Turk J
Field Crops
2024, 29(1), 18-27
DOI: 10.17557/tjfc.1380413

THE EFFECT OF IRRIGATION MANAGEMENT, MUNICIPAL WASTE COMPOST AND NITROGEN FERTILIZER ON SEED YIELD, QUALITY AND SOME PHYSIOLOGICAL TRAITS OF PEANUT (*Arachis hypogaea* L.)

Zeinab KHOSHOUEI[1], *Majid ASHOURI*[*1], *Hamid Reza DOROUDIAN*[1], *Ebrahim AMIRI*[2], *Naser MOHAMMADIAN ROSHAN*[1]

[1]*Department of Agronomy, Lahijan Branch, Islamic Azad University, Lahijan,Iran.*
[2]*Department of Water Engineering, Lahijan Branch, Islamic Azad University, Lahijan, Iran*
**Corresponding author: majidashouri69@gmail.com*

Received: 24.10.2023

ABSTRACT

Present study was conducted to investigate the effect of municipal waste compost and nitrogen fertilizer on yield and some physiological traits of peanut under both irrigation and no-irrigation conditions. A split-split plot experiment was conducted based on a randomized complete block design with three replications and performed in two years (2018 and 2019). The main plot consisted of irrigation at two levels of with and without irrigation. Compost treatment (at two levels of application of 5 t ha^{-1} and no application) was considered as a subplot. Nitrogen fertilizer (at four levels of 0.0, 20.0, 40.0 and 60.0 kg of pure nitrogen per ha) was considered as a sub-sub plot. The results showed that the application of 5 t ha^{-1} compost significantly increased carotenoids and rate of kernel production by 16.1% and 15.2%, respectively. In the interaction of irrigation and compost, the highest seed protein and seed yield were obtained in two levels of compost and irrigation conditions. In both years, the highest seed yield was observed in the treatments of irrigation and application of 40 and 60 kg N ha-1. Besides, the application of compost along with 40 and 60 kg N ha^{-1} resulted in a significant increase in seed yield. In the second year compared to the first year, under no-irrigation and no-application of nitrogen, seed yield was 21% higher. It seems that application of 40 kg ha^{-1} N along with 5 t ha^{-1} of municipal waste compost in peanut cultivation can be effective in improving the physiological traits and seed yield, especially under no-irrigation.

Keywords: Drought stress, Chlorophyll content, Seed oil, Seed protein

INTRODUCTION

Increasing world population and demand for more food production has reduced the organic matter content of agricultural lands due to continuous cultivation and limited sources of organic matter do not meet the growing demand for fertilizer (McDonagh et al., 2001). Therefore, the use of materials such as agricultural waste, industrial and municipal wastes as sources of supply organic matter is expanding. However, in order to reduce their environmental hazards, some of these wastes need to be decomposed and detoxified before they can be used in agriculture (Sirousmehr et al., 2014). Doing this process changes the nature of the waste and the formation of a new material that called compost. The use of compost is effective on economic and environmental factors such as reducing transport and landfill costs, complying with environmental legislation, reducing the use of mineral fertilizers and improving the properties of agricultural soils (Hargreaves et al., 2008). Applying compost improves the soil structure, strengthens the mineral content of the soil and allows the soil to retain moisture longer. Compost can hold water two to six times more than its volume of water, preventing it from volume of water, preventing it from being wasted (Agassi et al., 2004). Compost in heavy soils improves soil porosity and improves soil aeration. It also acts like a sponge in light soils and largely preventing leaching by retaining water and nutrients (Waqas et al., 2014). The use of compost in agriculture can increase plant growth and yield through its effect on increasing plant water use efficiency and nutrient release (Governog et al., 2003; Tepecik et al., 2022; Tepecik et al., 2023). In addition, compost enhances the activity of soil microorganisms and contributes to its fertility and prevents soil erosion by forming stable aggregates (Doan et al., 2015). Compost has the ability to increase the fertility of rainfed fields due to its organic composition and high water holding capacity (Ozturk and Yildirim, 2013; Doan et al., 2015; Abbott et al., 2018

Nitrogen deficiency, both directly and indirectly, has always been considered as a limiting factor in plant growth (Moshki et al., 2017). Nitrogen is directly involved in production of new cells, production of nitrogen compounds in cells, production of enzymes and cell membrane components of the cells and also has an indirect effect on also has an indirect effect on leaf area growth and plant growth (Arshadi and Asgharipour, 2011). Nitrogen deficiency symptoms in most plants appear as yellowing or pale leaves (chlorosis), especially in the lower leaves of the plant. Under severe nitrogen deficiency conditions, these leaves turn completely yellow and drop from the plant (Taiz and Zeiger, 2010). Some studies have shown that nitrogen deficiency reduces the water potential and also increases the abscisic acid of the leaves, which may be effective in the aging process of the leaves (Gardner et al., 1988; Haidari et al., 2023). Ichie et al. (2002) reported that among the macronutrients and essential elements for plants, nitrogen is the most important element for growth.

Photosynthetic pigments such as chlorophyll are the most important factors in the photosynthetic capacity of plants, because they directly affect the rate and amount of photosynthesis and biomass production (Nouri et al., 2020). These compounds, in addition to trapping the radiation energy of the sun and transferring it to the photosynthetic system (in form of antenna pigments, in the energy funnel complex), are also considered part of the plant's antioxidant system, contributing to the destruction of reactive oxygen species and effective factors in oxidative stress (Taiz and Zeiger, 2010; Inze and Montagu, 2000).

