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Effect of polymers and NPK fertilizer on the vegetative and flowering characteristics of *Senna surattensis* under deficient irrigation

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ABSTRACT

The experiment was conducted at the Department of Horticulture and Landscape at the College of Agriculture, Tikrit University, during fall of 2022. The aim was to investigate the effects of three factors on growth and flowering attributes of *Senna surattensis*. The first factor represented three drip irrigation methods full irrigation (FI) 100% on both sides, deficit irrigation (50%) on one side, and partial root-zone drying (PRD) with a 50% rate. The second factor involved adding hydrogel polymers SWT (soil water trap) at three levels 5 g plant^{-1}, 10 g plant^{-1}, well as without polymers. The third factor NPK fertilizer (12:12:36), applied 10 g plant^{-1} and without fertilizer. The randomized complete block design was used in this study. Data of number of vegetative branches, number of floral branches, plant height, weight of inflorescence, and total chlorophyll content were collected. The findings demonstrated that each treatments of (FI), 10 g plant^{-1} NPK fertilizer, and 10 g plant^{-1} polymer application had significant influences on the number of vegetative, and floral branches, plant height, inflorescence weight, and total chlorophyll content compared to rest of the treatments. The results also showed that interactions between (FI) and each of 10 g plant^{-1} polymer, 10 g plant^{-1} NPK were significant compared to others.

تأثير البوليمرات والتسميد NPK على الصفات الخضرية والزهرية لشجيرة الاكاسيا تحت الري الناقص

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الخلاصة

أجريت التجربة في حقول قسم البستنة وهندسة الحدائق / كلية الزراعة / جامعة تكريت. خلال موسم الخريف لعام 2022 لدراسة تأثير ثلاث معاملات في الصفات الخضرية والزهرية لشجيرة الاكاسيا؛ المعاملة الأولى: الري الكامل 100% (FI) ، الري الناقص 50% (DI) على جانب واحد من النبات والتجفيف الجزئي المتناوب لمنطقة الجذر 50% (PRD). المعاملة الثانية: إضافة البوليمر على ثلاث مستويات 5 غم نبات$^{-1}$، 10 غم نبات$^{-1}$، وبدون إضافة بوليمر (معاملة السيطرة). المعاملة الثالثة: التسميد NPK (12:12:36) بمستويين 10 غم نبات$^{-1}$ وبدون إضافة سماد (معاملة السيطرة). تم استخدام تصميم القطاعات العشوائية الكاملة (RCBD) بثلاث مكررات. أظهرت النتائج تفوقاً معنوياً في صفات عدد الأفرع الخضرية والزهرية وارتفاع النبات ووزن الازهار ومحتوى الكلوروفيل الكلي لأوراق شجيرة الاكاسيا للمعاملات: الري الكامل (FI) ، التسميد 10غم نبات$^{-1}$، وإضافة البوليمر 10 غم نبات$^{-1}$ مقارنة بجميع المعاملات الأخرى كما أظهرت النتائج تأثير معنوي للتداخل الثنائي بين الري الكامل مع كل من البوليمر 10 غم نبات$^{-1}$ والتسميد 10غم نبات$^{-1}$ مقارنة بجميع المعاملات الأخرى.

الكلمات الافتتاحية: الاكاسيا ، البوليمرات ، الري الناقص ، التجفيف الجزئي المتناوب لمنطقة الجذر ، التسميد.

INTRODUCTION.

