spray of thiourea by 250 ppm (T_5) had recorded the highest number of umbels $plant^{-1}$(228.70) and which was considerably (189.00) superior to T_{10} treatment (foliar spray of triacontanol by 5 ppm). Control (T_{11}) had recorded the lowest (113.50) number of umbels $plant^{-1}$.

The increase in number of umbels $plant^{-1}$ was observed with foliar sprays of thiourea by 250 ppm and triacontanol by 5 ppm could be attributed to enhance the number of primary and secondary branches $plant^{-1}$ and also due to rapid differentiation of inflorescence meristems into floral meristems by abundant supply of nutrients and assimilates to inflorescence meristems. The present results are in confirm with the findings of Balai and Keshwa [6], Balai [7], Meena et al. [8] and Singh et al. [9] in coriander. Nehara et al.[10] and Bochalia et al. [11] in fenugreek.

3.4 Number of Umbellates Umbel^{-1}

Table 1 displays the details on the number of umbellates umbel^{-1}. There were significant differences in the number of umbellate umbel-1 among the growth regulator sprays. Foliar spray of triacontanol by 5 ppm (T_{10}) had recorded the maximum (14.20) number of umbellate umbel^{-1}, which was on par with T_5(13.60) treatment (foliar spray of thiourea by 250 ppm), T_8(13.30) treatment (foliar spray of $^{-1}$ homobrassinolide by 0.2 ppm), T_6(12.80)treatment (foliar spray of thiourea by 500 ppm), T_9(12.40)treatment (foliar spray of triacontinol by 2.5 ppm), T_7(12.00)treatment (foliar spray of homobrassinolide by 0.1 ppm as foliar spray) and T_2(11.90)treatment (foliar spray of NAA by 100 ppm) but it was significantly superior to T_1(11.70)treatment (foliar spray of NAA by 50 ppm).The minimum (10.30)number of umbellate umbel^{-1}were noticed in T_4treatment (foliar spray of (GA_3 by 100 ppm).

The presence of high total chlorophyll content in leaves (3.97mg g^{-1}FW) was responsible for more photosynthetic activity, more drymatter production (95.21g plant-1) and better partitioning of drymatter into sink organs, which resulted in the production of more umbellates umbelafter application of traiacontanol @ 5ppm as foliar spray. Sarada et al. [1] expressed a similar perspective in the case of coriander [2].

3.5 Number of Seeds Umbel^{-1}

The data on number of seeds umbel^{-1}was shown in Table 1. Significant differences were existed among different growth regulator treatments for number of seeds umbel^{-1}. Foliar spray of thiourea by 250 ppm (T_5) had recorded the highest (183.60) number of seeds umbel^{-1}, which was on par with T_{10}(176.08) foliar spray of triacontinol by 5 ppm and T_8 (162.26) treatments foliar spray of homobrassinolide by 0.2 ppm but it was significantly superior to T_6(153.60) treatment (foliar spray of thiourea by 500 ppm).The minimum(100.94) number of seeds umbel^{-1} were observed in T_4treatment(foliar spray of GA_3 by 100 ppm).

3.6 Number of Seeds Umbellate^{-1}

Table 1 shows the details on the number of seeds umbellate-1. For the number of seeds umbellate^{-1}, the differences between the growth regulator treatments were found to be significant. Foliar sprays of thiourea by 250 ppm (T_5) had registered the maximum (13.50)number of seeds umbellate^{-1}, which was on par with T_{10}(12.40) treatment(foliar spray of triacontinol by 5 ppm), T_9(12.00)treatment (foliar spray of triacontinol by 2.5 ppm), T_8(12.20) treatment (foliar spray of homobrassinolide by 0.2 ppm), T_6(12.00) treatment (foliar spray of thiourea by 500 ppm), T_7(11.90) treatment (foliar spray of homobrassinolide by 0.1 ppm), T_2(11.80) treatment (foliar spray of NAA by 100ppm) and T_1(11.70) treatments (foliar spray of NAA by 50 ppm), but it was significantly superior to T_{11}(11.00) treatment (control). The minimum(9.40) number of seeds umbellate^{-1} were noticed in T_4 treatment (foliar spray of GA_3 by 100 ppm).