Peanut (*Arachis hypogaea* L.) is one of the sources of edible oil supply in the world and an important crop in Guilan province in Iran. This product has an effective role in promoting the economic prosperity of this province. In 2018, the area under peanut cultivation in Gilan province was 2860 ha and the largest share in the production of this product belonged to farmers in Astana region with 9529 tons of dry pods from 2507 ha (Anonymous, 2019). Peanut is not very drought tolerant and insufficient water supply is one of the factors limiting its yield. In other words, successful peanut cultivation and production requires adequate water supply during the growing season (Reddy et al., 2003). However, the sensitive stage of peanuts to water availability is from flowering to the end of the pod filling period (i.e. reproductive stage) and drought stress during the vegetative growth stage, compared to reproductive stage, has little effect on seed yield (Kumar et al., 2010). Therefore, it seems that peanut planting might be accomplished without irrigation in areas with adequate rainfall and a match between rainfall distribution and peanut reproduction stage. It is presumed that by applying compost which can increase the water use efficiency, a positive step can be taken to produce peanuts without irrigation.

Although legumes can provide some of the required nitrogen through their ability to biologically fix nitrogen (Denison and Kiers, 2011), studies demonstrated that nitrogen application at early growth stages is useful and even necessary, as nodules have not yet formed and the amount of starter nitrogen in the soil would be low (Salvagiotti et al., 2008). It is also advisable to use nitrogen fertilizers at the final stages of crop growth along with the formation of seeds, because seeds are very strong reservoirs of nitrogen accumulation and the amount of fixed nitrogen may not meet the needs of seeds (Silvia and Frantisek, 2012). Sugut et al. (2013) showed that the application of 200 kg N ha^{-1} resulted in the highest yield of fruits and seeds and increased the amount of nitrogen and protein content of peanut seeds. Accordingly, the present study aimed to investigate the effect of municipal waste compost and nitrogen fertilizer on yield and quality and physiological characteristics of peanut plants under both irrigation and no-irrigation conditions.

MATERIALS AND METHODS

This research was carried out in a farm located in Parkapasht village of Astaneh Ashrafieh city in Guilan province (37°18’N, 49°52’E, 2 m a.s.l.). The experimental design was Randomized Complete Block Design (RCBD) arranged in split plots with three replications, carried out in 2018 and 2019 and subjected to a combined analysis. In this experiment, the main plot consisted of two levels of irrigation, with and without irrigation. Compost application treatment (at two application levels of 5 t ha^{-1} and control) as a subplot and nitrogen fertilization treatment (at four levels of 0.0, 20.0, 40.0 and 60.0 kg of pure nitrogen per ha) as a sub-subplot. The homogeneity of the variance of the experimental errors was ensured by means of the Bartlett test before the performance of the combined data analysis.

Before land preparation, the soil was randomly sampled from six points at a depth of 0 to 30 cm and its physical and chemical properties investigated (Table 1). The texture of soil at the experimental site was silty. After soil preparation, planting took place in the third week of May in both years of the experiment. Before sowing, the physical and chemical properties of the municipal waste compost were analysed (Table 2) and then applied according to the determined rate in the respective treatments. Nitrogen was applied as urea fertiliser in two stages (half before planting and half one month after germination) according to the specified rate. Each plot consisted of six planting rows of 5m in length with a distance between rows of 0.6 m. Row spacing and planting depth were 20 and 6 cm, respectively, and plant density was considered to be 8.3 plants per m^2.

After planting, all field operations such as irrigation and application of nitrogen fertilizer (in the respective treatments), and weed control were applied equally in all treatments. In both years, for irrigation treatment, the amount of irrigation water was monitored by installing a volume meter in the field. Irrigation was applied eight times and in total of 2400 m^3 water was used. The amount of rainfall during the growing season in the two years of the experiment was 138 and 219 mm, respectively (Table 3).

Table 1. Soil characteristics of the experiment site

Year of experiment	pH	EC (dS m^{-1})	K (mg kg^{-1})	P (mg kg^{-1})	Total N (%)	OC (%)	Fe (mg kg^{-1})	Zn (mg kg^{-1})	S (%)	Ca (mg kg^{-1})
2018	7.32	0.60	195	12.0	0.11	1.08	98.6	3.2	2.2	38.1
2019	7.29	0.55	218	10.8	0.09	0.81	39.4	2.1	0.14	42.1

Table 2. Characteristics of used compost in the experiment

Year of experiment	EC (dS m $^{-1}$)	Na (%)	K (%)	P (%)	Total N (%)	OC (%)	Humidity (%)
2018	2.35	0.60	0.72	1.25	1.58	20.31	18.77
2019	2.75	0.50	0.31	1.60	1.66	21.32	18.14

Table 3. Meteorological information of the experiment site during the growing season

Months of growing season (from planting up to harvest)	Year of experiment	Rate of rainfall (mm)	Mean of humidity (%)	Mean of temperature (°C)
May	2018	12.0	75	19.0
	2019	61.3	77	19.1
June	2018	16.4	74	23.4
	2019	1.3	72	25.0
July	2018	14.0	74	28.4
	2019	54.6	76	26.7
August	2018	88.6	78	27.2
	2019	22.1	76	25.9
September	2018	7.0	77	25.1
	2019	79.7	83	23.3

In both years, in the middle of flowering stage, the amount of chlorophyll *a*, *b* and carotenoids of the leaves were determined using a spectrophotometer (Lichtenthaler and Wellburn, 1983). First, 0.1 g of leaves was ground with four ml of 80% acetone in a porcelain mortar and the resulting solution was centrifuged for 5 min at 3000 rpm. Adsorption of the supernatant was then measured using a model A model 2100 spectrophotometer at wavelengths of 646, 663 and 470 nm was used to determine the amount of chlorophyll and carotenoids. 80% acetone was used for resetting. The contents of chlorophyll a and b and of carotenoids (in mg/g fresh leaf weight) were calculated using equations 1, 2 and 3.

