

Journal of Medicinal and Industrial Plants (MEDIP)

<http://medip.uokirkuk.edu.iq/index.php/medip>

Influence of sowing date and different chickpea varieties *Cicer arietinum* L. on seed yield and quality in different harvesting stages

Sumaya Ahmad Abdullah¹ Vian Dler Ali² Raad Husien Salih³ Sebar Dlawar Abdulazeez⁴
Sakar Assad Kakarash⁵

1, 3,4,5 Field crop and medicinal plant, College of Agriculture Engineering Science/ Salaheddin University, Iraq
2, Horticulture, College of Agriculture Engineering Science/ Salaheddin University, Iraq
sumaya.abdullah@su.edu.krd vian.ali1@su.edu.krd raad.salih@su.edu.krd sebar.abdulazeez@su.edu.krd

ABSTRACT

This study was carried out at Grdarasha field /Collage of Agricultural Engineering Science during 2023-2024. A factorial experiment based on randomized complete block design (RCBD), with three replicates, sowing dates (December 23th, 2023, January 17th, 2024 and February 11th, 2024), and three varieties of chickpea (Rafidain, Gab3 and TH85) were implemented. Gab3 produced the highest rates of plant height and no. of branches plant-1. The maximum rates of plant height were found in sowing at December 23th, the no. of branches plant-1 at sowing on February 11th and fresh pods plant-1 at January 17th. From the interaction between varieties and sowing dates was recorded the highest plant by Gab3 at December 23th and maximum no. of branches was recorded by Gab3 at sowing February 11th and no significant effect were recorded for other parameters. Weight of 100 seed produced the highest rate for Gab3 in physiological maturity and no. of seed pod-1 recorded by TH85 in full maturity stage. At sowing on December 23th produced the highest weight of 100 seed while, on January 17th gave the maximum rate of no. of seed pod- in both stages. The interaction between treatments most of parameters recorded the maximum rate by Gab3 at December 23th in physiological maturity and by TH85 at January 17th in full maturity. TH85 surpassed all varieties in the protein percentage and protein yield in both harvesting stages and these parameters gave different rates between sowing dates, also with interaction between treatments.

KEY WORDS:

Sowing date, Chickpea, Varieties, Yield components, Harvesting stages.

Received: 2/07/2024

Accepted: 12/05/2024

Available online:

30/09/2024

© 2023. This is an open access article under the CC by licenses <http://creativecommons.org/licenses/by/4.0>



تأثير موعد الزراعة وأصناف مختلفة من نبات الحمص *Cicer arietinum* L. على إنتاجية البذور وجودتها في مرحلتين من الحصاد المختلفة

سمية أحمد عبد الله¹، فيان دلير علي²، رعد حسين صالح³، سيبقر دلاور عبدالعزيز⁴، ساكار اسعد كاكاش رش⁵
^{1,3,4,5} قسم انتاج المحاصيل والنباتات الطبية / كلية علوم الهندسة الزراعية/ جامعة صلاح الدين/ أربيل/العراق
² قسم البستنة/ كلية علوم الهندسة الزراعية/ جامعة صلاح الدين/ أربيل/العراق

تمت هذه الدراسة في حقل كردة رشة / كلية الهندسة الزراعية خلال الفترة من ٢٠٢٣ إلى ٢٠٢٤. تمت تنفيذ تجربة عاملية بناءً على تصميم القطاعات الكاملة العشوائية، مع ثلاثة مكررات، ثلاثة مواعيد للزراعة (٢٣ ديسمبر ٢٠٢٣، ١٧ يناير ٢٠٢٤، و١١ فبراير ٢٠٢٤)، مع ثلاثة أصناف من الحمص (رافدين، جاب، و٨٥TH) استخدم في هذه التجربة. أظهرت النتائج ان الصنف جاب أعطى أعلى معدلات لارتفاع النبات وعدد الفروع لكل نبات. وقد وجد أعلى معدل لارتفاع النبات في تاريخ الزراعة ٢٣ ديسمبر، ولعدد الفروع لكل نبات في تاريخ الزراعة ١١ فبراير، وللقرون الطازجة لكل نبات في تاريخ الزراعة ١٧ يناير. وقد أظهر التداخل بين الأصناف و مواعيد أعلى ارتفاع للنبات للصنف جاب في ٢٣ ديسمبر، وأعلى عدد للفروع للصنف جاب في تاريخ الزراعة ١١ فبراير. وزن ١٠٠ حبة أظهرت أعلى معدل للصنف جاب في النضج الفسيولوجي، وسجل أعلى عدد الحبوب لكل قرنة للصنف ٨٥TH في مرحلة النضج الكامل. وفي تاريخ الزراعة ٢٣ ديسمبر، أظهر أعلى وزن لـ ١٠٠ حبة، بينما أعطى تاريخ الزراعة في ١٧ يناير أعلى معدل لعدد الحبوب لكل قرنة في كلتا المرحلتين. أظهر التداخل بين المعاملات أعلى معدل لصنف جاب بتاريخ ٢٣ ديسمبر في النضج الفسيولوجي، ول٨٥TH في ١٧ يناير للنضج الكامل. تفوق ٨٥TH على جميع الأصناف في نسبة البروتين وإنتاج البروتين في كلتا مرحلتين الحصاد، وأعطت هذه المعاملات معدلات مختلفة بين مواعيد الزراعة، بالإضافة إلى التفاعل بين المعاملات.