Cassia glauca (*Senna surattensis* L.), Senna genus, belongs to the Senna genus and is commonly known as Glaucous. This plant is an attractive member of the Leguminosae family (Fabaceae). Sennas derive their name from the Arabic word "Sana." It is a tiny, upright evergreen shrub. This plant is moderate to large in size, 3-6 m in height with 2-3 m spread. Plants of this family are popular around the world, growing in many different climates (Stevens, 2001). Usually, it grows during fall and spring seasons (Hanelt et al., 2001). This plant produces vibrant golden yellow flowers at the tips of its branches, grouped in clustered inflorescences. The plant grows in full sun and is best suited for well-drained soil. It is also highly resistant to drought. The fruit of this plant is a pod contains 3–5 seeds, (Hanelt et al. 2001 and Ayo et al. 2007). In dry and semi-arid areas, polymers extensively serve as receptacles for water and plant nutrients. They significantly enhance water usage efficiency (Chang et al., 2021). They have the ability to absorb water at a rate 400–1500 times their dry weight which increase the amount of moisture in root zone (Islam et al., 2011; Nazarli et al., 2010). Polymers show greater potential as vehicles for delivering fertilizers and insecticides (Jungsinyatam et al., 2022; Di Martino et al., 2021). It has the ability to hold water that is several times its own weight and may release around 95% of the water it retains (Yazdani et al., 2007). According to Dehkordi (2016), polymers often maintain their full functionality for a period of 3-5 years. You can add chemical fertilizers to the soil to enhance plant growth and boost the quantity and quality of biomass the plant produces (Sakakibara et al., 2006). The primary nutrients contained in fertilizers are nitrogen, phosphorous, and potassium (NPK). (Abdulkhaliq et al., 2024) reported that the application of NPK fertilizer enhanced *Rosa damascene's* growth and flowering traits in comparison to the absence of fertilizer. Deficit irrigation refers to the practice of providing water to plants at a lower rate and/or volume than what is required by their evapotranspirative (ET) requirement (Álvarez et al., 2013). While this may theoretically decrease crop production, it will also result in a decrease in the amount of water consumed (Geerts and Raes, 2009). Significant decreases in soil water availability can have detrimental effects on plant growth, impacting factors such as flowering, leaf coloration, and plant size (Mieszkalska and Lukaszewska, 2011; Álvarez et al., 2013). The partial root drying approach, a crucial irrigation strategy, exposes a portion of the root to dry soil while cultivating the rest in irrigated soil conditions (Ahmad et al., 2020; Rashid et al., 2019). The goal of this research is to determine the polymer's efficacy in promoting *Senna surattensis'* vegetative and flowering growth, characterize its response to chemical fertilization, and study the impact of deficit irrigation on the plant's growth and development.

MATERIALS AND METHODS

A field experiment was conducted at the Department of Horticulture and Landscape College of Agriculture Tikrit University, during fall of 2022 to study the effect of three factors and their interactions. The first factor was irrigation at three levels: full irrigation (FI) at 100% on both sides of the plant, deficit irrigation (DI) at 50% on one side, and partial root-zone drying irrigation (PRD) at 50%. PRD irrigation is a novel improvement of deficit irrigation in which half of the root zone is irrigated alternatively in scheduled irrigation events. Therefore, PRD represents a unique irrigation approach, as it places half of the roots in drying soil while the other half thrives in irrigated soil. The second factor was adding the polymer at three levels: 5g plant^{-1}, 10 g plant^{-1}, and without polymer (control). The third factor was NPK fertilizer (12:12:36) at two levels: 10 g plant^{-1} and non-fertilizer (control). The field was divided into three rows, with a separation of 1.5 m between each row. *Senna surattensis* seedlings were transplanted into planting holes of 30 cm in diameter and 40 cm in depth, with a spacing of 1.5 m between each hole. The cultivation was conducted with rows spaced 2 m apart. A drip irrigation network was installed, including a main line with a diameter of 86 mm, a feed line with a diameter of 54 mm, and lateral lines with a diameter of 16 mm. The dripper discharge was 8-10 L/h. Five sub-lines were distributed to the treatments: two lines on each side of the plants for both full (FI) and partial root-zone irrigation (PRD) treatments, and one sub-line on one side of the plants for the deficit irrigation (DI) treatment. This research used a hydrogel polymer SWT (soil water trap), brand ISONEM, a white granular dry powder with particle sizes of 0.8–1.0 mm. Added 5 or 10 g of the hydrogel polymer to the soil at a depth of 20 cm. NPK fertilizer (12:12:36) is applied to the fertilized plants with a total of 10 g divided into two doses, the first dose is applied during the planting of the seedlings, and the second dose is applied two months after planting.