The number of seeds umbel^{-1} and umbellate^{-1} were high in plants sprayed with thiourea by 250 ppm might be due to production of more (228.70) number of umbels plant^{-1}.

3.7 Seed Yield Plant^{-1} (g)

The data on seed yield plant^{-1}was shown in Table 2. Application of different growth regulators as foliar spray had shown significant influence on seed yield plant^{-1}. Application of thiourea by 250 ppm asfoliar spray (T_5) had resulted in highest seed yield plant^{-1}(28.50 g) which was on par with T_{10}(26.00 g) treatment (foliar spray of triacontinol by 5 ppm) andT_8 (24.50g) treatments (foliar spray of homobrassinolide by 0.2 ppm) but it was significantly superior to T_6(23.50 g) treatment (foliar spray of thiourea by 500 ppm). The seed yield plant^{-1}(11.50 g) was lowest in T_4 treatment (foliar spray of GA_3 by 100 ppm).

Foliar spray of thiourea by 250 ppm had increased the number of primary branches (15.03) and secondary branches (83.40) plant^{-1}and total chlorophyll content (1.87mgg^{-1}) in leaves could be due to an increase in root expansion which leads to an increase in uptake of more water and nutrients from the soil and it also involved in nitrogen metabolism which had results in structural buildup of the plant. Thiourea was also responsible for improvement in gaseous exchange thereby improved the photosynthetic activity as indicated by an

Table 1. Effect of foliar sprays of plant growth regulators on number of days to 50% flowering, days to harvest and yield components in Ajowan

Treatments	Number of Days to 50%flowering	Number of Days to harvest	Number of umbels plant^{-1}	Number of umbellates umbel^{-1}	Number of seeds umbellate^{-1}	Number of seeds umbel^{-1}
T_1: Application of NAA @ 50 ppm as foliar spray at 30 and 45 DAT	57.00	115.00	141.10	11.70	11.70	136.89
T_2: Application of NAA @ 100 ppm as foliar spray at 30 and 45 DAT	56.50	113.00	144.90	11.90	11.80	140.42
T_3: Application of GA_3 @ 50 ppm as foliar spray at 30 and 45 DAT	49.00	104.00	138.60	11.50	10.90	125.35
T_4: Application of GA3 @ 100 ppm as foliar spray at 30 and 45 DAT	46.50	102.00	135.20	10.30	9.80	100.94
T_5: Application of Thiourea @ 250 ppm as foliar spray at 30 and 45 DAT	55.10	112.30	228.70	13.60	13.50	183.60
T_6: Application of Thiourea @ 500 ppm as foliar spray at 30 and 45 DAT	53.60	109.00	163.90	12.80	12.00	153.60
T_7: Application of 28 HB @ 0.1 ppm as foliar spray at 30 and 45 DAT	52.00	108.00	152.60	12.00	11.90	142.80
T_8: Application of HB @ 0.2 ppm as foliar spray at 30 and 45 DAT	48.00	103.50	176.00	13.30	12.20	162.26
T_9: Application of TRIA @ 2.5 ppm as foliar spray at 30 and 45 DAT	51.50	106.00	155.80	12.40	12.00	148.80
T_{10}: Application of TRIA @ 5 ppm as foliar spray at 30 and 45 DAT	46.00	100.20	189.00	14.20	12.40	176.08
T_{11}:Control (Foliar spray of water at 30 and 45DAT)	54.50	111.00	113.50	11.60	11.00	127.60
Mean	51.79	107.64	158.12	12.30	11.75	145.30
S Em	3.53	7.37	10.97	0.83	0.79	9.81
CD (0.05)	10.42	NS	32.37	2.47	2.35	28.95

NAA: Naphthelene Acetic Acid, GA3: Gibberellic acid, 28 HB: 28 Homobrassinolid, TRIA: Triacontanol

