RESEARCH ARTICLE

SABRAO Journal of Breeding and Genetics
56 (2) 867-874, 2024
http://doi.org/10.54910/sabrao2024.56.2.37
http://sabraojournal.org/
pISSN 1029-7073; eISSN 2224-8978

EFFECT OF NITROGEN FERTILIZER AND ITS APPLICATION TIMINGS ON THE GROWTH AND YIELD TRAITS OF PEANUT (*ARACHIS HYPOGAEA* L.)

I.A. MARHOON

College of Science, University of Al-Qadisiyah, Al-Diwaniyah, Al-Qādisiyyah, Iraq
Author's email: intedhar.abbas@qu.edu.iq

SUMMARY

The experiment transpired during the crop season 2021 using a clay mixture soil. The aim was to study the effects of different concentrations of nitrogen fertilizer and the date of its application on some growth and yield characteristics of peanut (*Arachis hypogaea* L.) in the College of Sciences, University of Al-Qadisiyah, Al-Diwaniyah, Al-Qādisiyyah, Iraq. Using the randomized complete block design (RCBD) in the arrangement of split plots had three replications. The first factor was on three additional dates: addition at the beginning of the vegetative growth stage, the start of the flowering stage, and when flowering is complete. The second factor included three nitrogen fertilizer concentrations (50, 100, and 150 kg N $ha^{-0.1}$). The results showed the following: The concentration of nitrogen fertilizer (50 kg N $ha^{-0.1}$) was significantly superior in some vegetative growth characteristics, i.e., the highest plant height (35.51 cm), maximum number of branches (8.31 branches $plant^{-1}$), and heaviest dry weight (104.60 g $plant^{-1}$). For yield characteristics: The concentration of 50 kg N $ha^{-0.1}$ recorded a significant increase in the yield characteristics—the highest average number of pods was 39.21 pods $plant^{-1}$, and the 100-seed weight was 50.91 g $plant^{-1}$. The 100 and 150 kg N $ha^{-0.1}$ treatments gave higher plant height (39.8 and 41.02 cm) and dry weight (120.40 and 124.50 g $plant^{-1}$), respectively. On the effect of time of adding, the addition at the beginning of flowering was significantly superior for plant height (37.41 cm), dry weight (114.30 g $plant^{-1}$), number of pods per plant (36.40 pods $plant^{-1}$), and 100-seed weight (46.61 g), compared with adding during the vegetative growth stage, which showed the lowest values for the studied characteristics. The interactions between nitrogen concentrations and the adding time resulted in a significant effect from the concentration of 50 kg added as the flowering starts on the number of pods and seeds compared with the control treatment.

Keywords: Peanut (*A. hypogaea* L.), nitrogen fertilizer, fertilizer application timings, growth and yield-related traits

Communicating Editor: Dr. Samrin Gul

Manuscript received: August 4, 2023; Accepted: December 16, 2023.

Citation: Marhoon IA (2024). Effect of nitrogen fertilizer and its application timings on the growth and yield traits of peanut (*Arachis hypogaea* L.). *SABRAO J. Breed. Genet.* 56(2): 867-874. http://doi.org/10.54910/sabrao2024.56.2.37.

Key findings: Peanut (*A. hypogaea* L.) is an oil crop containing essential fatty acids, such as, linoleic and oleic acids. Nitrogen fertilizer and the time to add fertilizer are resources to improve plant production and increase the oil percentage. This review presents these resources and ways to apply them to increase growth and productivity of ***A.** hypogaea.*

INTRODUCTION

Peanuts(*Arachis Hypogaea* L.) are considered one of the plants rich in oils and belong to the Fabaceae family. The proportion of global seed production from about 35 million tons to 20 million in 2004 (Ojiewo *et al.,* 2020). It comes in second of medical and economic importance in the Arab world (Jain *et al.,* 2018). The percentage of oils in Peanuts seeds is 35-50%, while the percentage of proteins ranges between *25-30%* (Mohapatra and Dixit, 2010). The importance of oils is due to their nutritional uses as vegetable butter because they contain essential fatty acids such as linoleic and oleic acids. There are other types of this plant, such as *A. glabrate* and *A. Pintoi* is grown as a fodder crop for animals. Nitrogen is an essential element, as the plant needs it in large quantities for its growth.