Eq 1: $Chl_a = 12.25A_{663} - 2.79A_{646}$

Eq 2: $Chl_b = 21.21A_{646} - 5.1A_{663}$

Eq 3: $carotenoid = \dfrac{1000A_{470} - 1.8chla - 85.02chlb}{198}$

In these equations: A_{646}, A_{663} and A_{470} are the light absorption at wavelength of 646, 663 and 470 nm, respectively.

In the lower half of each plot, used for yield assessment, the crop is harvested following removal of the weeds, threshed and seed separated for seed yield measurement. To calculate the rate of seed production, 200 g of fully ripe and dried pods were selected from each plot. A digital balance was then used to determine the weight of the shell, pods and seeds from this 200 g sample. The seed percentage was determined from the ratio of seed weight to pod weight. The amount of nitrogen in the seed was determined by titration after distillation using an automatic Kajeldahl system, and then seed protein was determined as the product of nitrogen multiplied by 5.46 (Smart, 1994). Seed oil was extracted by the Soxhlet method (Smart, 1994). Harvesting was carried out in the last week of September in both years of the experiment. The data were analysed using SAS software and the means were compared using the Duncan test.

RESULTS AND DISCUSSION

Chlorophyll a

The interaction effect of irrigation, compost and nitrogen on peanut chlorophyll *a* content was significant (Table 4). The highest amount of chlorophyll *a* was observed in treatment with irrigation and application of 5 t. ha^{-1} compost and 60 kg N ha^{-1} at the rate of 11.1 mg g^{-1} FW. In other treatments, the amount of chlorophyll *a* was less than 11 mg g^{-1} FW (Table 5). In both compost levels and irrigation conditions, the amount of chlorophyll *a* was significantly higher than in same levels of compost and non-irrigation conditions. The amount of chlorophyll an also increased significantly with increasing nitrogen use at different compost and irrigation levels. The lowest amount of chlorophyll *a* was also observed in treatment of no-irrigation and no-application of compost and nitrogen. The amount of chlorophyll *a* in this treatment did not even reach seven mg g^{-1} FW (Table 5). It seems that water scarcity has a negative effect on the process of chlorophyll a synthesis and this has reduced the amount of it. According to scientific reports, measuring the concentration of chlorophyll as an indicator of the strength of the main sources of photosynthesis (leaves) in the plant is a well-known and reliable method. (Nouri et al., 2020; Arshadi et al., 2021). Karami et al. (2020) reported a decrease in the amount of chlorophylls in Amaranth (*Amaranthus hypochondriacus*) along with reducing the soil moisture availability and increasing the intensity of drought stress. The decrease in chlorophyll content is caused by its increased degradation, destroying the photosynthetic pigment structure and lacking conditions for chlorophyll synthesis. In another study, Nikolaeva et al (2010) investigated the effects of drought stress on chlorophyll content and antioxidant enzyme activity in leaves of three wheat cultivars and found that chlorophyll content increased at the beginning of the drought stress and then decreased during the stress. In addition, this study showed that applying compost at irrigation levels resulted in a significant increase in chlorophyll a compared to no application. It appears that by providing water and nutrients necessary for chlorophyll synthesis (such as nitrogen), compost application was able to increase its levels. Research has shown that nitrogen is part of the chlorophyll molecule and that it may increase chlorophyll synthesis if it is available (Taiz and Zeiger, 2010). Arshadi et al. (2021) reported a significant increase in chlorophyll a in chickpea with the combined application of rhizobial and mycorrhizal biofertilisers and attributed this to the availability of elements required for chlorophyll a synthesis (particularly nitrogen) by rhizobia and mycorrhiza.

Table 4. Variance analysis results for studied traits of peanut

SOV	DF	Mean squares					
		Chlorophyll *a*	Carotenoids	Seed yield	Seed oil	Protein of seed	Rate of Kernel production
Year (Y)	1	1.66 ns	32.90 ns	63860 ns	117 ns	85.70 ns	84.40 ns
Replication * Y	4	13.61	49.70	16012	139	13.10	15.60
Irrigation (I)	1	128.70 **	204 **	2317574 **	1600 **	263 **	222 ns
Y × I	1	0.00 ns	18.90 ns	28635 **	0.04 ns	0.10 ns	0.37 ns
Error (a)	4	0.116	15.6	4001	0.145	1.85	194
Compost (C)	1	25.81 **	150 **	586875 **	2.10 **	68.00 **	1820 **
Y × C	1	0.00 ns	18.00 ns	5400 ns	0.40 ns	0.02 ns	0.04 ns
I × C	1	3.93 **	57.00 ns	148208 **	0.66 **	20.50 **	0.04 ns
Y × I × C	1	0.00 ns	19.60 ns	8702 ns	0.08 ns	0.14 ns	0.04 ns
Error (b)	8	0.08	18.61	5864	0.13	1.26	85.50
Nitrogen (N)	3	3.28 **	46.82 ns	484472 **	15.32 **	101 **	15.41 **
Y × N	3	0.00 ns	18.91 ns	9475 *	0.04 ns	0.06 ns	0.15 ns
I × N	3	0.16 **	17.82 ns	22875 **	6.96 **	0.22 ns	1.04 ns
C × N	3	0.18 **	22.83 ns	20186 **	4.07 **	1.76 ns	1.47 ns
Y × I × N	3	0.00 ns	18.50 ns	8964 *	0.05 ns	0.04 ns	0.15 ns
Y × C × N	3	0.00 ns	18.92 ns	2159 ns	0.07 ns	0.06 ns	0.26 ns
I × C × N	3	0.68 **	16.31 ns	6210 ns	4.77 **	2.97 ns	5.93 ns
Y × I × C × N	3	0.00 ns	18.40 ns	1074 ns	0.03 ns	0.04 ns	0.26 ns
Error (c)	48	0.01	18.90	2386	0.08	1.23	2.18
CV (%)	-	1.51	25.91	3.53	0.63	4.99	2.39

