



Impact of Cutting the Growing Apex and Nitrogen Fertilizer on the Growth and Yield of Brussels Sprout (*Brassica oleracea* var. *gemmifera*)

Kahlada A. Omar¹, Abdulah M.S. AL-Dabbagh¹,
Zina Mohammed Sarhan², Abdelmonnem S. Kahlel³

10.18805/ag.DF-710

ABSTRACT

Background: In Brussels sprouts, the number of buds along the stem can be increased by cutting the growing apex process, which stimulates the formation of lateral buds and increases plant yield and total yield.

Methods: An experiment was conducted in the Horticulture and Landscape Department/College of Agriculture and Forestry/ University of Mosul/Iraq during the 2020-2021 season to investigate the impact of cutting vis a vis no cutting of the growing apex and adding nitrogen fertilizer (urea 46% N), with four levels (0, 50, 75 and 100) kg N. Ha⁻¹ on growth and yield of Brussels sprout. The study was conducted in a factorial experiment in RCBD design, with three replicates.

Result: The results showed that the treatment of cutting the growing apex increased the total weight of heads per plant, head length, dry matter percentage and protein percentage. While the treatment without cutting the growing apex increased plant length, leaf number and leaf area of plant. Also, the nitrogen fertilizer gave a significant increase for all parameters compared to the control (0 nitrogen) and the highest values were from adding 100 Kg. N. Ha⁻¹ which reached 87.917 SPAD for Chlorophyll, 3624.3 cm² for plant leaf area, 482.37 g. for total weight of head per plant, 195.33 for number of heads per plant, 3.65% for nitrogen and 22.812% for protein in head. The interaction treatments between cutting the growing apex and nitrogen fertilizer gave a significant difference for many parameters.

Key words: Brussels sprout, Chlorophyll, Growing apex, Nitrogen, Protean.

INTRODUCTION

Brussels sprout (*Brassica oleracea* var. *gemmifera*) is one of the cruciferous family plants. It is an annual plant considered a nutritional and economic value vegetable. The part that is eaten is the sprout, which grows on the main stem under the leaves. Likewise, the rosette leaves can be eaten after cutting (Combs and Ernst, 2019). It contains vitamin A and C, iron, calcium, thiamine, niacin, riboflavin, high centralizations or concentrations of carotenoids and natural sulfur phytochemicals that increase their cancer prevention agent limit. It is rich in chlorophyll, glycosinolates, sulfuric substances and other compounds that give it a sharp taste (Natasa, 2006). In Iraq, Brussels sprouts are not grown, except for scientific research purposes, while it is widely cultivated in Europe, especially England and France, as well as in America, Canada, Australia and Japan (Turan *et al.*, 2009).

Plant growth is affected by several environmental factors, such as temperature, humidity, nutrition, *etc.* The nutrition factor, especially the nitrogen element, has a major role in plant growth, as the plant needs it in large quantities during the growth stage, bud formation and yield increase (Williams *et al.*, 1996; Al-Silmawy and Abdul-Ratha, 2023) and the amount added depends on weather conditions, soil type and fertility, in addition, it's content of mineral (Omar, 2017; Abo Al Maged, 2019; Booi, 2000). Saud *et al.* (2016)

¹Department of Hort. and Landscape/College of Agriculture and Forestry/Univ. of Mosul/Iraq.

²Department of Plant Protection, College of Agricultural Engineering Sciences, University of Baghdad, Iraq.

³Department of Plant Production, Technical Agric. College. Mosul/Iraq.

Corresponding Author: Abdelmonnem S. Kahlel, Department of Plant Production, Technical Agric. College. Mosul/Iraq.

Email: monnem1954@gmail.com

How to cite this article: Omar, K.A. Sarhan, Z.M., AL-Dabbagh, A.M.S. and Kahlel, A.S. (2025). Impact of Cutting the Growing Apex and Nitrogen Fertilizer on the Growth and Yield of Brussels Sprout (*Brassica oleracea* var. *gemmifera*). *Agricultural Science Digest*. 1-6. doi: 10.18805/ag.DF-710.

Submitted: 13-01-2025 **Accepted:** 12-07-2025 **Online:** 29-08-2025

found that application of nitrogen with 20,40,60,80,100 Kg/ N/Ha increased all growth and yield attributes of mustard. Al-Leela *et al.* (2019) revealed that the addition of urea fertilizer significantly improved head length, number of leaves per plant, stem length, the total weight of the head and total yield of the head in lettuce. Also, Al-Dabbagh *et al.* (2020) illustrated that spraying cabbage plants with mineral fertilizer (Agroleaf power), which contains 31% nitrogen, gave a significant superiority over the comparison treatment in the yield characteristics. Al-Dabbagh and Kahlel (2024)

found that spraying cabbage plants with nano NPK 20:20:20 increased vegetative growth and yield parameters compared to control.

