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Effects of Light and Fertilizer Amounts on Seedling Growth of *Brachychiton populneus* (Schott & Endl.)

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Abstract: Nutrient application and light intensity are two important abiotic factors that affect the plant growth and development. This study was carried out to determine the effect of different NPK fertilizer amount, viz. 0, 1, 2, 3 and 4 g.pot^{-1}, light regimes, viz. 50% full sunlight (inside the lath house) and 100% full sunlight (the open area) and their interactions on the growth, chlorophyll contents and biomass of potted *Brachychiton populneus* seedlings. At the end of the experiment, (after six months) growth parameter including plant height (cm), stem diameter (mm) and leaf numbers, chlorophyll contents and biomass allocation were measured. The results indicate that the greatest stem height increment, stem diameter increment, leaf number increment, stem dry weight and leaf dry weight were obtained from the seedlings grown in the open area. However, the highest chlorophyll content and root dry weight were observed from the seedlings grown inside the lath house. In addition, the seedlings fertilized with 3 and/or 4 g NPK every two months recorded higher growth traits, chlorophyll content and biomass allocation than other amounts of the fertilizer. Thus, the present study suggests that in order to obtain optimum growth of *B. populneus* potted seedlings, it should be grown in the open area and fertilized with 3 or 4 g NPK every two months.

Key words: *Brachychiton populneus*, NPK Fertilizer, Light intensity, Growth performance, Chlorophyll Content.

Introduction

Brachychiton populneus (Schott & Endl.) R. Br. is a tree species which belongs to the family of Sterculiaceae and native to Eastern Australia (Eastern Victoria to Townsville). It is a medium sized tree, that grows 15-20 m in height and it is considered as a relatively slow growing tree species (Anderson, 2016). It is commonly known as Kurrajong or a Bottle tree because it can store water in its stem; additionally, it has a very deep root system, which is responsible for its drought hardiness (Anderson, 2016; Karim *et al.*, 2020). The tree is cultivated as ornamental tree in gardens and roadsides. The bark was used as fibre, and the soft spongy wood for making shields. The leaves are also used as an emergency fodder for drought-affected animal stock. The seeds are used as a coffee supplement by roasting and crushing (Anderson, 2016).

Seedling production with a high quality and healthy depend on biotic and abiotic factors. Among abiotic factors, nutrient application and light intensity are two the most important factors that affect the plant growth and physiology (Kozlowski & Pallardy, 1997; Uchida, 2000).

Nitrogen (N), phosphorus (P) and potassium (K) play a very vital role in plant growth and development (Uchida, 2000).

Their functions range from being structural units to redox-sensitive agents. Growth and quality of trees are enhanced by the application of fertilizer (Tripathi *et al.*, 2014). Plants grown in containers face a number of limitations, including the lack of growing space, which provide the required nutrients (Dang, 2003). Therefore, nutrient application is commonly used in nurseries to enhance plant vigour and productivity. Furthermore, fertilization can improve seedling growth by either increasing soil resources or by enhancing the ability of seedlings to gather resources. Consequently, plants upsurge their photosynthesis rate, stem diameter, height, and volume (Razaq *et al.*, 2017).

Light is other essential factor influencing directly and indirectly on the plant growth. It contributes directly in seedling growth through governing its physiological characters such as photosynthesis, respiration, stomatal conductance, transpiration, hormone synthesis and chlorophyll creation (Pallardy, 2008). Light could also impact the plant growth indirectly through its influences on air temperature, humidity, soil temperature and soil moisture (Bhatla & Lal, 2018). The light intensity is more significant for growth performance since both high and low quantity of sunlight could cause plant stress and at this situation, the photosynthesis system works unsatisfactorily, thus plant growth will be reduced (Lambers *et al.*, 2008).

Subsequently, there is a global interest in optimizing fertilizer application and light regimes for different species in the nursery to achieve healthy and high quality seedlings (Sherzad *et al.*, 2015; Fu *et al.*, 2017). On the other hand, there is no previous study on the growth performance of *B. populneus* in responses to fertilizer amount, environmental situation and their interaction under the nursery condition. Therefore, the present study was conducted to determine the effect of different NPK fertilizer amount, light regimes and their interactions on the growth, chlorophyll contents and biomass of potted *B. populneus* seedlings.