*ns, * and **: non-significant, significant in 5% and 1% level, respectively*

Carotenoids

The effect of irrigation on peanut carotenoids was significant (Table 4). Irrigation caused a significant increase of 18.9% in amount of peanut leaves carotenoids compared to droughty condition (Figure 1). These results are in agreement with the findings of other researchers (add references). Karimi et al. (2020) also stated in their reports, a significant decrease in carotenoids during the decrease of soil moisture.

The effect of the compost on the carotenoids of the peanut was significant (Table 4). Applying 5 t ha^{-1} of compost significantly increased (16.1%) the amount of carotenoids in peanut leaves (Figure 2). It seems that the application of compost, due to its ability to release nutrients gradually (Governog et al., 2003), can be effective in providing the necessary substrate for carotenoid synthesis in the peanut plant. In general, carotenoids are isoprenoid molecules that are studied in the form of groups such as hydrocarbon carotenes, such as lycopene and beta-carotene, or xanthophylls (Taiz and Zeiger, 2010).

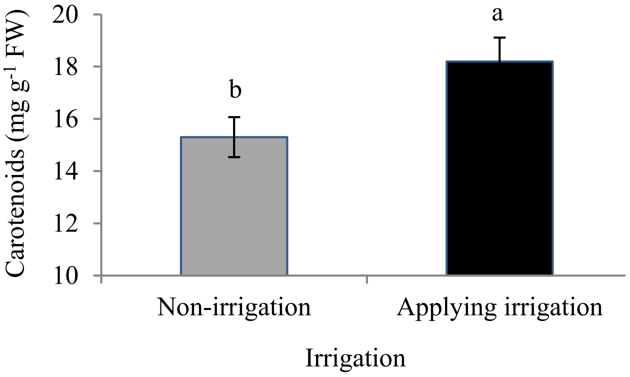

Figure 1. Effect of irrigation on carotenoids of peanut.
Means that have a common letter, have not significantly different together at 5% based on Duncan test.

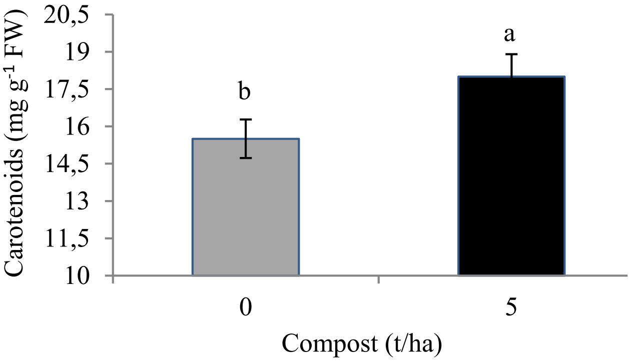

Figure 2. Effect of compost on carotenoids of peanut.
Means that have a common letter, have not significantly different together at 5% based on Duncan test.

Seed yield

The interaction effect of irrigation and application of compost on the seed yield of peanut was significant (Table 4). The treatment of irrigation and application of 5 t ha^{-1} compost at the rate of 1576 kg.ha^{-1} produced the highest seed yield. This treatment was statistically grouped with the irrigation and no compost treatment (Table 6). Seed yield was significantly higher in both compost levels and irrigated conditions compared to the unapplied and irrigated treatments. The lowest seed yield was also observed in the treatment without irrigation and without applying compost, so that the seed yield in this treatment was less than 1110 kg ha^{-1} (Table 6).

The interaction effect of compost and nitrogen on peanut seed yield was significant (Table 4). That is, the highest seed yield was obtained in two treatments of applying 5 t ha^{-1} compost and applying 40 and 60 kg N ha^{-1}, and it was only in these two treatments that the seed yield reached more than 1550 kg ha^{-1}. The evaluation of the results of the comparisons of means showed that the seed yield in the treatment with 5 t. ha^{-1} compost and 60 kg N/ha was about 10% higher than in the same conditions with nitrogen fertilizer and no compost (Table 7). In general, each level of nitrogen fertilizing in the conditions of application of 5 t ha^{-1} of manure, compared to their similar levels in the conditions of no application of manure, showed significantly higher seed yield (Table 7). The treatment of no application of compost and nitrogen fertiliser had the lowest seed yield of 1160 kg ha^{-1} (Table 7). It seems that application of compost with nitrogen fertilizer can significantly increase the yield of peanut because of its positive effects such as gradual release of nutrients (Governog et al., 2003) and increased soil moisture storage (Waqas et al., 2014).