Nitrogen influences increase production for crops, especially Fabaceae crops. It is essential for building proteins, amino acids, and nucleic acids. Lack of nitrogen in the soil leads to the yellowing of of them plants, the cessation of plants growth, and insufficient proteins (Ahmad and Rahim, 2007; Bhatti *et al*., 2010). Hence, Siam *et al*. (2015) indicated a significant increase in the plant height when adding 60 kg N compared with the control treatment, which gained support from Rizk *et al*. (2012). Nitrogen fertilizer also led to an increase in the number of branches of ***A.** hypogaea* and, thus, an increase in the number of pods in plants, boosting plant yield. Xie *et al.* (2015) observed a notable increase in the dry weight of the plant when fertilizing with nitrogen.

As for the timing of application, Mondal *et al.* (2020) found a significant increase in dry weight when adding nitrogen fertilizer to ***A.** hypogaea* at planting and during the vegetative growth until flowering. As for the timing of adding nitrogen to agricultural soil (Namvar *et al*., 2013), it emerged that nitrogen supplementation to chickpea (*Cicer arietinum* L.) plant markedly increased the number of pods, especially during the plant's vegetative growth stage. According to Sarr *et al.* (2015) an increase in number of pods was result to adds nitrogen fertilizers after two weeks of germination.

Sogut (2006) also found significant increase in number of seeds and pod of Soya bean (*Glycine max* L.) crops when fertilizing with nitrogen. Bekere *et al*. (2013) findings showed significant increase in the weight of 100 seeds of *Glycine max* with an increase in the levels of added nitrogen from (0, 100 kg N). The weight of 100 seeds of ***A.** hypogaea* increased when adding nitrogen fertilizer (Xia *et al*., 2021). In an experiment using three concentrations of nitrogen fertilizers (0, 60, and 80 kg N ha^{-1} a significant increase in the yield of plants was found when the concentration of 60 kg N ha^{-1} of nitrogen fertilizer(Caliskan *et al*., 2008). Zaki *et al*. (2017) indicated that nitrogen concentration added to ***A.** hypogaea* led to significant increase in yield of seeds. The presented study sought to determine the effects of nitrogen and timing of application on the growth of ***A.** Hypogaea,* know the influences of high nitrogen concentrations, and identify the most appropriate nitrogen concentration and the best time to add it.

MATERIALS AND METHODS

This experiment, executed in the fields of the College of Science, University of Al-Qadisiyah, Iraq, grew the peanut plant in salty, loamy soil on October 10, 2021. The RCBD experiment had a split-plane arrangement of three replications. The main panels included the coefficients for the dates of adding nitrogen fertilizer, which comprised three timings:

adding at the vegetative growth stage, the start of flowering, and when flowering is 100% complete.

The secondary treatment included the addition of nitrogen fertilizer in four concentrations (0, 50, 100, and 150 kg $ha^{-0.1}$). Preparing the experimental land included dividing the field according to the described design. The experimental unit has an area of 3 m × 4 m with three lines. The distance between one corridor and another was 0.75 m, and the expanse between one hole and another was 0.2 m. Separations contained a gap of 2 m between the prime treatments and 1.5 m between the secondary solutions. Seed planting comprised of two seeds placed in one jar. The plants' thinning to one plant ensued after the completion of the emergence. Crop servicing operations proceeded whenever needed.

Data recording and statistical analysis

Ten plants randomly selected from each treatment bore scrutiny for growth characteristics. Upon their removal, their pods sustained separation, cleaning the dust for studying the characteristics of the crop and its components at maturity by the following process: The vegetative growth characteristics included measuring plant height (cm), branches $plant^{-1}$, and dry weight (g). The plants dried in an oven at a temperature of 70 °C for 48 h, employing the method of Thangthong *et al.* (2018). The RCBD layout of the experiment had a split-plane arrangement and three replications. The main panels included the coefficients for the dates of adding nitrogen fertilizer. The secondary treatment comprised the addition of nitrogen fertilizer in four concentrations. The data recording occurred on the yield-related traits, i.e., pods per plant, seeds pod^{-1}, and 100-seed weight (g).