Material & Methods

The studied species

Healthy one years old *B. populneus* seedlings were obtained in the local nursery and used in this experiment which was carried out in the Grdarasha field affiliated to the College of Agricultural Engineering Sciences, Salahaddin University, Erbil, Iraq from 4th March until 4th September 2018 (six months), for this purpose, the seedlings were planted in black polyethylene bags with 30 cm diameter filled with 5 kg of loamy soil, the *B. populneus* seedlings were distributed in two different light regimes with adding different amounts of NPK fertilizer. Moreover, plant height, stem diameter and leaf number of the species at the beginning of the study were 36.8 ± 1.3 cm, 3.9 ± 0.16 mm and 13.5 ± 0.78 respectively.

Experimental design

The experiment was laid in a Factorial Completely Randomized Design (CRD) with two factors. The first factor was NPK fertilizer (20% N: 20% P: 20% K) with five amounts which were 0 (F0), 1 (F1), 2 (F2), 3 (F3), 4 (F4) g.pot^{-1} every two months (The fertilizer amounts were added three times during the experiment, in the early March, May and July). The second factor was two light regimes i.e. inside the lath house (L1), where light intensity is 50%, and the open area (L2) where light intensity is 100%, each treatment with one seedling that replicates four times, in which there were altogether 40 experimental units.

The studied parameters

At the beginning of the experiment, plant height (cm), stem diameter (mm) and leaf numbers of the seedlings were recorded. At the end of the study (September) the mentioned parameters were re-measured to find out plant height increment (cm), stem diameter increment (mm), leaves number increment.seedling^{-1} as indicator of seedling growth. In addition, the biomass parameters viz. the stem dry weight (g), leaves dry weight (g) and root dry weight were measured after separating the seedling into their components and dried in a furnace at 80°C until the constant weight obtained (Sherzad *et al*., 2017).

Photosynthetic pigments were calculated by pigments extracted in 95% Ethanol and Spectrophotometric determination absorbance taken at 664 nm and 649 nm. Chlorophyll-a and Chlorophyll-b were calculated using the following formulas as described by Sumanta *et al.* (2014).

$$\text{Chlorophyll\_a} = 13.36\ \text{A664} - 5.19\ \text{A649}$$

$$\text{Chlorophyll\_b} = 27.43\ \text{A649} - 8.12\ \text{A664}$$

Data Analysis

Data of studied parameters were analysed using two-way analysis of variance (ANOVA); Duncan test was used to separate means that were significant at 5% by using SPSS version 20.

Results & Discussion

Table (1) shows that the light intensities and the amounts of NPK fertilizer had a significant effect on the stem height increment, stem diameter increment and leaf number increment of *B. populneus* seedlings. However, the interaction effect of both factors had not observed on the mentioned growth parameters except for the stem height increment. Moreover, table (2) illustrates that the seedlings grown in the open area were recorded significantly higher value of the stem height increment, stem diameter increment and leaf number increment (17.9 cm, 5.97 mm and 37.5 respectively) compared with those grown under the lath house condition (14.75 cm, 3.61 mm and 15.65 respectively). It means that environmental factors especially light intensity has played major role in enhancing growth of *B. populneus* seedlings as the seedlings planted under the full sunlight (the open area) had better growth than the seedlings planted under the partial shade (the lath house). This result confirmed that this species is considered as light demanding species (Elliot, 2003; Llamas, 2003).

In addition, the increments of the stem height, stem diameter and leaf number of the seedlings fertilized with 3 g NPK.Pot^{-1} every two months were greater than those treated with other fertilizer amounts. The result highlighted the superiority of the fertilized seedlings with adequate amount over unfertilized and poorly fertilized ones in terms of growth properties. This study confirmed that the application of an adequate fertilizer amounts is essential to improve growth performance of potted seedlings (Dang, 2003). The same results were reported by other researchers on different potted tree seedlings. For instance, Sherzad *et al.* (2015) reported that application of 2 g NPK.pot^{-1}. month^{-1} significantly increased the height increment, leaf number increment of *Shorea materialis* seedlings compared with unfertilized seedlings. Han *et al.* (2016) investigated that fertilization treatments significantly increased plant height and root collar diameter of yellow poplar (*Liriodendron tulipifera* L.). AbdelKader *et al.* (2016) showed that among NPK fertilizer treatments (0, 1.5, 3.0 and 4.5 g. plant^{-1}), the medium fertilizer amount 3 g.pot^{-1} was optimum for growth of *Magnolia grandiflora* L. Razaq *et al.* (2017) showed that both N and P application significantly affected plant height and root collar diameter of *Acer mono* and the maximum values of these two parameters were obtained when 10 g N and 8 g P were used together. So, the application of macronutrient increases yield, growth, and quality of trees (Tripathi *et al.*, 2014).