Year, irrigation and N interactions on peanut seed yield were significant (Table 4). In both years, the highest seed yield was assigned to irrigation treatments and application of 40 and 60 kg N ha^{-1}, and only under these treatments the obtained seed yield was more than 1600 kg ha^{-1}. In the other treatments the seed yield was less than 1530 kg ha^{-1} (Table 8). In both years, the highest seed yield was assigned to irrigation treatments and application of 40 and 60 kg N ha^{-1}, and only under these treatments the seed yield obtained was more than 1600 kg ha^{-1}. This is probably due to higher precipitation during the growing season in the second year than in the first year (Table 3). In both years, however, the negative effect of water shortage was reduced by nitrogen application under non-irrigated conditions (Table 8). The role of nitrogen fertiliser in the reduction of the negative effects of moisture deficiency has been reported by other researchers (Tran et al., 2014). Studies have shown that cell growth is strongly dependent on water availability and maintenance of cell turgor, and that reducing turgor pressure reduces the rate of cell growth and development (Khalid et al., 2019). It appears that the negative effects of the lack of moisture on the peanut can be compensated to some extent by the application of nitrogen fertilizer in areas such as Gilan. Nitrogen availability can be effective in producing more dry matter and achieving higher yields by having a positive effect on chlorophyll and plant protein synthesis and plant leaf development (Arshadi and Asgharipour, 2011).

Table 5. Mean comparisons of interaction of irrigation, compost and nitrogen on Chlorophyll a and seed oil of peanut

Irrigation	Compost (t ha^{-1})	Nitrogen (kg ha^{-1})	Chlorophyll *a* (mg g^{-1} FW)	Seed oil (%)
Non-irrigation	0	0	6.7 p	41.9 i
		20	7.1 o	42.6 h
		40	7.4 n	43.6 g
		60	7.5 m	42.8 h
	5	0	8.4 l	43.3 g
		20	8.5 k	41.8 i
		40	8.7 j	42.0 i
		60	7.9 i	44.5 f
Applying irrigation	0	0	9.7 g	48.9 e
		20	9.8 f	50.7 c
		40	10.0 e	51.7 b
		60	10.2 d	51.7 b
	5	0	9.5 h	49.8 d
		20	10.6 c	50.8 c
		40	10.9 b	52.5 a
		60	11.1 a	51.8 b

Means that have a common letter, have not significantly different together at 5% based on Duncan test.

Table 6. Mean comparisons of interaction of irrigation and compost on seed yield and seed protein of peanut

Irrigation	Compost (t ha^{-1})	Seed yield (kg ha^{-1})	Seed protein (%)
Non-irrigation	0	1109 c	19.2 c
	5	1344 b	21.8 b
Applying irrigation	0	1498 a	23.5 a
	5	1576 a	24.2 a

Means that have a common letter, have not significantly different together at 5% based on Duncan test.

Table 7. Mean comparisons of interaction of compost and nitrogen on seed yield of peanut

Compost (t.ha^{-1})	Nitrogen (kg ha^{-1})	Seed yield (kg ha^{-1})
0	0	1160 e
	20	1256 d
	40	1356 c
	60	1443 b
5	0	1233 d
	20	1450 b
	40	1555 a
	60	1603 a

Means that have a common letter, have not significantly different together at 5% based on Duncan test.

Table 8. Mean comparisons of interaction of year, irrigation and nitrogen on seed yield

Year	Irrigation	Nitrogen (kg ha^{-1})	Seed yield (kg ha^{-1})
2018	Non-irrigation	0	920 h
		20	1144 g
		40	1270 ef
		60	1401 cd
	Applying irrigation	0	1367 d
		20	1507 b
		40	1618 a
		60	1623 a
2019	Non-irrigation	0	1114 g
		20	1235 f
		40	1305 e
		60	1424 c
	Applying irrigation	0	1385 cd
		20	1526 b
		40	1630 a
		60	1643 a

Means that have a common letter, have not significantly different together at 5% based on Duncan test.

Seed oil

The analysis of variance showed that the interaction of irrigation, compost and nitrogen on the amount of seed oil was significant (Table 4). The highest amount of seed oil was observed in the treatment of irrigation and compost application and 40 kg N ha^{-1}, and only in this treatment the amount of seed oil reached more than 52%. This was followed by irrigation and compost application and 60 kg N ha^{-1}. In the other treatments, seed oil was less than 51% (Table 5). The amount of seed oil in different levels of compost and nitrogen fertilizer application and doing irrigation conditions was significantly higher than the same levels of compost and nitrogen fertilizer in non-irrigation conditions. Especially, each levels of nitrogen fertilizer in conditions of applying irrigation, compared to their similar levels in the conditions of non-irrigation, showed a significantly higher amount of seed oil (Table 5). The lowest seed oil content was observed in the treatment that did not irrigate and did not apply composting and N fertilizing, with seed oil content in this treatment not even reaching 42% (Table 5). Although temperature is reported to be the most important environmental factor affecting seed oil production in oilseed crops (Damian et al., 1998; Dragicevic et al., 2015), water availability seems to have a significant effect on oil production and transfer to peanut seeds. Scientific research indicates that the synthesis of oil and its accumulation in peanut seeds strongly depend on the photosynthetic material produced during the period of 5-12 weeks after flowering, and most of the photosynthetic compounds produced during this period are used for oil synthesis and its transport (Fageria, 2009). Therefore, the occurrence of drought stress during this period can be effective in reducing the amount of seed oil in peanut, as the availability of moisture during this period is important for photosynthesis and the conversion of photosynthetic products into oil and its transfer to the growing seed.