الكلمات المفتاحية: موعد الزراعة، الحمص، الأصناف، مكونات الحاصل، مراحل الحصاد.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) belongs to the family Fabaceae, it is a self-pollinated, diploid, annual grain legume crop is the most important food grain legume of South Asia and the third most important in the world after common bean and field pea (Kumari, 2023). In the 2021-2022 growing season, chickpea cultivation covered approximately 14.573 million hectares globally, India led the production with 10.984 million tons, accounting for 73% of the world's total chickpea output. Australia ranked second with 661 thousand tons, followed by Pakistan with 601 thousand tons (FAO, 2023).

Chickpea is a cheap and important source of protein for those people who cannot afford animal protein or who are largely vegetarian. It is also a good source of minerals (calcium, phosphorus, magnesium, zinc and iron), unsaturated fatty acids, fiber and β -carotene (Zhang et al., 2024).

A crop's growth, development, and yield can be accelerated by choosing the best sowing time and highly productive types. This is because sowing time affects a variety of climatic elements, including temperature, moisture content, and sunlight. Also, higher yields are produced by using suitable varieties and sowing at the right time. Yield loss in chickpea can vary between 30% and 60% depending on genotype, sowing time, location, and climatic conditions during sowing season (Goud and Karunakar, 2023).

Varoglu and Abak (2018) in their study about five different chickpea varieties with five different sowing dates, resulted that, the Sezenbey variety gave the maximum yield for normal years (10th December sowing) and arid years (30th October sowing) with 4050 kg/ha and 610 kg/ha, respectively. On the other hand, the Hasanbey variety had the lowest yield of 350 kg/ha and 110 kg/ha, respectively, in both years when sown on 20 the January.

Salih et al. (2018) studied different sowing dates (January 20, February 9, March 1, and March 21), and two cultivars of chickpea (Rafidain and Gab). They found that planting at January, 20 recorded the maximum rate of plant height, leaf area, leaf area index, dry matter, crop growth rate, number of primary branches plant-1, number of pod plant-1 and seed yield. As well as, sowing at March, 21 recorded the lowest of all above studied parameters. Also Gab variety superior the Rafidain variety in all characteristics studied except no. of seeds plant-1 and 100-seed weight. From the results of felid experiment consists of three cultivars (Himmat, Shulabh-45 and Chirag) and three dates of sowing November 5th, 15th and 25th, concluded that the cultivars Shulabh-45 with sowing on November 25th significantly increased the growth and yield parameters (Sandeep et al., 2023).

The aim of this study to response of different dates of sowing in relation to different varieties, so as to provide wider sowing period to the farmer for the sowing of chickpea with the highest productivity and seed quality of the best variety in different maturity stages.

MATERIALS AND METHODS

This experiment conducted at Grdarasha Research Field, Collage of Agricultural Engineering Sciences, Salahaddin University – Erbil to study the effect of three sowing dates and three chickpea varieties on seed yield and quality in two harvesting stages, during December 23th, 2023 to June 5th, 2024. Grdarasha Research Field is locating at 36. 40° N, 44.10° E and at an elevation 470m above sea level and it is about 5 km away from the city center. Representative air – dried soil sample was taken form field at the depth (0-30cm), then sieved with 2mm mesh and analyzed for some physical and chemical properties as shown in Table (1). Minimum and maximum temperature, relative moisture and the amount of rain fall of field in planting season are shown in Table (2).