A common technological practice in Brussels sprouts production is the removal of the apical plant apex before harvest by a few weeks to stimulate the development of lateral buds (sprouts) and increased yield. This practice essentially redirects the plant's energy from vertical growth to producing larger and more uniform sprouts. It is well-known that this measure positively influences the size of the sprouts (Jakopic *et al.*, 2016). In addition, the number of buds can be increased by cutting the growing apex process. Removing the growing top stimulates the formation of lateral buds. The results of previous studies indicated that it is possible to increase the productivity of some vegetable plants when removing the growing tops of the plants. It was found an increase in plant yield was found when removing the growing top and this was mentioned by (Sajjan *et al.*, 2002; Sailaja and Panchbhai, 2014 and Sideman *et al.*, 2023) .

Since no such study has been carried out on Brussels sprout in Iraq (Mosul) so far, it was undertaken to investigate the effect of urea and cutting the growing apex of the plant under the environmental conditions of Mosul city.

MATERIALS AND METHODS

The experiment was conducted in Horticulture and Landscape Department / College of Agriculture and Forestry / University of Mosul/Iraq to study the impact of cutting the growing apex vis a vis no cutting and adding nitrogen fertilizer (urea 46% N), with four levels (0, 50, 75 and 100) kg N per hectare in growth and yield of Brussels sprout.

The seeds of Brussels Sprout, Oliver variety, produced by Bejozaden Company, were planted on 1st September 2020, in germination trays filled with peat moss. When the seedlings reached the stage of 3-4 true leaves, they were transplanted into large plastic pots (35 cm in diameter and 30 cm in height), which were filled with soil mixed with organic fertilizer residues (remains from mushroom cultivation) at a ratio of 1:3. The cutting of the growing apex was at 15th Jan. 2021.

Nitrogen fertilizer was added in 2 batches, the first on 26 Dec. 2020 and the second on 26 Jan. 2021 (after one month between one batch and the next), with 1.43 gr. fertilizer for each pot for 50 kg N. ha⁻¹. Level, 2.5 gr. N for 75 kg N ha⁻¹ level and 2.90 gr. N for 100 kg N ha⁻¹ level.

The study was conducted in a factorial experiment in RCBD design with 8 treatments (2 × 4) and three replicates, with five plants for each experimental unit.

The following characteristic measurements were recorded:

1-Plant height (cm), 2-Number of leaves/plants, 3- Diameter of main stem mm/plant, 4-Total Chlorophyll in leaves (SPAD), 5-Leaf area of plant (cm²), 6-total weight of heads/plant (gm.), 7- Number of heads/plants, 8- Diameter of head (mm), 9- Length of head (cm), 10- The percentage

of dry matter in the leaves, 11-The percentage of elements (N, P, K) in heads, 12- Protein in green heads.

The calculated protein was according to the equation:

$$\text{Protein percentage} = \text{Percentage of nitrogen} \times 6.25.$$

The data were statistically analyzed and the means were tested according to Duncan's at the 0.05 level (Al-Rawi and Khalaf Allah, 2000).

RESULTS AND DISCUSSION

Data from Table 1 revealed that the treatment of cutting the growing apex caused a significant difference in the characteristics of plant height, number of leaves and leaf area. The highest mean value of plant height was 57.392 cm, from treatment without cutting the growing apex, while the lowest value was 27.125 cm, from cutting the growing apex. Similarly, the highest number of leaves per plant was 58.225, from the treatment without cutting the growing apex, compared to the lowest value, 26.750, from cutting the growing apex. Again, the highest value of leaf area of the plant was (4578.8 cm²) from treatment without cutting the growing apex, compared to the values when cutting the growing apex, which recorded 1505.4 cm². The treatment of cutting the growing apex had no significant effect on stem diameter (cm) and total chlorophyll in leaves (SPAD).

The addition of nitrogen fertilizer (urea), increased significantly all the studied traits compared to the control treatment (without adding nitrogen fertilizer).The highest values were 49.250 for plant height and 46.383 for leaves number, 21.117, for head diameter, 87.917 for chlorophyll and 3624.3 for leaf area from an additional 100 kg N/ha., while the lowest value was recorded from the control treatment which is 24.533 cm for plant height, 37.117 for leaves number per plant, 17.967 cm. for steam diameter, 29.217 SPAD for total chlorophyll and 2147.7 cm² for leaf area of plant.