RESULTS AND DISCUSSION

Results indicated a significant effect occurred on the plant height characteristic. Plant height increased with increasing nitrogen fertilizer concentrations (0–150 kg $ha^{-0.1}$) (Table 1). However, the concentrations (100 and 150 kg $ha^{-0.1}$) showed nonsignificant differences. As for the application timing, the supplementation time during the beginning and completion of flowering was superior over the vegetative growth stage. Between the start and end of flowering, there was a nonsignificant difference, showing an average plant height of 37.41 and 37.51 cm, respectively, compared with the treatment of adding nitrogen at the start of vegetative growth as it reached 34.31 cm. On the interaction between nitrogen concentrations and application times, the differences were nonsignificant.

Notable differences with varying concentrations of nitrogen used appeared. The fertilizer concentration of 50 kg was significantly higher than the zero and 150 kg $ha^{-0.1}$ concentrations (Table 2). The highest number of branches surfaced, reaching 8.31 branches $plant^{-1}$. Meanwhile, the comparison treatment's number of branches reached 7.10 branches $plant^{-1}$. The timing of nitrogen application and the interactions showed irrelevant effects.

Table 1. Effect of nitrogen fertilizer concentrations, timing of application, and their interactions on plant height.

Timing of application	Nitrogen fertilizer concentrations (kg $ha^{-0.1}$)				Means (cm)
	0	50	100	150	
Beginning of vegetative growth	27.80	33.21	38.40	38.00	34.30
Beginning of flowering	30.80	36.31	39.50	43.25	37.41
Full flowering	29.70	37.01	41.6	41.80	37.51
Means (cm)	29.40	35.51	39.8	41.02	
$LSD_{0.05}$ Nitrogen doses: 1.79 Timing of application: 2.09 Interactions: NS					

Table 2. Effect of nitrogen fertilizer concentrations, timing of application, and their interactions on the number of branches per plant.

Timing of application	Nitrogen fertilizer concentrations (kg ha$^{-0.1}$)				Means (branches plant^{-1})
	0	50	100	150	
Beginning of vegetative growth	7.10	9.61	8.90	8.20	8.40
Beginning of flowering	7.20	8.10	8.01	7.10	7.61
Full flowering	7.20	7.20	7.51	6.91	7.20
Means (branches. plant^{-1})	7.10	8.31	8.11	7.40	
$LSD_{0.05}$ Nitrogen doses:0.67 Timing of application: NS Interactions: NS					

Table 3. Effect of nitrogen fertilizer concentrations, timing of application, and their interactions on dry weight of plant.

Timing of application	Nitrogen fertilizer concentrations (kg ha$^{-0.1}$)				Means (g plant^{-1})
	0	50	100	150	
Beginning of vegetative growth	79.41	98.40	104.01	100.41	95.60
Beginning of flowering	74.20	112.10	138.30	132.40	114.30
Full flowering	67.81	103.40	118.70	140.60	107.60
Means (g plant^{-1})	73.81	104.60	120.40	124.50	
$LSD_{0.05}$ Nitrogen doses:5.29 Timing of application: 7.35 Interactions: 10.94					

An increase in plant dry weight was due to the influence of nitrogen concentrations, and all the nitrogen concentrations were significantly superior to the control treatment (Table 3). The nitrogen concentration (150 kg ha$^{-0.1}$) was significantly outstanding by recording the highest dry matter weight, amounting to 124.50 g plant^{-1}, compared with the control treatment (73.80 g plant^{-1}). Noteworthily also, no significant differences emerged between the two concentrations (100 and 150 kg ha$^{-0.1}$), which were superior to the compost concentration (50 kg ha$^{-0.1}$), recording an average of 104.60 g plant^{-1}. On application timing, the beginning of flowering excelled by providing the highest value (114.30 g plant^{-1}), and no significant effect between it and the time of completion of flowering appeared, which recorded a lower value (107.60 g plant^{-1}).

However, a twice significant superiority arose compared with the addition timing during the vegetative growth, which recorded the lowest value reaching 95.60 g plant^{-1}. Concerning the interaction between the two study factors, the plant response to the added nitrogen concentrations differed for dry weight at the varying timing of addition of the plant at the fertilizer concentration 150 kg ha$^{-0.1}$). Yet, the highest average dry weight was 140.60 g plant^{-1}.