Table 1. Some chemical and physical properties of the field soil of Grdarasha

Soil properties		Soil component
Particle size distribution (g kg ⁻¹)	Sand	384.75
	Slit	515.00
	Clay	100.25
Texture Class		Silty clay loam
pH		7.53
Electrical Conductivity (EC) ds m ⁻¹		0.38
Organic Matter (%)		0.91
Bulk density (Mg m ⁻³)		1.45
Total Nitrogen (N) ppm		89.17
Total Phosphor (P) ppm		5.36
Total Potassium (K) ppm		64.10

*Laboratory Soil and Water Sciences Department, College of the Agricultural Engineering Sciences, University of Duhok.

Table 2. Maximum and Minimum temperature, relative moisture and the amount of rain fall during the growing season

Months (2023_2024)	Air Temp. C°		Relative moisture %	Rainfall (mm)
	Minimum	Maximum		
December	8.7	17.55	68.2	46.5
January	7.2	14.45	72.6	66
February	6.9	15.4	64.9	116.8
March	9.6	19.52	113.7	71.0
April	16.65	28.9	39.5	67.0
May	19.4	3.55	34.45	46
June	28.25	41.2	13.35	

*Data source: Meteorological Directory- Erbil province

The land was ploughed with two perpendicular lines and the soil was well softened with rotavator plow to erosion control and conservation of soil moisture. land divided in to plots with dimensions (2m × 1.5m) area, the number of rows were 6 with 30cm distance between rows and 12cm between plants, providing a density of about (83.33 plants.m-2), with three replications resulting, 27 plots .

Three chickpea varieties (Rafedain, Gab3 and TH85) called (V1, V2 and V3), were chosen for this study. The seeds were sown in different dates on (December 23th, 2023, January 17th, 2024 and February 11th, 2024) called (S1, S2 and S3) at depth of 3cm. Through the experimental period plants watered depending on rainfall and manual weed control repeated more than once. The chemical fertilizer urea (N% 46) was added with preparing the soil at a rate 50kg ha-1 and phosphate fertilizer was also added in the form of superphosphate (P2O5 46%) at a rate 40kg ha-1 at planting for all experimental units (Alnori and Al-Obady, 2014).

Five plants were selected randomly from the middle line in each experimental unit to study the plant height (cm), no. of branches plant-1, no. of pods plant-1, fresh weight of pods plant-1 (g) and

dry weight of pods plant-1 (g). No. of seed plant-1, weight of seed plant-1 (g), weight of 100 seed (g) and seed yield (kg ha-1) were measured in two harvesting stage physiological maturity and full maturity. Seeds ground by electrical grinder for each experimental unit. A 0.3g of ground samples were digested by adding 10ml of concentrated H₂SO₄ and 10ml of H₂O₂ with heating for digestion as described by Ryan et al., (2001). The percentage of protein and protein yield (kg ha-1) in seeds were estimated from digested samples by kjeldahl method (Rizvi et al., 2022).

The experiment was designed according to factorial randomized complete block design (RCBD) with three replicates, comparisons between means were made using Duncan's Multiple Range Test at 5% level. The statistical analysis was carried out by using SPSS (Statistical Package for Social Sciences) Program, version (22.0) in 2019.

RESULT AND DISCUSSION

According to the results presented in Table (3) Gab3 variety recorded the highest value (45.335cm) of plant height and (2.433) of branches plant-1 when compared with other varieties and no significant differences were observed for other parameters between all varieties. From the results of effect of sowing dates, plant height significantly increased for the first sowing date and gave the maximum rate (48.889cm), while the no. of branches plant-1 significantly progressed with delay in the sowing time, on the other hand, the second planting date significantly produced the maximum weight of fresh pods plant-1 (60.689g), whereas, the lowest rate (32.578g) of this character was obtained by the third sowing date. The interaction effect between varieties and sowing date it also shows in the same table, the results observed that plant height in all varieties significantly affected by sowing date and the greater rate was recorded for all varieties with the first planting date, no. of branches plant-1 significantly increased in second variety Gab3 to (3.033) with third sowing date. No significant differences were obtained for other parameters for interaction between varieties and sowing dates .