Table 2. Effect of foliar sprays of plant growth regulators on seed yield and quality parameters in Ajowan

Treatments	Seed yield Plant^{-1} (g)	Seed yield Plot^{-1} (g)	Seed yield Hectare^{-1} (Kg)	Test weight (g)	Harvest Index (%)	Essential oil (%)	Protein (mg/g)
T_1: Application of NAA @ 50 ppm as foliar spray at 30 and 45 DAT	19.50	975	1083.33	0.93	52.35	3.08	17.64
T_2: Application of NAA @ 100 ppm as foliar spray at 30 and 45 DAT	20.00	1000	1111.11	0.95	52.35	3.10	18.03
T_3: Application of GA_3 @ 50 ppm as foliar spray at 30 and 45 DAT	16.50	825	916.67	0.87	39.53	2.86	16.43
T_4: Application of GA3 @ 100 ppm as foliar spray at 30 and 45 DAT	11.50	575	638.89	0.8	37.93	2.61	15.42
T_5: Application of Thiourea @ 250 ppm as foliar spray at 30 and 45 DAT	28.50	1425	1583.33	1.56	69.71	3.64	19.26
T_6: Application of Thiourea @ 500 ppm as foliar spray at 30 and 45 DAT	23.50	1175	1305.56	1.06	58.43	3.28	18.76
T_7: Application of 28 HB @ 0.1 ppm as foliar spray at 30 and 45 DAT	21.50	1075	1194.44	0.96	54.63	3.15	18.24
T_8: Application of HB @ 0.2 ppm as foliar spray at 30 and 45 DAT	24.50	1225	1361.11	1.09	63.28	3.37	18.97
T_9: Application of TRIA @ 2.5 ppm as foliar spray at 30 and 45 DAT	21.50	1075	1194.44	1.05	55.86	3.19	18.4
T_{10}: Application of TRIA @ 5 ppm as foliar spray at 30 and 45 DAT	26.00	1300	1444.44	1.14	69.41	3.42	19.12
T_{11}:Control (Foliar spray of water at 30 and 45DAT)	17.00	850	944.44	0.89	51.08	2.94	16.81
Mean	20.91	1045.45	1161.62	1.03	54.96	3.28	18.76
S Em	1.38	69.38	77.09	0.07	3.78	0.21	1.23
CD (0.05)	4.09	204.69	227.44	0.22	11.15	0.64	3.64

NAA: Naphthelene Acetic Acid, GA3: Gibberellic acid, 28 HB: 28 Homobrassinolid, TRIA: Triacontanol increase in drymatter production plant^{-1}(103.54g) and better partitioning of dry matter into reproductive sinks helps to an increase in number of umbellate umbel^{-1} (14.20), number of umbels plant^{-1} (228.70), number of seeds umbel^{-1} (183.60) and number seeds umbellate^{-1} (13.50) which ultimately increased the seed yield plant^{-1}. Additionally, the involvement of SH group present in thiourea in active accumulation and phloem transport of sucrose into reproductive sinks may also play an important role in increasing the seed yield plant^{-1} as earlier reported by Giaguinta [12]. The results are in consent with the findings of Nehara et al.[10] in fenugreek. Balai [7], Balai and Keshwa [6], Meena et al. [8], and Singh et al. [9] in coriander. Garg et al. (2006) in clusterbean. Application of GA_3 @ 100 ppm had showed an inhibitory effect on number of branches plant^{-1}(primary and secondary), chlorophyll content, dry matter production and partitioning of dry matter into reproductive sinks i.e. umbellates umbel^{-1}, number of umbels plant^{-1}, number of seeds umbellate^{-1} and umbel^{-1} and finally the seed yield plant^{-1}. It might be due to utilization of photoassimilates more in cell division and cell elongation activities in apical meristem than the meristamatic tissue present in axillary buds.