The interaction treatments between cutting the growing apex and nitrogen fertilizer had significant differences in all the characteristics mentioned in Table (1). The interaction treatment of without cutting the growing apex and addition of 75 kg N/ha of urea fertilizer was superior in giving the highest plant height (68.50 cm) and highest stem diameter (22,100 mm). While the highest number of leaves (67,133), the highest percentage of chlorophyll (88,600 SPAD) and the highest leaf area (5733.9 cm²) were from the interaction treatment without cutting the growing apex and addition of 100 kg N/ha of urea fertilizer.

On the other hand, the lowest value of plant height was 18.767 cm., leaves number per plant 21.300, steam diameter 19.200 cm, total chlorophyll in leaves 28.267 SPAD and leaf area per plant 1211.0 cm² was from interaction treatment between cutting the growing apex and 0 kg N/ha of urea fertilizer.

This result is in harmony with (Abou El- Magd, 2019; Abou El- Magd *et al.*, 2019) in Brussels sprout and Patil *et al.* (2003) in Kohlrabi, who revealed that increasing nitrogen

fertilizer increased the vegetative growth parameters of plants. It is clear that the application of nitrogen plays an important role in cell division and enlargement and consequently in plant growth. Also, the nitrogen element may work to increase and activate the biochemical processes that increase plant growth, such as the synthesis of amino acids, which are the building blocks of proteins and enzymes and thus control all the important biological reactions that occur within the plant (Abou El- Magd *et al.*, 2019; Sadik *et al.*, 2016).

Nitrogen also enters into the composition of nucleic acids such as DNA and RNA, which are necessary for cell division (Williams *et al.*, 1996) and is involved in the construction of some growth regulators such as auxins

and gibberellins, which encourage cell division, cell elongation and increased plant height (Omar, 2017, Abou El- Magd, 2019).

The data presented in Table (2) revealed that the treatment of cutting the growing apex of the plant caused a significant difference in head weight and the length of heads, the values were (431.45 g and 4.022 cm.) compared to the not cutting the growing apex which gave 268.76 gr. and 2.903 respectively, while no significant effect showed in number of head per plant and head diameter.

The significant effect of cutting growing apex treatments in the values of some characteristics studied may be because any cutting of plant apex stimulates the growth of lateral buds, as the number of lateral buds increases and

Table 1: Impact of cutting the growing apex and nitrogen fertilizer on the growth parameters of Brussels sprout.

Treatments		Parameters				
		Plant length (cm.)	laves number	Stem diameter (cm.)	Total Chlorophyll in leaves (SPAD).	Leaf area of plant (cm ²)
Without cutting the growing apex	0	30.300b	52.933c	16.733c	30.167c	3084.3b
	50	64.633a	54.967bc	21.700a	67.567b	5496.2a
	75	68.500a	57.867b	22.100a	82.967a	4000.8b
	100	66.133a	67.133a	21.533a	88.600a	5733.9a
Cutting the growing apex	0	18.767c	21.300F	19.200b	28.267c	1211.0c
	50	28.833b	32.967b	21.300a	82.200a	1851.0c
	75	28.533b	27.100e	19.100b	87.500a	1444.7c
	100	32.367b	25.633ef	20.700ab	87.233a	1514.7c
Cutting the growing apex means	Without cutting	57.392a	58.225a	20.517a	71.300a	4578.8a
	Cutting the growing apex	27.125b	26.750b	20.075a	67.325a	1505.4b
Nitrogen means	0	24.533b	37.117c	17.967b	29.217c	2147.7b
	50	46.733a	43.967ab	21.500a	74.833b	3673.6a
	75	48.517a	42.483b	20.600a	85.233a	2722.7b
	100	49.250a	46.383a	21.117a	87.917a	3624.3a

Table 2: Impact of cutting the growing apex and nitrogen fertilizer in yield parameters of Brussels sprout.