These differences in genotypes of varieties are due to their toleration behaviour at both low and high temperature condition (Kumar et al., 2023). The differences of the periods between sowing dates and that periods are located in different season effect on growth and development of the plants and measurements parameters are extremely sensitive to environmental factors such as, light intensity, growing season, day length, rainfall and temperature (Table 2) and soil properties (Table 1). Additionally, agronomic factor like plant density, fertility and weeds also play a role (Ceyhan et al., 2012).

Table (4) clarifies the effect of sowing date on yield and yield components of three varieties of chickpea in two harvesting stages. Findings show significant variation in the weight of 100 seeds between chickpea varieties at physiological maturity, and number of seed pod-1 at full maturity. No significant differences were observed between the varieties for other parameters in both harvesting stages. At physiological maturity the number of seed pod-1 significantly increased on the first sowing date, while a reduction in the weight of 100 seeds was observed with a delay in sowing time. At full maturity, the second planting date significantly improved the parameters: no. of seeds pod-1, weight of seeds (g plant-1) and seeds yield (kg ha-1) by (29.255, 8.109g and 2251.529kg) respectively, compared to other crop sown. From the results of interaction between varieties and sowing dates in the physiological maturity, the highest weight of 100 seeds (35.633g) was produced by second variety on the first sowing and the lowest value (22.673g) with third variety and third sowing date. No significant effect was recorded for other parameters at this stage. The varieties used and the different sowing times significantly impacted the no. of seed pod-1, weight of seed (g plant-1) and seed yield (kg ha-1) at full maturity and the maximum values (44.400, 9.687g and 2689.524kg) respectively, achieved by the third variety on the second sowing .

The variation in yield characteristics of cultivars may be related to the genetic differences and their response to environmental conditions (Sandeep et al. 2023). Abiotic environment factor include temperature, humidity, light intensity, water supply, mineral and CO₂, these parameters and recourses that determine plant growth and differ from year to year and season to season (Schulze et al., 2002). The temperature fluctuation between seasons (shown in Table 2) affect plant growth

because temperature influences all biochemical reactions of photosynthesis and membrane integrity in chloroplasts (Taiz and Zeiger, 2006).

The data presented in Table (5) indicated that the ratio of protein and protein yield significantly progressed in third variety of chickpea in both harvesting stages. The time of sowing significantly influenced protein content and protein yield. The highest protein ratio was (24.290%) was observed on third sowing while, the lowest rate (22.047%) was found on second planting date at physiological maturity. Late sowing decreased the protein ratio and total protein at full maturity. Sowing different varieties of chickpea on different dates impacted the protein ratio and total protein in both harvesting stages. This variation among varieties might be due to differences in physiological traits responsible for production potential (Kumar et al., 2023). This could be caused by variations in the general development and growth of each individual variety, indicating increased photosynthesis activity. The results are similar with those found by (Choudhary et al., 2020).

Table 3. Effect of sowing date on growth parameters of different varieties of chickpea

Treatments	Plant height (cm)	No. of branches plant ⁻¹	No. of pods plant ⁻¹	Fresh weight of pods plant ⁻¹ (g)	Dry weight of pods plant ⁻¹ (g)
V ₁	41.255 b	2.200 ab	20.841 a	45.444 a	23.489 a
V ₂	45.335 a	2.433 a	18.073 a	46.156 a	22.956 a
V ₃	44.044 a	1.889 b	22.000 a	47.511 a	23.756 a
S ₁	48.889 a	1.711 b	16.711 a	45.844 ab	22.378 a
S ₂	42.313 b	2.233 a	24.229 a	60.689 a	24.889 a
S ₃	39.433 b	2.578 a	19.974 a	32.578 b	22.933 a
V ₁ S ₁	48.633 a	1.933 cd	20.733 a	50.600 a	24.067 a
V ₁ S ₂	39.833 ab	2.067 bcd	22.600 a	55.000 a	23.333 a
V ₁ S ₃	35.300 b	2.600 abc	19.190 a	30.733 a	23.066 a
V ₂ S ₁	49.133 a	1.633 d	13.433 a	43.800 a	21.733 a
V ₂ S ₂	44.473 ab	2.633 ab	22.953 a	61.200 a	25.000 a
V ₂ S ₃	42.400 ab	3.033 a	17.833 a	33.467 a	22.133 a
V ₃ S ₁	48.900 a	1.567 d	15.967 a	43.133 a	21.333 a
V ₃ S ₂	42.473 ab	2.000 bcd	27.133 a	65.867 a	26.333 a
V ₃ S ₃	40.600 ab	2.100 bcd	22.900 a	33.533 a	23.600 a

The similar letters between treatment mean there are no significant differences between them using Duncan multiple Test at 5% level.