Seed protein

The interaction effect of irrigation and compost on peanut seed protein was significant (Table 4). Thus, the highest seed protein was observed in the two treatments of irrigation and no compost application and application of 5 t. ha^{-1} compost, and in these two treatments the amount of seed protein reached more than 23.4% (Table 6). In other words, in both compost levels under irrigated conditions, seed protein reached more than 23.4%. On the other hand, in the non-irrigated conditions (Table 6), the seed protein in both composts did not even reach 22%. The treatment with no irrigation and no compost also had the lowest seed protein. Thus, the seed protein in this treatment was less than 20% (Table 6). However, in the conditions of doing irrigation, there was no significant difference between the two levels of compost treatment in terms of seed protein; But in the condition of no irrigation, the use of compost caused a significant increase in seed protein compared to the condition of not using it (Table 6). Under drought stress conditions, protein is usually degraded, which is probably due to the formation of some amino acids by protein degradation in response to drought stress (El-Sabagh et al., 2019). In the present study, reduced seed protein was quite evident when not irrigated. However, compost application under no-irrigation could significantly improve seed protein content. This is probably due to the high moisture holding capacity of compost (Waqas et al., 2014). However, the amount of seed protein was still significantly lower with no irrigation and compost application compared to different levels of irrigation.

The effect of nitrogen fertilizer on the amount of peanut protein was significant (Table 4). The amount of seed protein increased significantly with increasing N application. The highest amount of seed protein was obtained under 60 kg N ha^{-1} with a rate of 23.9% (Figure 3). The lowest amount of seed protein (less than 19.3%) was observed with no nitrogen fertilizer (Figure 3). Considering the important role of nitrogen in protein molecule structure (Taiz and Zeiger, 2010), the effect of reduced nitrogen availability on seed protein synthesis is obvious and increasing nitrogen availability may improve peanut seed protein levels. These results are consistent with the findings of other researchers. A significant increase in peanut seed protein during the application of nitrogen fertilizer was reported by Sugut et al. (2013).

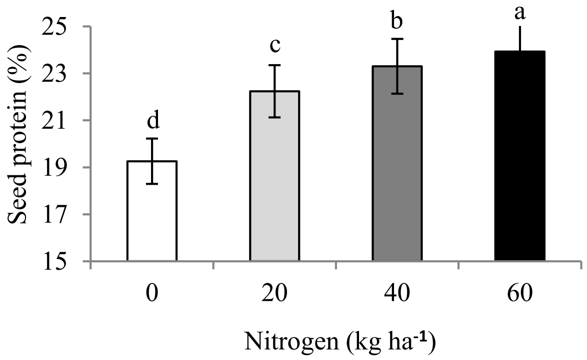

Figure 3. Effect of nitrogen on seed protein of peanut
Means that have a common letter, have not significantly different together at 5% based on Duncan test.

Rate of kernel production

The effect of compost on the rate of peanut kernel production was significant (Table 4). Applying 5 t ha^{-1} of compost resulted in a significant increase of 15.2% in the rate of kernel production (Figure 4). Apparently, compost application is effective in allocating more nutrients to rate of kernel production of peanut due to its ability to absorb and retain water and nutrients (Governog et al., 2003) and gradual release of nutrients (Waqas et al., 2014). The effect of nitrogen fertilization on the rate of kernel production of peanut was significant (Table 4). The rate of kernel production also increased when the amount of nitrogen applied was increased from zero to 60 kg N ha^{-1}. However, between 40 and 60 kg N ha^{-1} there was no significant difference. On this basis, the lowest rate of kernel production was observed in the no nitrogen fertilizer treatment (Figure 5). These results agree with those reported by other researchers. Abdzad Gohari et al. (2018) also found in their research that with an increase in the amount of nitrogen consumption from zero to 60 kg per ha, the rate of kernel production increased and with a further increase in the amount of nitrogen from 60 to 90 kg per ha, the percentage rate of kernel production decreased significantly.

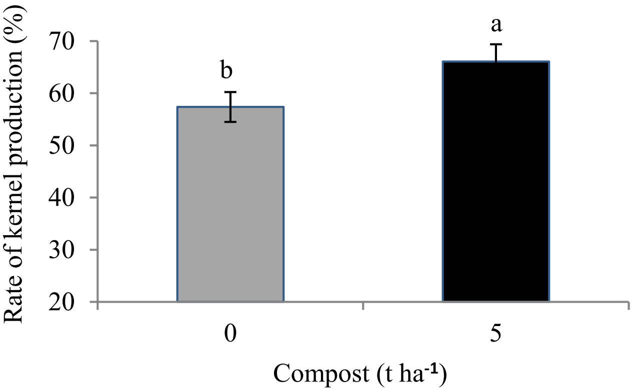

Figure 4. Effect of compost on rate of kernel production of peanut
Means that have a common letter, have not significantly different together at 5% based on Duncan test.