The experiment had 18 factorial treatments made by the above-mentioned factors interacting with each other. There were three replicates, and each had three seedlings, for a total of 162 seedlings: 18 x 3 x 3. The experiment used a split-plot system with a randomized complete block design (RCBD), where irrigation levels were put in main plots while polymers and fertilizers were in secondary plots.. The results were evaluated using Duncan's Multiple Range Test, which compares the means at a significance level of 0.05. The data collected included the number of vegetative branches, number of floral branches, plant height, inflorescence weight, and total chlorophyll content.

RESULTS AND DISCUSSION

The number of vegetative branches on *Senna surattensis* increased significantly following the three treatments shown in table (1): FI, NPK fertilizer and polymer addition (10 g plant^{-1}). The treatments gave 19.44, 15.49, and 15.07 branches plant^{-1}, respectively. On the other hand, the other treatments (DI, without fertilizer and polymer) showed the lowest values, measuring 9.51, 13.03, and 13.36 branches per plant, respectively. There were big differences between the treatments shown in the table between the double interaction treatments (FI) with 10 g plant^{-1} of NPK, (FI) with 10 g plant^{-1} of polymer, and the interaction of NPK 10 g plant^{-1} with polymer 10 g plant^{-1}. The maximum values recorded were 21.45, 20.50, and 16.24 branch plant^{-1}, respectively. The triple interaction analysis results in the same table indicated substantial differences among the treatments. The treatment comprising the triple interaction of (FI) with NPK at 10 g per plant and polymer at 10 g per plant produced the greatest average of 22.67 branches per plant. Conversely, the treatment characterized by the triple interaction of deficit irrigation (DI), without fertilizer and polymer had the lowest average value of 8.15 branches per plant.

Table (1): Effect of irrigation, NPK fertilizer, and polymers and their interaction on the number of vegetative branches (branch plant $^{-1}$) of *Senna surattensis*

Irrigation	NPK fertilizer g plant^{-1}	Polymer g plant^{-1}			Interaction between irrigation and NPK fertilizer	Means of irrigation
		0	5	10		
FI	**0**	15.29 g	18.66 d	18.33 e	17.43 b	**19.44 a**
	10	20.34 c	21.34 b	22.67 a	21.45 a	
DI	**0**	8.15 q	8.63 p	9.65 o	8.81 f	**9.51 c**
	10	9.70 o	10.33 n	10.63 m	10.22 e	
PRD	**0**	12.35 l	12.55 k	13.70 j	12.87 d	**13.84 b**
	10	14.31 i	14.70 h	15.44 f	14.82 c	
Interaction between irrigation and polymer	**FI**	17.81 c	20.00 b	20.50 a	**Means of NPK fertilizer**	
	DI	8.92 i	9.48 h	10.14 g		
	PRD	13.33 f	13.62 e	14.57 d		
Interaction between NPK fertilizer and polymer	**0**	11.93 f	13.48 e	13.98 d	**13.03 b**	
	10	14.78 c	15.45 b	16.24 a	**15.49 a**	
Means of polymer		**13.36 c**	**14.37 b**	**15.07 a**		

Averages with the same alphabet for single factors and their overlaps do not differ significantly according to the Dunkin' polynomial test at a probability level of 0.05.
FI (full irrigation 100% on both sides of the plant).
DI (deficient irrigation 50% on one side of the plant).
PRD (partial root-zone drying irrigation 50%).

The data presented in table 2 demonstrates that full irrigation (FI), applying 10 g plant^{-1} of NPK fertilizer and 10 g plant^{-1} of polymer resulted in the highest plant height, measuring 137.74, 95.23, and 98.45 cm, respectively. In comparison, (DI), non-fertilized (control) and non-polymer (control) plants had the lowest plant height, measuring 58.68, 86.63, and 82.33 cm, respectively. The table's data revealed significant differences in plant height for the double interaction treatments. In particular, the combinations of (FI) and NPK 10 g plant^{-1}, (FI) and polymer 10 g plant^{-1}, and NPK 10 g plant^{-1} and polymer 10 g plant^{-1} had greater values (144.47, 149.83, and 100.39 cm, respectively) than the combinations of the other treatments. The results revealed distinct and statistically significant variations in the plant height of *Senna surattensis* due to the triple-interaction treatment. Specifically, combining (FI), NPK (10 g plant^{-1}), and polymer (10 g plant^{-1}) resulted in the maximum recorded value of 152.44 cm of plant height. However, combining deficient irrigation (DI), no fertilizer (control), and no polymers (control) resulted in the lowest recorded value of 51.34 cm.