Table 4. Effect of sowing date on yield and yield components of different varieties of chickpea in two harvesting stages

Treatment _s	Physiological maturity				Full maturity			
	No. of seed pod ⁻¹	Weight of 100 seed (g)	Weight of seed (g plant ⁻¹)	Seed yield (kg ha ⁻¹)	No. of seed plant ⁻¹	Weight of 100 seed (g)	Weight of seed (g plant ⁻¹)	Seed yield (kg ha ⁻¹)
V ₁	18.767 a	26.447 b	4.747 a	1318.334 a	17.511 b	26.787 a	4.787 a	1329.134 a
V ₂	14.889 a	31.306 a	4.168 a	1157.639 a	17.755 b	29.807 a	5.548 a	1540.186 a
V ₃	20.244 a	24.579 c	4.183 a	1161.619 a	27.211 a	26.422 a	6.016 a	1670.64 a
S ₁	15.333 b	30.070 a	4.539 a	1260.449 a	16.133 b	25.039 a	3.625 b	1006.662 b
S ₂	16.800 ab	27.012 b	4.486 a	1245.854 a	29.255 a	28.504 a	8.109 a	2251.529 a
S ₃	21.767 a	25.249 c	4.074 a	1131.288 a	17.089 b	29.473 a	4.616 b	1281.771 b
V ₁ S ₁	17.200 a	27.083 c	4.913 a	1364.433 a	18.567 bc	24.257 a	4.217 bc	1170.135 bc
V ₁ S ₂	22.733 a	23.000 d	4.834 a	1342.494 a	19.233 bc	26.223 a	5.793 b	1608.809 b
V ₁ S ₃	16.366 a	29.256 b	4.494 a	1248.076 a	14.733 c	29.880 a	4.350 bc	1208.458 bc
V ₂ S ₁	12.700 a	35.633 a	4.313 a	1197.812 a	13.333 c	26.913 a	3.390 bc	940.940 bc
V ₂ S ₂	17.933 a	29.177 b	4.388 a	1218.732 a	24.133 b	31.120 a	8.847 a	2456.257 a
V ₂ S ₃	14.033 a	29.107 b	3.804 a	1056.371 a	15.800 bc	31.390 a	4.407 bc	1223.36 bc
V ₃ S ₁	16.100 a	27.493 c	4.390 a	1219.103 a	16.500 bc	23.947 a	3.270 c	908.912 c
V ₃ S ₂	24.633 a	23.570 d	4.236 a	1176.337 a	44.400 a	28.170 a	9.687 a	2689.524 a
V ₃ S ₃	20.000 a	22.673 d	3.923 a	1089.417 a	20.733 bc	27.1500 a	5.090 bc	1413.493 bc

The similar letters between treatments means there are no significant differences between them using Duncan's Multiple Test at 5% level.

Table 5. Effect of sowing date on protein ratio in seed of different varieties of chickpea in two harvesting stages

Treatments	Physiological maturity		Full maturity	
	Protein %	Protein yield (kg ha ⁻¹)	Protein %	Protein yield (kg ha ⁻¹)
V ₁	23.273 b	306.95 a	21.640 c	286.41 b
V ₂	22.457 c	259.50 a	23.510 b	355.77 ab
V ₃	24.290 a	281.50 a	24.737 a	413.18 a
S ₁	23.683 b	299.02 a	24.087 a	241.21 b
S ₂	22.047 c	274.57 a	22.663 c	517.34 a
S ₃	24.290 a	274.36 a	23.236 b	296.81 b
V ₁ S ₁	45.500 b	334.39 a	22.660 f	265.16 b
V ₁ S ₂	22.050 f	296.03 a	20.830 i	335.09 b
V ₁ S ₃	23.270 d	290.43 a	21.430 h	258.98 b
V ₂ S ₁	22.670 e	271.55 a	23.880 d	224.70 b
V ₂ S ₂	21.430 g	261.15 a	22.050 g	541.59 a
V ₂ S ₃	23.270 d	245.79 a	24.600 c	301.03 b
V ₃ S ₁	23.880 c	291.11 a	25.720 a	233.78 b
V ₃ S ₂	22.660 e	266.53 a	25.110 b	675.34 a
V ₃ S ₃	26.330 a	286.86 a	23.380 e	330.43 b

*The similar letters between treatments means there are no significant differences between them using Duncan's Multiple Test at 5% level.