Treatments		Total weight of heads/plant (g.)	Number of heads per plants	Head diameter (cm.)	Head length (cm.)
Without cutting the growing apex	0	48.03 g	60.67d	15.233b	1.877c
	50	275.45e	145.67c	19.33ab	3.187b
	75	400.47cd	200.33a	22.437a	3.220b
	100	351.08d	197.67ab	20.880a	3.330b
Cutting the growing apex	0	144.15f	86.33	14.780b	2.027c
	50	509.06b	182.00abc	21.720a	4.700a
	75	458.93bc	156.67bc	18.420ab	4.683a
	100	613.65a	193.00ab	20.593a	4.677a
Cutting the growing apex means	Without cutting the growing apex	268.76b	151.083a	19.471a	2.903b
	Cutting the growing apex	431.45a	154.500a	18.878a	4.022a
Nitrogen means	0	96.09c	73.50c	15.007b	1.952b
	50	392.26b	163.83b	20.527a	3.943a
	75	429.70b	178.50ab	20.428a	3.952a
	100	482.37a	195.33a	20.737a	4.003a

the nutritional status of the plant increases and the nutritional compounds go to the terminal bud directly (Sideman *et al.*, 2023) and this encourages the growth of these buds and since the nature of the growth of Brussels sprouts plants stems have short internodes and the lateral buds are close together, we found that these buds begin to form a group of leaves wrapped together instead of taking on elongation growth and begin to form small heads, which are a group of leaves wrapped together. (Jankovic *et al.*, 2016).

The nitrogen fertilizer treatments led to differences in all the characteristics mentioned in Table 2. The addition of nitrogen (50,75,100 kg N.) was significantly superior to the control (0 N) and the treatment of adding 100 kg N/ha was significantly superior in head weight per plant (482.37 g) and number of heads (195.33) compared to the rest fertilizer treatments. The same treatment was also significantly superior in head diameter (20.737 mm.) and length of the head (4.003 cm) compared to the control treatment only.

However, interaction treatments between cutting the growing apex and nitrogen fertilizer caused significant differences in all studied traits.

This result corresponds with (Abou El Magd, 2019), who found that a high level of nitrogen increased (head weight, head number, total sprout yield, head diameter and height). Kaur and Sharma 2018. Rai *et al.*, 2003 found that broccoli head yields were increased by increasing N levels; they added that the effect of N level on the yield of terminal curd was highly significant. Nitrogen plays a great role in photosynthesis and increases its products through plant tissues. in addition, chlorophyll A and B concentrations increased in leaf tissues by nitrogen increments.

Chlorophyll A and B are the major light-absorbing pigments of the plant leaves and play an important role in the metabolic activities in plant tissues, obtaining higher vegetative growth and dry matter accumulation. (20,21 Ridha *et al.*, 2020, AL-Zaidy and AL-Ubaidy. 2017, Dhatt *et al.*, 2023).

The interaction treatments of cutting growing apex with the addition of 100 kg. N/ha was superior in terms of head weight per plant (613.65 g.), the highest values of number of heads (200.35) and head diameter (22.437) was from interaction treatment between without cutting the growing apex and nitrogen fertilizer 75 kg N/ha, while the highest value of head length (4.700) was from interaction treatment of cutting the growing apex and nitrogen fertilizer 50 kg N/ha. The lowest values of head weight (48.03 g.), number of heads per plant (60.67) and head length (1.877 cm.) were recorded from interaction treatment without cutting the growing apex and 0 nitrogen.

Table 3 revealed the impact of cutting the growing apex and nitrogen fertilizer on some chemical properties of Brussels sprout. It was found that the non-cutting growing apex treatment led to a significant increase in the percentage of nitrogen (3.38%), percentage of potassium (3.975%), as well as the protean percentage (21.125%), but the phosphorus and dry matter percentage increased when cutting the growing apex and recorded (0.690%, 17.00%) respectively.

All nitrogen fertilizer treatments led to significant differences in the percentages of the studied traits except the dry matter percentage compared to the control treatment. The highest percentage of nitrogen and protein was from adding 100 kg N/ha and recorded (3.65%, 22.812%), with superior to other treatments. The treatment of adding 50 kg N/ha had a significant effect in increasing the percentage of phosphorus (0.3765%) and potassium (4.110%) compared to the rest fertilizer treatments.

In addition, the interaction treatments between the two factors created significant differences in the percentage of the studied traits and the highest value for nitrogen (4.30%) and protein (26.875 %) was from the non-cutting growing apex and the addition of 75 kg N/ha. The highest percentage of phosphorus (0.830%) was from cutting the growing apex with the addition of 50 kg N/ha. The non-cutting growing

Table 3: Impact of cutting the growing apex and nitrogen fertilizer on some chemical properties of Brussels sprout.