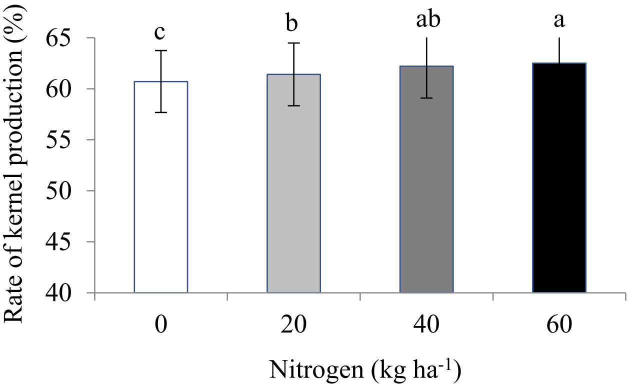

Figure 5. Effect of nitrogen on rate of kernel production of peanut
Means that have a common letter, have not significantly different together at 5% based on Duncan test.

CONCLUSIONS

Nitrogen application compensated to some extent for the negative effects of drought stress on the physiological traits studied, based on the results of the present study. However, for some traits, such as seed yield, there was no significant difference between 40 and 60 kg N ha^{-1}. This is probably due to the ability of the peanut plant to biologically fix nitrogen. In other words, the peanut plant's nitrogen requirements up to 40 kg N ha^{-1} are probably supplied by the nitrogen fertilizer and the remaining plant requirements are met by biological fixation. Furthermore, the application of municipal waste compost reduced the negative effects of water stress under drought stress conditions and improved physiological characteristics and seed yield under no-stress conditions. Therefore, it seems that in order to improve the physiological characteristics and seed yield of peanut, the application of 40 kg N ha^{-1} together with 5 t ha^{-1} of municipal waste compost can be effective.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest or personal relationships.

STATEMENTS AND DECLARATIONS

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

LITERATURE CITED

Abbott, L.K., L.M. Macdonald, M.T.F. Wong, M.J. Webb, S.N. Jenkins and M, Farrell. 2018. Potential roles of biological amendments for profitable grain production-A review. Agriculture, Ecosystems and Environment 256: 34-50.

Abdzad Gohari, A and E. Amiri. 2018. Evaluations of Production Function and Water Productivity of Peanut Plant (Guil cv.) under Irrigation Conditions and Nitrogen Fertilizer. Journal of Water Research in Agriculture 32(1): 55-66.

Agassi, M., G.J. Levy, A. Hadas, Y. Benyamini, H., Zhevelev, E. Fizik, M. Gotessman and Sasson, N. 2004. Mulching with composted municipal solid wastes in Central Negev, Israel. Effects on minimizing rainwater losses and on hazards to the environment. Soil and Tillage Research 78: 103-113.

Anonymous. 2019. Information bank of database and statistic of agricultural Jihad organization of Guilan province. Ministry of Agriculture.

Arshadi, J and M.R. Asgharipour. 2011. The effects of seed size on germination and early seedling growth of pelleted seeds of sugar beet. Journal of Applied Sciences Research 7(8): 1257-1260.

Arshadi, M., M. Parsa, A. Lakzian and M. Kafi. 2021. Effects of mycorrhiza symbiosis on seed yield and some physiological responses of chickpea genotypes. Agriculture, Environment and Society 1(1): 31-37.

Damian, M.M., O.L. Diana, M.M. Jose, L.L. Alicia, A.Z. Julio and A.G. Carlos. 1998. Seed composition of soybean cultivar evaluated in different environmental regions. J. Sci Food Agric., 77: 494 - 8.

Doan, T.T., T. Henry-des-Tureaux, C. Rumpel. J.L. Janeaua and P. Jouquet. 2015. Impact of compost, vermicompost and biochar on soil fertility, maize yield and soil erosion in Northern Vietnam: A three year mesocosm experiment. Science of the Total Environment 514: 147-154.

Dragicevic, V., S. Kratovalieva, Z. Dumanović, Z. Dimov and N. Kravić. 2015. Variations in level of oil, protein, and some antioxidants in chickpea and peanut seeds. Chemical and Biological Technologies in Agriculture 2(2): 1-6.

El-Sabagh, A., A. Hossain, C. Barutcular, O. Gormus, Z. Ahmad, S. Hussain, M. Islam, H. Alharby, A. Bamagoos, N. Kumar, H. Akdeniz, S. Fahad, R.S. Meena, M. Abdelhamid, A. Wasaya, M. Hasanuzzaman, S. Sorour and H. Saneoka. 2019. Effects of drought stress on the quality of major oilseed crops: Implications and possible mitigation strategies. A review. Applied Ecology and Environmental Research, 17: 4019-4043.

Fageria, N.K. 2009. The use of nutrients in crop plants. CRC Press. Publisher Taylor and Francis Group. New York.

Denison, R.F and E.T. Kiers. 2011. Life histories of symbiotic rhizobia and mycorrhizal fungi. Current Biology, 21(18): R775-R785.

Gardner, F.P., R.B. Pearce and R.L. Mitchell. 1988. Physiology of Crop Plants (2nd Edition). Scientific Publishers 327 pp.

Governog, J., J. Gaskin, B. Faucette and D. Borden. 2003. The compost white paper (large-scale composting in Georgia). Prepared for the Pollution Pre-Ventation Assistance Division. Department of Natural Resource Atlanta, Georgia.

Hargreaves, J.C., M.S. Adl and P.R. Warman. 2008. A review of the use of composted municipal solid waste in agriculture. Journal of Agriculture, Ecosystem and Environment 123: 1-14.

Ichie, T., Y. Kitahashi, S. Matsuki, Y. Maruyama and T. Koike. 2002. The use of a portable non- destructive type nitrogen meter for leaves of woody plants in field studies. Photosynthetica, 40(2): 289-292.