Table (2): Effect of irrigation, NPK fertilizer, and polymers and their interaction on plant height (cm) of *Senna surattensis*

Irrigation	**NPK fertilizer g plant^{-1}**	**Polymer g plant^{-1}**			**Interaction between irrigation and NPK fertilizer**	**Means of irrigation**
		0	**5**	**10**		
FI	**0**	110.38 f	135.44 e	147.23 b	131.02 b	**137.74 a**
	10	137.25 d	143.72 c	152.44 a	144.47 a	
DI	**0**	51.34 q	55.18 p	62.51 l	56.34 f	**58.68 c**
	10	57.16 o	60.72 n	65.18 k	61.02 e	
PRD	**0**	62.23 m	75.55 j	79.81 i	72.53 d	**76.37 b**
	10	75.64 j	81.45 h	83.56 g	80.21 c	
Interaction between irrigation and polymer	**FI**	123.82 c	139.58 b	149.83 a	**Means of NPK fertilizer**	
	DI	54.25 i	57.95 h	63.84 g		
	PRD	68.93 f	78.50 e	81.68 d		
Interaction between NPK fertilizer and polymer	**0**	74.65 f	88.72 e	96.52 b	**86.63 b**	
	10	90.01 d	95.30 c	100.39 a	**95.23 a**	
Means of polymer		**82.33 c**	**92.01 b**	**98.45 a**		

Averages with the same alphabet for single factors and their overlaps do not differ significantly according to the Dunkin' polynomial test at a probability level of 0.05.

As shown in table 3, the three treatments FI, NPK fertilizer (10 g plant^{-1}), and adding polymer (10 g plant^{-1}) significantly increased the number of floral branches of *Senna surattensis* (16.68, 13.44, and 12.91 branch plant^{-1}, respectively) compared to the other treatments. The same table's recorded data led to the conclusion that the interaction between (FI) with NPK 10 g plant^{-1}, (FI) with polymer 10 g plant^{-1}, and NPK 10 g plant^{-1} with polymer 10 g plant^{-1} was more effective in this regard, yielding maximum values of 18.12, 17.52, and 14.12 branch plant^{-1}, respectively, for the number of floral branches, compared to all other interaction treatments. According to the data in the same table, it was noticed that significant differences were shown in the triple interaction among the (FI) with NPK 10 g plant^{-1} and polymer 10 g plant^{-1}, since they recorded 18.69 branch plant^{-1}. On the other hand, *Senna surattensis* recorded the lowest value of 6.16 branch plant^{-1} in the triple interaction among the DI, non-fertilizer (control), and non-polymer (control).

Table (3): Effect of irrigation, NPK fertilizer, and polymers and their interaction on the number of floral branches (branch plant $^{-1}$) of *Senna surattensis.*

Irrigation	NPK fertilizer g plant^{-1}	Polymer g plant^{-1}			Interaction between irrigation and NPK fertilizer	Means of irrigation
		0	5	10		
FI	0	13.65 g	15.69 e	16.36 d	15.24 b	**16.68 a**
	10	17.36 c	18.31 b	18.69 a	18.12 a	
DI	0	6.16 r	6.67 q	7.34 p	6.72 f	**7.75 c**
	10	8.34 o	8.66 n	9.33 l	8.78 e	
PRD	0	8.82 m	10.91 k	11.41 j	10.38 d	**11.90 b**
	10	12.61 i	13.33 h	14.34 f	13.42 c	
Interaction between irrigation and polymer	**FI**	15.50 c	17.00 b	17.52 a		
	DI	7.25 i	7.66 h	8.33 g	**Means of NPK fertilizer**	
	PRD	10.71 f	12.12 e	12.87 d		
Interaction between NPK fertilizer and polymer	**0**	9.54 f	11.09 e	11.70 d	**10.78 b**	
	10	12.77 c	13.43 b	14.12 a	**13.44 a**	
Means of polymer		**11.16 c**	**12.26 b**	**12.91 a**		

Averages with the same alphabet for single factors and their overlaps do not differ significantly according to the Dunkin' polynomial test at a probability level of 0.05.