Treatments		N%	P%	K%	dry matter %	Protean%
Without cutting the growing apex	0	2.31f	0.610f	3.900b	13.46bc	14.437f
	50	3.29d	0.700c	4.300a	14.84abc	20.562d
	75	4.30a	0.690d	3.690b	12.78c	26.875a
	100	3.64b	0.680e	4.010b	13.16c	22.750b
Cutting the growing apex	0	1.69g	0.530h	2.290d	17.65a	10.562g
	50	3.36c	0.830a	3.920b	17.45a	21.000c
	75	2.83e	0.590g	2.940c	16.06ab	17.687e
	100	3.67b	0.810b	3.190c	16.85a	22.937b
Cutting the growing apex means	Without cutting the growing apex	3.38a	0.670b	3.975a	13.56b	21.125a
	Cutting the growing apex	2.88b	0.690a	3.085b	17.00a	18.000b
Nitrogen means	0	2.00d	0.570d	3.095c	15.15a	12.500d
	50	3.32c	0.765a	4.110a	16.15a	20.750c
	75	3.56b	0.640c	3.315c	14.42a	22.250b
	100	3.65a	0.745b	3.600b	15.00a	22.812a

apex treatment with the addition of 50 kg N/ha led to the highest percentage of potassium (4,300%) and the highest percentage of dry matter (17.65%) was from cutting the growing apex with 0 addition of nitrogen.

While the lowest value of nitrogen (1.69%), phosphorus (0.530%), potassium (2.290%) and protein (10.562%) were from interaction treatment between cutting the growing apex and 0 nitrogen, the lowest percentage of dry matter (12.78%) was from interaction treatment between without cutting the growing apex and 75 nitrogen's.

CONCLUSION

From the results, it can be concluded that the treatment of cutting the growing apex increased the total weight of heads per plant, head length, dry matter percentage and protein percentage. While the treatment without cutting the growing apex increased plant length, leaf number and leaf area of plant. Also, the nitrogen fertilizer gave a significant increase for all parameters compared to the control (0 nitrogen) and the highest values were from adding 100 Kg. N. Ha⁻¹.

ACKNOWLEDGEMENT

We extend our thanks and appreciation to the presidency of the Horticulture and Landscape Design Department, Deanship of the College of Agriculture and Forestry/ University of Mosul, for providing research requirements and continuous support for us that helped us to complete this research.

Conflict of interest

????