There were differences between the nitrogen concentrations' effects. The fertilizer concentration (50 kg ha$^{-0.1}$) was significantly higher, recording the highest (39.21 pods plant^{-1}), compared to other concentrations (Table 4). However, the control treatment recorded the lowest 27.31 pods plant^{-1}. No different effects resulted in the number of pods for the two concentrations (100 and 150 kg ha$^{-0.1}$), which recorded an average pod number of 33.30 and 30.90 plant^{-1}, respectively, superior to the control treatment. As for the fertilizer's application timing, significant differences appeared between the numbers of pods due to the effect of the varying time of addition. Fertilization during the beginning of flowering was markedly superior by recording the highest value (36.40 pods plant^{-1}), compared with the two times of addition, at the vegetative growth and complete flowering. The supplementation time at the flowering completion was superior, with an average number of pods reaching 31.80 plant^{-1}, compared with the addition time at the vegetative growth stage (29.71 pods plant^{-1}).

Table 4. Effect of nitrogen fertilizer concentrations, timing of application, and their interactions on the number of pods per plant.

Timing of application	Nitrogen fertilizer concentrations (kg ha$^{-0.1}$)				Means (pods plant^{-1})
	0	50	100	150	
Beginning of vegetative growth	27.61	35.71	28.60	27.11	29.71
Beginning of flowering	26.81	45.10	39.60	34.40	36.40
Full flowering	27.51	36.81	31.90	31.30	31.80
Means (pods plant^{-1})	27.31	39.21	33.30	30.90	
$LSD_{0.05}$ Nitrogen doses:1.17 Timing of application: 0.92 Interactions: 2.79					

Table 5. Effect of nitrogen fertilizer concentrations, timing of application, and their interactions on the number of seeds per pod.

Timing of application	Nitrogen fertilizer concentrations (kg ha$^{-0.1}$)				Means (seeds pod^{-1})
	0	50	100	150	
Beginning of vegetative growth	1.93	1.81	1.96	1.98	1.93
Beginning of flowering	1.93	1.73	1.84	1.95	1.86
Full flowering	1.84	1.91	1.99	1.99	1.96
Means (seeds pod^{-1})	1.91	1.81	1.95	1.99	
$LSD_{0.05}$ Nitrogen doses: 0.32 Timing of application: NS Interactions: NS					

The interactions between fertilizer concentrations and application times revealed the addition of fertilizer at a concentration of 50 kg ha$^{-0.1}$ at the time of the start of flowering increased by a higher percentage than in the last two stages.

Prominent effects between the rates of the number of seeds in the pod occurred due to the influence of nitrogen concentrations as the concentrations exceeded 100 and 150 kg ha$^{-0.1}$ over the 50 kg that recorded the lowest average (1.81 seeds pod^{-1}) with the two concentrations (100 and 150 kg) (Table 5). The highest average were 1.95 and 1.99 seeds pod^{-1}), respectively. Nonsignificant differences were evident between the concentration of 50 kg N ha$^{-0.1}$ and the control treatment. The time of application and the interactions between the concentrations of nitrogenous fertilizer and the time of addition also showed no significant differences.

A significant effect manifested between the nitrogen concentrations; all the added concentrations were superior to the control treatment. The 50 kg ha$^{-0.1}$ concentration was significantly higher than other concentrations (Table 6). The highest average 100-seed weight recorded was 50.91 g, with the control treatment recording the lowest average 100-seed weight at 32.31 g. The times of addition also showed significant effects. The time of adding fertilizer during the beginning of flowering gave the highest average weight for 100 seeds, amounting to 46.61 g, followed by the date of adding when flowering is complete, as it achieved 43.11 g. Meanwhile, the addition time during the vegetative growth recorded an average 100-seed weight of 40.31 g. The interactions between nitrogen concentrations and the time of addition significantly increased at all times of addition in the 100-seed weight, and the highest rate of 100-seed weight was at two concentrations (50 and 100 kg ha$^{-0.1}$) during the start of the flowering stage, as it achieved 55.01 and 52.80 g. The average 100-seed weight decreased at the fertilizer concentration of 150 kg ha$^{-0.1}$ for all schedules of fertilizer addition.

The increase in the concentrations of nitrogen fertilizer caused a boost in the plant height due to the increased production of essential amino acids for growth, prompting a significant increase in the leaves' area and then an increase in the plant's vegetative

Table 6. Effect of nitrogen fertilizer concentrations, timing of application, and their interactions on the 100-seed weight.