Table (1): Analysis of variance for the effect of different light intensities, NPK fertilizer amounts and their interactions on, stem height increment, stem diameter increment and leaf number increment of *B. populneus* seedlings.

Source of Variation	DF	P- value		
		Stem height increment	Stem diameter increment	Leaf number increment
Light Intensity (L)	1	0.001	0.000	0.000
NPK Fertilizer (F)	4	0.000	0.000	0.003
L * F	4	0.008	0.177	0.410

Significant occurs when P- value is ≤ 0.05. DF = degree of freedom.

Table (2): Effect of different light intensities and NPK fertilizer amounts on stem height increment, stem diameter increment and leaf number increment of *B. populneus* seedlings.

Factors	Mean of stem height increment (cm)	Mean of stem diameter increment (mm)	Mean of leaf number increment
Light Intensity			
Lath house (50% of the sunlight)	14.75 b	3.61b	15.65 b
Open area (100% of the sunlight)	17.9 a	5.97 a	37.5 a
NPK Fertilizer (g)			
0	9.88 c	3.28 b	18.75 c
1	15.50 b	3.90 b	23.50 bc
2	16.50 b	5.32 a	27.63 ab
3	20.25 a	5.76 a	31.63 a
4	19.50 a	5.70 a	31.38 a

Means with the same letter in a column for each factor are not significantly different by Duncan at p ≤ 0.05.

Fig. (1) exposed that the combination of both light intensity and NPK fertilizer had a significant effect only on stem height increment of the species, where the highest mean value of this growth character was obtained from the seedlings grown in the lath

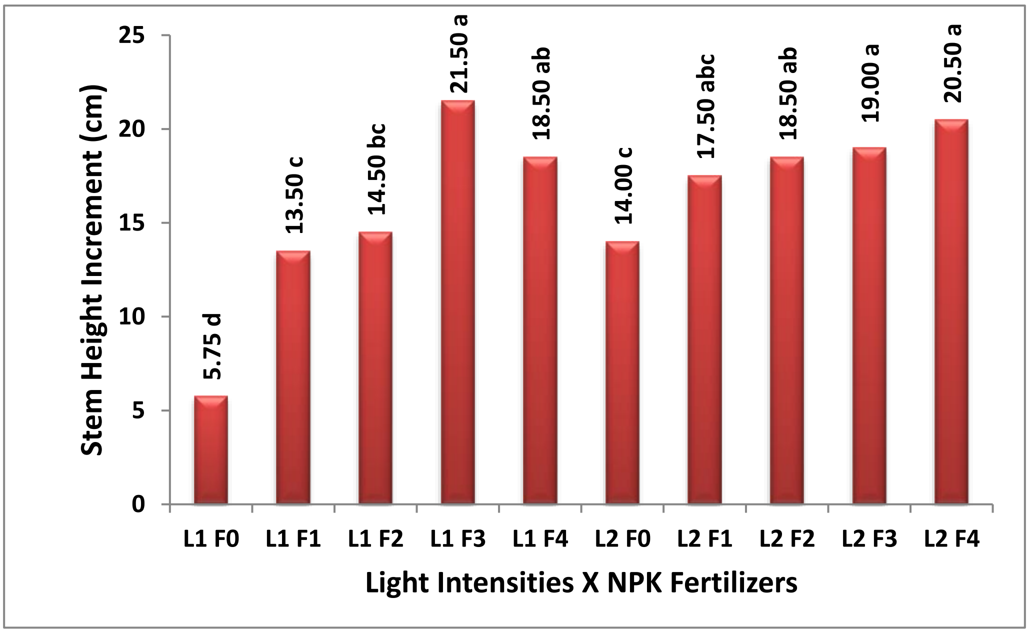

Fig. (1): Interaction effect of the light intensities (the lath house (L1) and the open area (L2)) and NPK fertilizers (0 (F0), 1 (F1), 2 (F2), 3 (F3), 4 (F4) $g.pot^{-1}$) on stem height increment value of *B. populneus*.