3.8 Seed Yield Plot^{-1} (g)

The data on seed yield plot^{-1}was shown in Table 2.The differences among the treatments for seed yield plot^{-1} was found significant. Foliar sprays of thiourea by 250 ppm (T_5) had registered the maximum seed yield plot^{-1}(1425 g) which was on par with T_{10} (1300.00 g) (foliar spray of triacontinol by 5 ppm) andT_8 (1225.00 g) treatments (foliar spray of homobrassinolide by 0.2 ppm), but it was significantly superior to T_6 (1175.00 g)treatment (foliar spray of thiourea by 500 ppm). The minimum seed yield plot^{-1}(575.00 g) was noticed in T_4 treatment (foliar spray of GA_3 by 100 ppm).

The increase in seed yield plot^{-1} might be due to corresponding increase in number of umbellate umbel^{-1}, number of umbels plant^{-1}, number of seeds umbellate^{-1} and number of seeds umbel^{-1} and finally the seed yield plant^{-1}.

3.9 Seed Yield Hectare^{-1}(Kgha^{-1})

The data on seed yield hectare^{-1}was shown in Table 2.Significant differences were observed among the treatments for seed yield hectare^{-1}. Foliar sprays of thiourea by 250 ppm (T_5) had recorded the maximum seed yield hectare^{-1}(1583.33 kgha^{-1}) which was on par with T_{10}(1444.44 kgha^{-1}) (foliar spray of triacontinol by 5 ppm) and T_8(1361.11 kgha^{-1}) treatments (foliar spray of homobrassinolide by 0.2 ppm) but it was significantly superior to T_6(1305.56 kgha^{-1}) treatment (foliar spray of thiourea by 500 ppm). The seed yield hectare^{-1} was minimum (638.89 kg) in T_4 treatment (foliar spray of GA_3 by 100 ppm).

The increase in seed yield hectare^{-1}with the application of thiourea by 250 ppm as foliar spray might be due to corresponding increase in seed yield plant^{-1}and seed yield plot^{-1}. The results are incorroborate with the findings of Gupta and Yadav [13] in fenugreek, Shanuet al. [14]; Singh et al. [9] in coriander and Chowdary et al. [15] in ajowan.

3.10 Test Weight (1000 seeds) (g)

Table 2 shows the details on the test weight for the test weight, the differences between the growth regulator treatments were found to be significant. Foliar sprays of thiourea by 250 ppm (T_5) had registered the maximum test weight (1.56 g), followed by T_{10} (1.14 g) treatment (foliar spray of triacontinol by 5 ppm). Minimum test weight (0.80 g) was recorded in T_4 treatment (foliar spray of GA_3 by 100 ppm). It could be attributed to the better partitioning of dry matter into the reproductive sinks. The sulphydryl group present in thiourea might have improved the activity of starch synthase enzyme and helps in effective filling of seeds as earlier reported by Gupta and Yadav [13] in fenugreek. The results are in consent with the findings of Sumeria [16] in mustard, Bochalia et al. [11] in fenugreek, Singh et al. [9] in coriander and Choudary et al. [15] in ajowan.

3.11 Harvest Index

The data on harvest index was shown in Table 2.The application of plant growth regulators as foliar sprays in ajowan showed significant influence on harvest index. Application of thiourea by 250 ppm as foliar spray (T_5) had registered the maximum harvest index (69.71) which was on par with T_{10}(69.41) (foliar spray of triacontanol by 5 ppm) and T_8 (63.28) treatments (foliar spray of homobrassinolide by 0.2 ppm), but it was significantly superior to T_6(58.43) treatment (foliar spray of thiourea by 500 ppm). Minimum harvest index (37.93) was noticed in T_4 treatment (foliar spray of GA_3 by 100 ppm). The results are in agreement with the findings of Shanu et al. [14] in coriander.