Timing of application	Nitrogen fertilizer concentrations (kg $ha^{-0.1}$)				Means (g)
	0	50	100	150	
Beginning of vegetative growth	33.01	48.91	41.30	37.81	40.31
Beginning of flowering	31.91	55.01	52.80	46.81	46.61
Full flowering	32.01	48.81	46.30	45.61	43.11
Means (g)	32.31	50.91	46.80	43.41	
$LSD_{0.05}$ Nitrogen doses: 1.05Timing of application: 0.94 Interactions: 2.02					

growth. The expanse in shadowing came from the auxin, which is less susceptible to photo-oxidation. Hence, its concentration increases working with gibberellins to elongate the plant (Song *et al.,* 2019; Wang *et al*., 2019). The study result agrees with the past findings as they noticed that nitrogen fertilization enhanced the plant height (Salvagiotti *et al*., 2008; Ayoola, 2010).

Also, plant height during reproductive stages increased due to the formation of a large vegetative and root mass. It increases the ability of plants to absorb more nitrogen, which leads to an increase in the activity of hormones and enzymes responsible for cell division and plant elongation (Stefanelli *et al*., 2010; El-sherbeny *et al*., 2023).

The reason for exceeding the level of 50 kg $ha^{-0.1}$ may refer to increased growth (Table 5), as this concentration recorded the lowest average height compared with other fertilizer concentrations, which created a state of equation between the height of the plant and the number of branches. It is consistent with Xia *et al*. (2021), whose findings indicated that plant branches increased when increasing nitrogen. The reason for the decrease in the plant branches at the two concentrations (100 and 150 kg $ha^{-0.1}$) may be because of the increase in plant height (Table 1) due to the concentration of gibberellin in the growing apex of the plant, reducing plant branches and increasing in plant height. Also, the plant's dry weight escalated with the addition of nitrogen. It is due to its role in increasing the height and branches of plants and thus enhancing their vegetative growth, leading to an increase in dry weight (Basal and Szabó, 2020; Mondal *et al*., 2020; Al-Yasari *et al*., 2022; Elnagar *et al*., 2022).

The nitrogen addition caused a rise in the division cell and elongation, which is what caused the dry weight to increase, which leads to a large vegetative system and then the dry weight increasing (Abid *et al*., 2016). The increase in them number of pods caused the effect of fertilizer in increasing of flowering, resulting in a rise in them number of pods. This agrees with Hong *et al*. (2022) who said that quantity of pods of peanut increases when nitrogen fertilizers is added. The results indicated decrease in number of pod with an increase in nitrogen levels. It may be due to an elevation in the concentration of nitrogen in plant tissues harming the rate of fertilization in flowering and, therefore, the number of pods decreases at these concentrations (Wang *et al.,* 2016).

The reason for the increase in the second and third dates of application over the vegetative growth date can refer to the addition of nitrogen fertilizer in the flowering stage, leading to a reduction in flower fall and, thus, an increase in the plant's number of pods (Siam *et al.,* 2015; Argaw, 2018). The number of seeds in pods at concentrations of 100 and 150 kg increases due to the decrease in the total pods in these two levels. It means that photosynthetic products were well-distributed to fewer flowers and, thus, the fertilization rate increased in flowering.

The number of seeds in pods increasing the 100-seed weight may be due to the higher concentration of 100 kg $ha^{-0.1}$ lowering the number of seeds in the pod, which caused an increase in dry matter in the seeds; hence, seed contents increased of which the dry weight of the seed rose. The reason for the significant effect in the increase of 100-seed weight was the addition of fertilizer during flowering. It may refer to the fact that the response of plants to nitrogen addition during the flowering stage is higher than the other stages (Zaki *et al*., 2017; Xia *et al*., 2021).

CONCLUSIONS

Nitrogen fertilizer is vital for plants because of its positive effects on many physiological activities. Choosing appropriate fertilizer concentrations is crucial, as the concentration of 50 kg positively affected plant growth and yield. Meanwhile, concentrations of 100 and 150 kilograms had opposite effects on some characteristics. The plant response to nitrogen fertilizer sustained influences from the time of application. In the stage of vegetative growth and the beginning of flowering, positive effects occurred in most plant characteristics.