The data presented in table 4 demonstrates that there were notable variations in inflorescence weight across the treatments of (FI), NPK (10 g plant^{-1}), and polymer (10 g plant^{-1}). The greatest weights recorded were 20.86, 15.66 , and 15.42 g, respectively, which were significantly greater than the weights observed in the other treatments. The same table revealed significant differences in the double interaction treatments, which included (FI) with NPK 10 g plant^{-1}, (FI) with polymer 10 g plant^{-1}, and the interaction between NPK 10 g plant^{-1} and polymer 10 g plant^{-1}. The highest recorded values were 21.76, 21.55, and 16.08 g, respectively. On the other hand, the lowest values were found when DI was mixed with non-fertilizer (control), DI was mixed with non-polymer (control), and non-fertilizer was mixed with non-polymer. These values were 7.50, 7.37, and 13.15 g, respectively. The triple interaction analysis of the treatments revealed significant differences among them. Specifically, the triple interaction of (FI), NPK (10g plant^{-1}), and polymer (10 g plant^{-1}) resulted in the highest inflorescence weight of 22.37 g. Conversely, the triple interaction treatment of DI, non-fertilization, and non-polymer recorded the lowest inflorescence weight at 7.32 g.

Table (4): Effect of irrigation, NPK fertilizer, and polymers and their interaction on the inflorescence weight (g) of *Senna surattensis*.

Irrigation	NPK fertilizer g plant^{-1}	Polymer g plant^{-1} 0	Polymer g plant^{-1} 5	Polymer g plant^{-1} 10	Interaction between irrigation and NPK fertilizer	Means of irrigation
FI	**0**	18.46 f	20.65 e	20.73 d	19.95 b	**20.86 a**
	10	21.13 c	21.79 b	22.37 a	21.76 a	
DI	**0**	7.32 r	7.52 p	7.65 o	7.50 f	**7.59 c**
	10	7.42 q	7.74 n	7.92 m	7.69 e	
PRD	**0**	13.68 l	15.66 k	15.93 j	15.09 d	**16.30 b**
	10	17.07 i	17.54 h	17.93 g	17.51 c	
Interaction between irrigation and polymer	**FI**	14.79 c	21.22 b	21.55 a	**Means of NPK fertilizer**	
	DI	7.37 i	7.63 h	7.79 g		
	PRD	15.37 f	16.60 e	19.93 d		
Interaction between NPK fertilizer and polymer	**0**	13.15 f	14.61 e	14.77 d	**14.18 b**	
	10	15.20 c	15.69 b	16.08 a	**15.66 a**	
Means of polymer		**14.18 c**	**15.15 b**	**15.42 a**		

Averages with the same alphabet for single factors and their overlaps do not differ significantly according to the Dunkin' polynomial test at a probability level of 0.05.