3.12 Essential Oil Content (%)

The data on essential oil content was shown in Table 2 significant differences were found among the growth regulator sprays with respect to essential oil content. Application of thiourea by 250 ppm as foliar spray (T_5) had recorded the maximum essential oil (3.64%) content in ajowan seeds, which was on par with T_{10} (3.42%) foliar spray of triacontinol by 5 ppm, T_8 (3.37%) (foliar spray of homobrassinolide by 0.2 ppm), T_6 (3.28%) treatment (foliar spray of thiourea by 500 ppm), T_9 (3.19%) (foliar spray of triacontinol by 2.5 ppm) treatment, T_7 (3.15%) (foliar spray of homobrassinolide by 0.1 ppm) treatment, T_2 (3.10%) (foliar spray of NAA by 100 ppm) and T_1 (3.08%) treatment (foliar spray of NAA by 50 ppm) but it was significantly superior to (T_{11}) control (2.94%) treatment. The essential oil content was minimum in T_4 (2.61%) treatment (foliar spray of GA_3 by 100 ppm). In biological reactions thiourea molecule is a good donor of sulphur atoms as reported by Randle and Bussard [17]. Nitrogen and sulphur present in thiourea play an important role in protein synthesis and enhancing the carbohydrate and also activate various enzymes involved in essential oil synthesis as earlier reported by Kumar et al. [18]. The results are in agreement with the findings of Balai [7], Balai and Keshwa [6], Meenaet al. [8] and Singh et al. [9] in coriander.

3.13 Protein Content (mg100 g^{-1})

Table 2 shows the details on protein content. The differences between the growth regulator treatments were found to be significant. Foliar sprays of thiourea by 250 ppm (T_5) had recorded the highest protein content in seeds (19.26 mg 100 g^{-1}) which was on par with T_{10} (19.12 mg 100 g^{-1}) (foliar spray of triacontinol by 5 ppm), T_8 (18.97 mg 100 g^{-1}) (foliar spray of homobrassinolide by 0.2 ppm), T_6 (18.76 mg 100 g^{-1}) (foliar spray of thiourea by 500 ppm), T_9 (18.40 mg 100 g^{-1}) (foliar spray of triacontinol by 2.5 ppm), T_7 (18.24 mg 100 g^{-1}) (foliar spray of homobrassinolide by 0.1 ppm), T_2 (18.03 mg 100 g^{-1}) (foliar spray of NAA by 100 ppm), T_1 (17.64 mg 100 g^{-1}) (foliar spray of NAA by 50 ppm), T_{11} control (16.81 mg 100 g^{-1}) and T_3 (16.43 mg 100 g^{-1}) treatments (foliar spray of GA_3 by 50 ppm). Minimum protein content (15.42 mg 100 g^{-1}) was noticed in T_4 treatment (foliar spray of GA_3 by 100 ppm) of ajowan seeds.

Application of thiourea had increased the seed protein content not only by increasing the uptake of nutrients (N, P, K and S) from the soil but also enhanced the nitrartereducatse activity, levels of free aminoacids and soluble proteins in the seeds as earlier reported by Garg et al. [19] in cluster bean and Premaradhya et al. [20] in lentil. The present results are in harmony with the findings of Balai and Keshwa [6], Meenaet al. [8], and Shanu et al. [9] in coriander.

4. CONCLUSION

In the present investigation it was concluded that foliar sprays of thiourea by 250 ppm and triacontanol by 5 ppm at 30 and 45 DAT had significantly influenced the yield, yield parameters and quality attributing characters in ajowan.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sarada C, Girdhar K, Reddy TV. Effect of bio-regulators and their time of application on growth and yield of coriander (*Coriandrum sativum L.*). J Spice Aro Crop.2008;17(2):183-86.
2. Reddy YR, Ramanandam G, Subbaramamma P, Dorajeerao AVD. Effect of foliar application of growth regulators on vegetative and physiological growth parameters in Ajowan (*Trachyspermum ammi L. Sprague*). Current Journal of Applied Science and Technology. 2020;39(29):100-109. Available:https://doi.org/10.9734/cjast/2020/v39i2930962
3. Bharud R W, Deore B P, Patil V A. Effectsof growth substances on the growthand yield of methi. J. Maharashtra Agril. Univ. 1988;13: 340–341.
4. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. Protein measurement with Folin-phenol reagent. J. Biol. Chem.1951; 193:276-75.
5. Panse V G &Sukhatmae P V Statistical methods for Agricultural workers. Ind Coun Agri Res, New Delhi:1995.