REFERENCES

Abid M, Tian Z, Ata-Ul-Karim ST, Cui Y, Liu Y (2016). Nitrogen nutrition improves the potential of wheat (*Triticum aestivum* L.) to alleviate the effects of drought stress during vegetative growth periods. *Front. Plant Sci.* 3(6):7-981. https://doi.10.3389/fpls.2016.00981.

Ahmad N, Rahim M (2007). Evaluation of promising groundnut (*Arachis hypogaea* L.) varieties for yield and other characters. *J of Agric Research*. 45(3):185-189.

Al-Yasari BAA, Al-Yasari MNH (2022). Response of peanut to weed control management and nano-zinc foliar application in growth, yield, and quality traits. *SABRAO J. Breed. Genet.* 54(5): 1191-1201. http://doi.org/10.54910/sabrao2022.54.5.20.

Argaw A (2018). Integrating inorganic NP application and *Bradyrhizobium* inoculation to minimize production cost of peanut (*Arachis hypogaea* L.) in Eastern Ethiopia. *J. Agric. Sci.* 5(6):7-20.

Ayoola OT (2010). Yield performance of crops and soil chemical changes under fertilizer treatments in a mixed cropping system. *Afr. J. Biotechnol*. 26(7):9-26.

Basal O, Szabó A (2020). The combined effect of drought stress and nitrogen fertilization on soybean. *Bangladesh J. Agric. Res. 41(3):*10(3):3-84. https://doi.10.3390/agronomy10030384.

Bekere W, Kebede T, Dawud J (2013). Growth and nodulation response of soybean (*Glycine max* L.) to lime, *Bradyrhizobium japonicum* and nitrogen fertilizer in acid soil at Melko, South Western Ethiopia. *Int. J. Soil Sci. 8*(3): 25-31.

Bhatti IA, Shahid M, Asi R, Mehboob S (2010). Quality index of oils extracted from γ-irradiated peanuts (*Arachis hypogaea* L.) of the golden and bari varieties. *Not. Sci. Biol*. 68(12): 2197-2201.

Caliskan S, Özkaya I, Caliskan M, Arslan M (2008). The effects of nitrogen and iron fertilization on growth, yield and fertilizer use efficiency of soybean in a Mediterranean-type soil. *Field Crop. Res.* 10(8): 126-132.

Elnagar AAA, Zeidan EM, Abdul-Galil AA, Ali AA-G (2022). Response of high-yielding peanut cultivars to various seed treatments under marginal fertility sandy soil conditions. *SABRAO J. Breed. Genet.* 54(5): 1171-1182. http://doi.org/10.54910/sabrao2022.54.5.18.

El-sherbeny TS, Abeer M, Zhran M (2023). Response of peanut (*Arachis hypogaea* L.) plant to bio-fertilizer and plant residues in sandy soil. *J. Nutr. Health. Sci*. 45(6):253-265. https://doi.org/10.1007/s10653-022-01302-z.

Hong D, Zhimeng Z, Guanchu Z, Yang X, Qing G, Feifei Q, Liangxiang D (2022). Nitrogen application improved peanut yield and nitrogen use efficiency by optimizing root morphology and distribution under drought stress. *J. Appl. Genet*. 82(8):24-65.https://doi:10.4067/S0718-58392022000200256.

Jain K, Jat R, Yadav R, Bhaduri D, Meena H (2018). Polythene mulching and fertigation in peanut (*Arachis hypogaea*): Effect on crop productivity, quality, water productivity and economic profitability. *Indian J. Agric. Sci*. 8(8): 1168-1178.

Mohapatra A, Dixit L (2010). Integrated nutrient management in rainy season groundnut (*Arachis hypogaea*). *Indian J. Agron.* 5(5): 123-127.

Mondal M, Skalicky M, Garai S, Gunri S, Hossain A, Sarkar S, Banerjee H, Kundu R, Brestic M, Barutcular C (2020). Supplementing nitrogen in combination with Rhizobium inoculation and soil mulch in peanut (*Arachis hypogaea* L.) production system: Part I. Effect on productivity, nutrient dynamics, soil moisture and microbial activity. *Int. J. Agron.* 8(5): 23-76. //doi.org/10.3390/agronomy10101513.

Namvar A, Seyed S, Khandan T, Jafari M (2013). Seed inoculation and inorganic nitrogen fertilization effects on some physiological and agronomical traits of chickpea (*Cicer arietinum* L.) in irrigated condition. *J. Cent. Eur. Agric.* 14(8): 28-40.