The data in table (5) showed that the treatments of (FI), NPK 10 g plant^{-1}, and polymer 10 g plant^{-1} had a substantial impact on the total chlorophyll content in the leaves of *senna surattensis*. Specifically, these treatments recorded chlorophyll contents of 5.50, 4.73, and 4.87 mg g^{-1}, respectively, which were the highest among all the treatments. Conversely, the treatments of (PRD), no fertilizer, and no polymer had the lowest overall chlorophyll concentration. The results of the experiment indicate that the combination of (FI) with NPK 10 g plant^{-1}, (FI) with polymer 10 g plant^{-1}, and NPK 10 g plant^{-1} with polymer 10 g plant^{-1} led to an increase in the total chlorophyll content. Specifically, the total chlorophyll content was recorded as 5.62 mg g^{-1} for the (FI) with NPK 10 g plant^{-1} treatment, 5.76 mg g^{-1} for the (FI) with polymer 10 g plant^{-1} treatment, and 5.14 mg g^{-1} for the NPK 10 g plant^{-1} with polymer 10 g plant^{-1} treatment. These values were higher compared to all other double interaction treatments. The analysis of the recorded data from the table revealed that the combination of (FI), NPK 10 g plant^{-1}, and polymer 10 g plant^{-1} had a significant impact on increasing the total chlorophyll content, resulting in a recorded value of 5.88 mg g^{-1}. On the other hand, the combination of (DI), no fertilizer (control), and no polymer (control) had the least effect, with a recorded value of 3.44 mg g^{-1}.

Table (5): Effect of irrigation, NPK fertilizer, and polymers and their interaction on the total chlorophyll content (mg g^{-1}) in the leaves of *Senna surattensis*.

Irrigation	NPK fertilizer g plant^{-1}	Polymer g plant^{-1}			Interaction between irrigation and NPK fertilizer	Means of irrigation
		0	5	10		
FI	**0**	5.14 f	5.33 d	5.64 c	5.37 b	**5.50 a**
	10	5.25 e	5.74 b	5.88 a	5.62 a	
DI	**0**	3.44 q	3.49 o	4.42 k	3.78 e	**4.01 b**
	10	3.47 p	4.50 j	4.72 h	4.23 d	
PRD	**0**	3.46 p	3.54 n	3.74 l	3.58 f	**3.97 c**
	10	3.62 m	4.63 i	4.81 g	4.35 c	
Interaction between irrigation and polymer	**FI**	5.19 c	5.54 b	5.76 a	**Means of NPK fertilizer**	
	DI	3.46 i	3.99 g	4.57 d		
	PRD	3.54 h	4.08 f	4.28 e		
Interaction between NPK fertilizer and polymer	**0**	4.07 e	4.12 d	4.60 c	**4.24 b**	
	10	4.11 d	4.96 b	5.14 a	**4.73 a**	
Means of polymer		**4.06 c**	**4.54 b**	**4.87 a**		

Averages with the same alphabet for single factors and their overlaps do not differ significantly according to the Dunkin' polynomial test at a probability level of 0.05.

In this study, it was discovered that all three treatments—full irrigation (FI) at 100% on both sides of the plant, NPK fertilizer at a rate of 10 g plant^{-1}, and the addition of polymer at a rate of 10 g plant^{-1} were much better than any other at determining the number of flowering and vegetative branches, plant height, flower weight, and total chlorophyll content of the leaves of *Senna surattensis*. The full irrigation (FI) treatment displayed a significant benefit over the deficit irrigation (DI) treatment at a 50% level on one side of the plant, as well as the partial root-zone irrigation (PRD) treatment at a 50% level. In the present investigation, a water deficit resulted in a decrease in plant height as well as branch number compared to the treatment of 100% application of water (FI). The plant undergoes morphological changes in growth as a morphological adaptation to water and environmental challenges, the plant undergoes growth changes. These changes serve to decrease transpiration and promote lower water consumption (Banon et al., 2003). The reduction in turgor is an initial indication of water scarcity, leading to a decline in both growth and cell differentiation, particularly in the stem and leaves. Water stress primarily impacts cellular growth, which in turn leads to a reduction in plant height. Deficit watering caused changes in the physical structure of *Senna surattensis*, resulting in decreased plant height and shoot growth (Nicola´s et al., 2008). Water scarcity has extensively documented the phenomenon of growth reduction (Bettaieb et al., 2009; Ekren et al., 2012). In addition, the plant's ability to withstand drought conditions may be attributed to a decrease in both stomatal conductance and biomass in the aerial portions, as shown by Díaz-Lópeza et al. (2012). Plants respond to water stress by closing their stomata, which helps to reduce water loss through transpiration.Without enough water, photosynthetic pigments break down and chlorophyll structure is destroyed when stomata close