REFERENCES

- Abou El Magd, M.M. (2019). Effect of planting times and nitrogen fertilization on the vegetative growth, total yield and quality of Brussels sprouts. *Middle East Journal of Applied Sciences*. **9(2)**: 610-621.
- Abou El-Magd, M.M., Zaki, M.F., Abo Sedera, S.A. and Hamouda, H.A. (2019). Application of some bio-stimulants combined with mineral nitrogen fertilizer for enhancing growth, yield and quality of Brussels sprouts. *Middle East Journal of Agriculture Research*. **8(2)**: 482-494.
- AL-Dabbagh, A.M.S. and Kahlel, A.S. (2024). Response of Red Cabbage (*Brassica oleracea* var. capitata) to Nano Fertilizers and Application Methods AIP Conf. Proc. 3092, 070007.
- Al-Leela, W.B., AL-Bayati, H.J.M., Fadel, F.R. (2019). Effect of intercropping and ground adding of seaweed extracts on the growth and yield of lettuce plant (*Lactuca sativus* L.). *Euphrates Journal of Agriculture Science*. **11(3)**: 98- 105.
- Al-Dabbagh1, A.M.S. Al-Khashab, S.M.S. and Sulieman, M.S. (2020). Effect of ground addition of humic acid and foliar spraying of organic extract fylloton, mineral fertilizers Agroleaf power on the growth and yield of cabbage. *Plant Archives*. **20(1)**: 2543-2549.
- Al-Rawi, K.M. and Khalaf Allah, M.A.M. (2000). Design and analysis of agricultural experiments. Faculty of Agriculture, University of Al Mosul, Mosul, Iraq.
- Al-Silmawy, N.A. and Abdul-Ratha, H.A. (2023). Effect of biofertilizer, vermicompost and phosphate fertilizer on growth and yield of cauliflower (*Brassica oleracea* Var botrytis). *Iraqi Journal of Agricultural Sciences*. **54(2)**: 505- 515.
- AL-Zaidy tand AL-Ubaidy. (2017). Effect of adding wheat peat and spraying with its extract and organic nutrient vegetation on the growth and yield of red cabbage. *The Iraqi Journal of Agricultural Sciences*. **48(2)**: 429-438.
- Booij, R. (2000). Effect of nitrogen on yield component of Brussels sprouts (*Brassica oleracea* var. *gemmifera*). *Gartenbauwissenschaft*. **65(1)**: 30-34.
- Combs, M.H., Ernst, M. (2019). Brussels sprouts. University of Kentucky Center for Crop Diversification Crop Profile CCD-CP89. <https://www.uky.edu/ccd/production/crop-resources/vegetables/Brussels-sprouts>.
- Dhatt, J.S., Singh, K., Kaur, H. and Hundal, S.S. (2023). Efficient utilization of paddy straw and sugarcane bagasse through vermicomposting and its impact on growth, yield and quality of broccoli [*Brassica oleracea* (var.) *italica*]. *Agricultural Science Digest*. **43(6)**: 802-806. doi: 10.18805/ag.D-5316.
- Jakopic, J., Weber, N., Cunja, V., Veberic, R., Slatnar, A. (2016). Brussels sprout decapitation yields larger sprouts of superior quality. *J. Agric Food Chem*. **64**: 7459-7465.
- Kaur, G. and Sharma, M. (2018). Effect of nitrogen doses and intercrops on growth and yield of broccoli (*Brassica oleracea* L. var. *italica*). *Indian Journal of Agricultural Research*. **52(5)**: 566-570. doi: 10.18805/IJARE.A-5058.
- Natasa, M.S. (2006). Influence of the planting dates on chemical components and yield of Brussels sprouts (*Brassica oleracea* L. *germifera*). *Acta Agriculture Scrbica*. **21**: 53-61.
- Omar, S.J. (2017). Effect of different manures on the growth, yield and quality of two Brussels sprouts *Brassica oleracea* var. *gummier* hybrids. *Euphrates Journal of Agriculture Science*. **9(4)**: 26- 41.
- Patil, B.N., Ingle, V.G. and Patil, SS. (2003). Effect of spacing and nitrogen levels on growth and yield of Knolkhol (*Brassica oleracea* var. *Caulerpa*) cv. White Vienna. *Ann. Plant Physiol*. **17(2)**: 110-113.
- Rai, N., Patel, R.K. and Dongra, R. (2003). Effect of various spacing and fertilizer combinations on growth and yield of Knolkhol cv. White Vienna. *Agric. Sci. Digest*. **23(1)**: 41-43.
- Al-Ubaidy, R.M.A., Hussein, W.A. and Razzq, A.H.A. (2020). Response of growth and production of Brussels sprouts to different levels of nitrogen, phosphorus and potassium. *Indian Journal of Ecology*. **47**: 114-129.
- Sadik, S.K., Salman, A.D., Hussien, W.A. (2016). Response of two cabbage hybrids to spraying with Vegeamno and Alga-ton 20 and covered with Agral under a sustainable agriculture system. *Iraqi Journal of Agricultural Sciences*. **47(1)**: 303-310.
- Sailaja, S.M. and Panchali, D.M. (2014). Effect of pinching on growth and quality characters of China aster varieties. *The Asian Journal of Horticulture*. **9(1)**: 36-39.
- Sajjan, A.S., Shekar, A.M. and Bandana, V.P. (2002). Influence of apical pinching and fruit picking on growth and seed yield of okra. *Journal of Agriculture Science*. **15(2)**: 367-372.

- Saud, R.K., Singh, B.P. and Pannu, R.K. (2016). Effect of limited irrigation and nitrogen levels on growth, yield attributes and yield of Indian mustard (*Brassica juncea* L.). *Agriculture Science. Digest*. **36(2)**: 142-145. doi: 10.18805/asd.v36i2.10636.
- Sideman, R.G., Caterina, R. and Elisabeth, H. (2023). Brussels sprout cultivar performance and response to apical meristem removal. *Hort Technology*. **33(2)**: 193-202.
- Turan, M., Ataoglu, N., Genes, A. and Oztas, T. (2009). Yield and chemical composition of brussels sprout *Brassica oleracea* L. gemmifera as affected by boron management. *Hort Science*. **44(1)**: 176-182.
- Williams, C.M.J., Maier, N.A., Potter, M.J. and Collins, G.G. (1996). Effect of nitrogen and potassium on the yield and quality of irrigated brussels sprouts (*Brassica oleracea* L. gemmifera) Cv. Roger and Oliver grew up in South Australia. *Australian Journal of Experimental Agriculture*. **36(7)**: 877-886.