Ojiewo C, Janila P, Bhatnagar-Mathur P, Pandey M, Desmae H, Okori P, Mwololo J, Ajeigbe H, Njuguna-Mungai E, Muricho G (2020). Advances in crop improvement and delivery research for nutritional quality and health benefits of groundnut (*Arachis hypogaea* L.). *Front. Plant Sci*. 11(8): 1-15.

Rizk T, Soliman EM, EL-Araby F (2012). Growth response of peanut (*Arachis hypogaea* L.) to inoculation with *Bradyrhizobium* conjugated with rhizobacteria under different levels of organic fertilization on sandy soil. *Egypt. J. Agron*. 34(2): 179-20.

Salvagiotti F, Cassman K, Specht J, Walters D, Weiss A, Dobermann A (2008). Nitrogen uptake, fixation and response to fertilizer N in soybeans: A review. *Field Crop. Res*. 10(8):1-13.

Sarr S, Araki S, Begoude A, Yemefack M, Manga A, Yamakawa T, Htwe Z (2015). Phylogeny and nitrogen fixation potential of *Bradyrhizobium* species isolated from the legume cover crop *Pueraria phaseoloides* (Roxb.) Benth. in Eastern Cameroon. *J. Soil Sci. Plant Nutr*. 3(3): 98-106. https://doi.org/ 10.1080/00380 768.2015.1086279.

Siam HS, Mahmoud A, Taalab AS, Shaban KA (2015). Evaluation of nitrogen levels and application methods with or without compost on yield and quality of peanut under the newly reclaimed soils. *Int. J. Agron*. 8(2): 1-12.

Sogut T (2006). Rhizobium inoculation improves yield and nitrogen accumulation in soybean (*Glycine max*) cultivars better than fertilizer. *N. Z. J. Crop. Hort.* 3(4): 115-120.

Song Y, Li J, Liu M, Meng Z, Liu K, Sui N (2019). Nitrogen increases drought tolerance in maize seedlings. *Functional Plant Bio*. 4(6):350-359. https://doi.10.1071/ FP18186.

Stefanelli D, Goodwin I, Jones R (2010). Minimal nitrogen and water use in horticulture: Effects on quality and content of selected nutrients. *Food Res. Int.* 4(3):1833-1843.

Thangthong N, Jogloy S, Jongrungklang N, Kvien C, Pensuk V, Kesmala T (2018). Root distribution patterns of peanut genotypes with different drought resistance levels under early-season drought stress. *J. Agro. Crop Sci.* 20(4):111-122. https:// doi:10.1111/jac.12249.

Wang C, Zheng M, Shen P, Zheng P, Wu Z, Sun X (2016). Determining N supplied sources and N use efficiency for peanut under applications of four forms of N fertilizers labeled by isotope 15N. *Int. J. Agron.* 15(6):432-439. https://doi:10.1016/S2095-3119(15)61079-6.

Wang Y, Zhang X, Chen J, Chen A, Wang L, Guo X (2019). Reducing basal nitrogen rate to improve maize seedling growth, water and nitrogen use efficiencies under drought stress by optimizing root morphology and distribution*. Agric. Water Manag.* 2(12): 328-337. https://doi:10.1016/j.agwat.2018.09.010.

Xia G, Wang Y, Hu J, Wang S, Zhang Y, Wu Q (2021). Effects of supplemental irrigation on water and nitrogen use, yield, and kernel quality of peanut under nitrogen-supplied conditions. *Agric. Water Manag.* 2(43): 106-518. https://doi:10.1016/j.agwat.2020.106518.

Xie Y, Li X, He F, Zhang Y, Wan L, David BH, Wang D, Qin Y, Gamal M (2015). Effect of nitrogen fertilization on yield, N content, and nitrogen fixation of alfalfa and smooth bromegrass grown alone or in mixture in greenhouse pots. *J. Soil Sci. Plant Nutr.* 14(4): 1864-1876.

Zaki N, Amal G, Hassanein S, Mohamed MG (2017). Effect of organic and bio-fertilizer on yield and some chemical composition of two peanut cultivars under newly reclaimed sandy soil condition. *Middle East J. Appl. Sci.* 7(4): 937-943.