Conclusions

It is concluded that Gab3 variety surpassed other varieties in some of growth parameters and yield and yield components except the percentage of protein and protein yield were produced the maximum rate by TH85 variety. Sowing date on December 23th and February 11th excelled in plant height and no. of branches plant-1. In both harvesting stages sowing date on January 17th recorded highest rate of some yield and yield components. From the interactions between varieties and sowing dates, for all characteristics selected the maximum values with Gab3 variety on December 23th and for TH85 variety on January 17th in both harvesting stages.

REFERENCES

- Alnori, M. and Al-Obady, R. (2014). Effect of sowing depths on germination and yield for three varieties of winter chickpea. Journal of Tikrit university for agriculture sciences. 1813(1646): 378-384. (In Arabic).
- Ceyhan, E., Kahraman, A. and Onder, M. (2012). The impacts of environment on plant products. International Journal of Bioscience, Biochemistry and Bioinformatics. 2 (1). p.48-51.
- Choudhary, A., Shekhawat, P. S., Kumar, S., and Pareek, B. (2020). Performance of chickpea (*Cicer arietinum* L.) varieties to seed rate and nipping in arid irrigated western plain zone. International Journal of Current Microbiology and Applied Sciences. 9(8):3895-3903.
- FAO, 2023, FAOSTAT. statistical database. <https://www.fao.org/faostat> .
- Goud, V. and Karunakar, A. (2023). Effect of Sowing Time Induced Weather Regimes on Growth and Yield of Chickpea under Irrigated Condition. International Journal of Plant & Soil Science. 35(23): 338-344 .
- Kumar A., Kumar N., Devi S., Dhaka A. and Khokhar S. (2023). Physiology and yield of chickpea (*Cicer arietinum* L.) genotypes in response to different sowing dates in semi-arid regions of north India. Legume Research- An International Journal. 46 (7): 843-848.
- Kumari, U. (2023). Chickpea (*Cicer arietinum* L.): nutrition beyond protein, bioactives and associated health benefits. The Pharma Innovation Journal. 12(9): 134-142.

- Rizvi N., Aleem S., Khan M., Ashraf S. and Busquets R. (2022). Quantitative estimation of protein in sprouts of *Vigna radiata* (Mung Beans), *Lens culinaris* (Lentils), and *Cicer arietinum* (Chickpeas) by Kjeldahl and Lowry Methods. *Molecules*. 27(814):1-10.
- Ryan, J., Estefon, G. & Rashid, A. (2001). Soil and Plant Analysis Laboratory Manual. 2nd Edition, National Agriculture Research Center (NARC) Islamabad, Pakistan.
- Salih, R. H., Abdullah, S. A. and Mohammed, B. I. (2018) Effect of Sowing Dates and Two Chickpea Cultivars on Some Growth Parameters and Yield. *ZANCO Journal of Pure and Applied Sciences*, 30 (4): 49-57.
- Sandeep, G. S., Umesha, C. and Uday Kiran, V. (2023). Effect of Dates of Sowing on Growth and Yield of Chickpea Varieties. *International Journal of Environment and Climate Change*. 13(10): 834-838.
- Schulze, E., Beck, E. and Muller-Hohenstein, K. (2002) *Plant Ecology*. Spektrum Akademischer Verlag GmbH, Heidelberg. p.9-361.
- Taiz, L. and Zeiger, E. (2006) *Plant Physiology*. 4th ed. Sinauer Associates, Inc.
- Varoglu, H. and Abak, K (2018). Effect of sowing dates on yield and quality characteristics of chickpea varieties under Mediterranean climate conditions. *Agricultural Research Communication Centre*. ISSN:0250-5371: 1-5.
- Zhang, J., Wang, J., Zhu, C., Singh, R. and Chen, W. (2024). Chickpea: Its Origin, Distribution, Nutrition, Benefits, Breeding, and Symbiotic Relationship with *Mesorhizobium* Species. *Plants*. 13(429): 1-13.