Inze, D and M.V. Montagu. 2000. Oxidative stress in plants. Cornavall, Great Britain 105-135.

Karami, S., H. Hadi, M. Tajbaksh and S.A.M. Modarres-Sanavy. 2020. Effect of Zeolite on Nitrogen Use Efficiency and Physiological and Biomass Traits of Amaranth (Amaranthus hypochondriacus) Under Water-Deficit Stress Conditions. Journal of Soil Science and Plant Nutrition, 20: 1427-1441.

Khalid, M.F., S. Hussain, S. Ahmad, S. Ejaz, I. Zakir, M.A. Ali, N. Ahmed and M.A. Anjum. 2019. Impacts of Abiotic Stresses on Growth and Development of Plants. In Plant Tolerance to Environmental Stress. CRC Press: Boca Raton, FL, USA P 1–8.

Kumar, V., M.P. Ghewande, I.K. Girdhar, R.D. Padavi and P.K. Bhalodia. 2010. Effect of salinity stress on foliar fungal diseases of peanut. Indian Phytopathol 63: 273–277.

Lichtenthaler, H.K and A.R. Wellburn. 1983. Determinations of total carotenoids and chlorophylls a and b of leaf extracts in different solvents. Portland Press Ltd., South Portland. 591-592.

McDonagh, J.F., T. Birch Thomsen and J. Majid. 2001. Soil organic matter decline and compositional change associated with cereal cropping in southern Tanzania. Land Degradation and Development 12(1): 13-26.

Moshki, A., E. Nouri and N. Soleyman Dehkordi. 2017. The pattern of soil carbon sequestration changes regarding physico-chemical soil properties (Case study: Semnan Sokan forest park). Iranian Journal of Forest and Poplar Research, 25(2): 244-253.

Nikolaeva, M.K., S.N. Maevskaya, A.G. Shugaev and N.G. Bukhov. 2010. Effect of Drought on Chlorophyll Content and Antioxidant Enzyme Activities in Leaves of Three Wheat Cultivars Varying in Productivity. Russian Journal of Plant Physiology, 57(1): 87–95.

Nouri, E., M. Matinizadeh. A. Moshki, A. Zolfaghari, S. Rajaei and M. Janoušková. 2020. Arbuscular mycorrhizal fungi benefit drought-stressed S alsola laricina. Plant Ecology. 221: 683-694.

Ozturk, G. and Z. Yildirim. 2013. Effect of bio-activators on the tuber yield and tuber size of potatoes. Turkish Journal of Field Crops 18(1): 82-86.

Papkyadeh, S.M.S., N.M. Roshan, S.M. Sadeghi, E. Amiri and M. Ashouri. 2023. Evaluation of nitrogen fertilizer and row spacing effect on yield and physiological characteristics of maize (Zea mays l.) under irrigated and rainfed conditions. Turkish Journal of Field Crops 28(2):183-193.

Reddy, T.Y., V.R. Reddy and V. Anbumozhi. 2003. Physiological responses of peanut (Arachis hypogea L.) to drought stress and its amelioration: a critical review. Plant Growth Regulation 41: 75–88.

Salvagiotti, F., K.G. Cassman, J.E. Specht, D.T. Walters, A. Weiss and A. Dobermann. 2008. Nitrogen uptake, fixation and response to fertilizer N in soybeans: A review. Field Crops Research 108(1): 1–13.

Silvia, P and B. Frantisek. 2012. Signaling and Communication in Plant Symbiosis. Springer – Verlang Berlin Heidelberg.

Sirousmehr, A., J. Arbabi and M.R. Asgharipour. 2014. Effect of drought stress levels and organic manures on yield, essential oil content and some morphological characteristics of sweet basil (Ocimum basilicum). Advances in Environmental Biology 8(4): 880-885.

Smart, J. 1994. The groundnut crop: A scientific basis for improvement. London. Chapman and Hall 734 pp.

Taiz, L and E. Zeiger. 2010. Plant Physiology. Sinauer Associates is an Imprint of Oxford University Press; 5th edition 782 pp.

Tepecik, M., A.R. Ongun, H.H. Kayikcioglu, S. Delibacak, O.L. Elmaci, A.E. Celen and E. Ilker. 2022. Change in cotton plant quality in response to application of anaerobically digested sewage sludge. Saudi Journal of Biological Sciences, 29(1): 615-621.

Tepecik, M., A.R. Ongun, H.H. Kayikcioglu, S. Delibacak, T. Birisci, E. Aktas, A.K. Onac and G. Balik. 2023. Effects of Sewage Sludge on Marigold (Tagetes erecta L.) and Garden Verbena (*Verbena hybrida*) Plants and Soil. Kahramanmaras Sutcu Imam University Journal of Agriculture and Nature, 26(1):162-173.

Tran, T.T., M. Kano-Nakata, M. Takeda, D. Menge, S. Mitsuya, Y. Inukai and A. Yamauchi. 2014. Nitrogen application enhanced the expression of developmental plasticity of root systems triggered by mild drought stress in rice. Plant and Soil 378: 139-152.

Waqas, M., B. Ahmad, M. Arif, F. Munsif, A.L. Khan, M. Amin, S.M. Kang, Y.H. Kim and I.J. Lee. 2014. Evaluation of humic acid application methods for yield and yield components of mungbean. American Journal of Plant Sciences 5: 2269-2276.