(Rodriguez-Dominguez and Brodribb, 2020; Devi and Reddy, 2020). Our findings reveal a decline in chlorophyll concentration under water deficiency, which in turn leads to a decrease in photosynthetic efficiency, as reported by Khalid (2006). In our experiment, chlorophyll loss was a negative outcome of water stress. However, plants cultivated under water scarcity have regarded it as an adaptive characteristic. Furthermore, deficit irrigation resulted in a decline in the chlorophyll content of *Senna surattensis* leaves, indicating a negative impact. The findings were consistent with the studies conducted by Hassan et al. (2013) and Houshang et al. (2022). Agriculture employs polymers because they can reduce irrigation water usage, lower irrigation expenses, minimize plant and crop mortality, stabilize soil nutrients, limit the leaching of active chemicals into groundwater, and promote plant growth (Hekmat et al., 2009). The current study showed that adding a 10 g plant^{-1} polymer made a significant difference in the number of vegetative and flowering branches, the plant's height, and the chlorophyll content of its leaves overall. Beckett and Augarde (2013) attribute this to enhanced efficacy in water and fertilizer utilization. An augmentation in the retention of nutrients in the polymer may also contribute to the growth of plants. These results were in line with the discoveries made by Islam et al. (2011). The findings also indicated that the use of NPK fertilizer played a significant role in promoting plant development and enhancing the overall chlorophyll content of the leaves. Among the various agricultural approaches used, providing an appropriate supply of nutrients is the most crucial aspect for promoting the growth of higher plants. Researchers have identified nitrogen (N), phosphorus (P), and potassium (K) as the most limiting macronutrients for plant growth and development among all necessary nutrients for plants (Steven et al., 2020). The involvement of nitrogen, phosphorus, and potassium in the synthesis of many chemicals in plants, including amino acids and proteins, is the reason for this (Adesemoye and Kloepper, 2009; Da Costa et al., 2013). The results of this study align with earlier studies by Gad (2003) on *Ficus benjamina*, Ahmed and Aly (1998) on *Acacia saligna*, and Kamaluddin et al. (2022) on *Kalanchoe blossfeldiana*. These studies have demonstrated that using NPK treatments leads to an increase in plant growth and chlorophyll a and b levels. In addition, the results of this study agree with those of putra et al. (2024), who said that adding NPK manure had a big effect on the growth of the number of leaves and branches of *Portulaca grandiflora* compared to not adding NPK. Results also showed that adding 10 g of polymer and 10 g of NPK fertilizer to each plant had a big positive effect on the plant's ability to grow and flower, as well as on the leaves' overall chlorophyll content. We can link this phenomenon to the polymers' capacity to absorb water and fertilizers, which they then release to the plant at a precise moment. (Abobatta, 2018). According to the results, the best values were found when full irrigation and 10 g of polymer were applied to each plant. These values were highest for the leaves' total chlorophyll content, as well as their vegetative and flowering traits. These findings were consistent with the results obtained by Fadlallah et al. (2022). The results indicated substantial differences in the triple interaction treatment between full watering, adding 10 g plant^{-1}, and fertilizing 10 g plant^{-1}, compared to the other treatments. Individual factors can influence the observed disparities in bilateral relationships.

CONCLUSION

The results showed that the use of polymers and NPK fertilizers with full irrigation led to positive results in the vegetative and flowering growth of the acacia shrub. On the other hand, using incorrect irrigation methods has harmful effects on all stages of plant growth. It is worth noting that partial irrigation of the root zone was not suitable for achieving optimal growth. The satisfactory results indicate the possibility of conducting further research and experiments using partial root zone drying technology. This may include, for example, increasing the percentage of irrigation water to 75% instead of 50% and gradually increasing polymer concentrations. This is because polymers have a high ability to retain water and release it to plants when needed. This can indirectly affect the plant's response to drought stress, which can be beneficial in situations where water is scarce. In addition to using NPK fertilizer doses, our study and previous studies have proven the effective role of appropriate NPK fertilizer doses in biological processes and plant growth and development.

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