6. Balai LR, Keshwa GL. Effect of thiourea on yield and economics of coriander (*Coriandrum sativum* L.) varieties under normal and late sowing conditions. J Prog Agri. 2010;1(1): 52-55.
7. Balai LR. Effect of thiourea on growth and productivity of coriander (*Coriandrum sativum* L.) varieties under normal and late sown conditions. Ph.D. (Ag.) Thesis, Rajasthan Agricultural University,Bikaner:2005.
8. Meena SK, Effect of Plant Growth Regulators and Sulphur on Productivity of Coriander (*Coriandrum sativum* L.). M.Sc. (Ag.) Thesis, Swami Keshwanand Rajasthan Agri Uni,Bikaner:2011.
9. Singh R, Shivran A C, Bamboriya S D, Choudhary S. Influence of stress mitigating chemicals on growth, yield parameters and quality of coriander (*Coriandrum sativum* L.). Int J Chem Stud. 2017;5(6): 159- 61.
10. Nehara KC, Kumawat PD, Singh BP. Response of fenugreek (*Trigonellafoenum-graecum*) to phosphorus, sulphur and plant growth regulators under semi-arid eastern plains zone of Rajasthan. Ind J Agron. 2006;51(1): 73-76.
11. Bochalia GC, Tiwari R.C, Ram B, Kantwa SR, Choudhari AC. Response of fenugreek (*Trigonellafoenum-graecum*) genotypes to planting geometry, agro-chemicals and sulphur levels. Indian J Agro 2011;56(3): 273-79.
12. Giaquinta AT, Evidence of phloem loading from apoplast: chemical modification of membrane sulphydral groups. P physio. 1976;53: 872-75.
13. Gupta DK, Yadav SS. Response of fenugreek (*Trigonellafoenum-graecum*) to varying levels of sulphur and bio-regulators.Published by S.K.N. College of Agriculture in National Seminar on “Spices and Aromatic Plants in 21st Century India”, pp. 67:2009.
14. Shanu IS, Naruka P P, Singh R P S, Shaktawat, K S Verma. Effect of seed treatment and foliar spray of thiourea on growth, yield and quality of coriander (*Coriandrum sativum* L.) under different irrigation levels. Int J. Seed Spic.2013;3(1) : 20-25.
15. Choudhary S. Effect of nitrogen and plant growth regulators on growth and productivity of ajwain (*TrachyspermumAmmi*L.) M.Sc. (Agri.) Thesis, Sri Karan Narendra Agri Uni, Jobner:2017.
16. Sumeria H K. Response of mustard (*Brassica Juncea*L.)to phosphorus, triacontanol granule and growth promoters, Agri Sci Digest.2003;23(2): 134 - 36.
17. Randle WM, Bussard ML Pungency and sugars of short day onions as affected by S nutrition J Amer Horti Sci.1993;118 (6): 766-70.
18. Kumar N, Khadar JMA, Rangaswami P, Irulappan I. Introduction to spices, plantation crops, medicinal and aromatic plants. Oxford and IBH publishing company PVT. LTD., New delhi: 2010.
19. Garg BK, Burman U, Kathju S. Influence of thiourea on photosynthesis, nitrogen metabolisam and yield of clusterbean (*cymopsistetragonoloba*L.) under rainfed condition of Indian arid zone. P grow regul. 2006;48: 237-45.
20. Premaradhya N, Shashidhar K S, Jeberson S, Krishnappa R, Singh N. Effect and profitability of foliar application of thiourea on growth and yield attributes of lentil (*lens culinaris* L.) under Manipur conditions of north-east, India, Inter J Curr micro and applied sci:2018;7(5): 1040-50.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/71354