house condition and fertilized with 3 g $NPK.pot^{-1}$ (L1F3) followed by L2F4, L2F3, L2F2 and L1F4, while the lowest mean value was found in the seedlings grown in the lath house and unfertilized (L1F0). This result revealed that even though *B. populneus* is considered as light demanding tree species, it can grow well under the shade when sufficient amount of nutrients is available. The previous studies reported the same results about shade tolerant tree species as they displayed that shade tolerant species are able to survive and grow agreeably under the full sunlight during establishment stages if the seedlings are supported by a suitable amount of nutrients (Nussbaum *et al.*, 1995; Amrhein *et al.*, 2012; Tripathi & Raghubanshi, 2014). Thus, existent of a suitable amount of nutrients may be a compensation for inadequate sunlight for growing and survival tree seedlings. The analysis of variance for the effect of different light intensities, NPK fertilizer and their interactions displayed that both studied factors and their combinations had a high significant effect on, Chlorophyll-a (Chl.a), and Chlorophyll-b (Chl.b) of *B. populneus* seedlings (Table 3). Furthermore, the results in table (4) demonstrated that the seedlings under the lath house had significantly higher Chlorophyll-a (Chl.a: 1.86 mg g^{-1} F.W), and Chlorophyll-b (Chl.b: 0.69 $mg.g^{-1}$ F.W) compared with those under the full sunlight (Chl.a:1.38 mg. g^{-1} F.W, Chl.b: 0.56 mg. g^{-1} F.W). It means that the chlorophyll content (Chl.a and Chl.b) of the seedlings under the shade was higher than those under the full sunlight. The same result for different tree species was informed by many investigators (Lambers *et al.*, 2008; Mitamura *et al.*, 2008; Kenzo *et al.*, 2011; Perrin & Mitchell, 2013; Sherzad *et al.*, 2015). Extra chlorophyll content in the leaf of seedlings developed under the shade is a physiological mechanism to adapt with low light intensity. This phenomenon contributes to the light-capturing efficiency at low light condition (Kenzo *et al.*, 2011).

Table (4) also revealed that the amount of these two pigments increased statistically with increasing fertilizer NPK, where the highest value of the pigments (Chl.a: 2.05 mg g^{-1} F.W, Chl.b: 0.80 mg g^{-1} F.W) were recorded from the seedlings treated by 4 g NPK.pot^{-1} and the lowest value of the pigments (Chl.a: 1.36 mg.g^{-1} F.W, Chl.b: 0.52 mg.g^{-1} F.W) were noted from unfertilized seedlings. This result displays that usage of NPK fertilizer particularly nitrogen element directly leads to rising chlorophyll content of the plants because nitrogen is one of the main elements to make chlorophyll molecular (Pallardy, 2008). This result is in agreement with those achieved by Hokmalipour & Darbandi (2011), as they found that nitrogen application significantly increased chlorophyll content. Razaq *et al.* (2017) also showed that both N and P application significantly affected chlorophyll content of *Acer mono* and the maximum values of chlorophyll content, was obtained when 10 g N and 8 g P were used together.

Table (3): Analysis of variance for the effect of different light intensities, NPK fertilizer amounts and their interactions on, Chlorophyll-a, and Chlorophyll-b of *B. populneus*.

Source of variation	DF	P- Value	
		Chlorophyll- a	Chlorophyll- b
Light intensity (L)	1	0.000	0.000
NPK Fertilizer (F)	4	0.000	0.000
L * F	4	0.000	0.000

Significant occurs when P- value is ≤ 0.05. DF = degree of freedom.

Table (4): Effect of different light intensities and NPK fertilizer amounts on Chlorophyll-a, and Chlorophyll-b of *B. populneus* seedlings

Factors	Chlorophyll-a (mg g^{-1} F.W)	Chlorophyll-b (mg g^{-1} F.W)
Light intensity		
Lath house (50% of the sunlight)	1.86 a	0.69 a
Open area (100% of the sunlight)	1.38 b	0.56 b
NPK Fertilizer (g)		
0	1.36 e	0.52 e
1	1.39 d	0.56 d
2	1.48 c	0.57 c
3	1.81 b	0.66 b
4	2.05 a	0.80 a

Means with the same letter in a column for each factor are not significantly different by Duncan at p ≤ 0.05.

The interaction effect of the light intensity and NPK fertilizer on the chlorophyll content in the leaves of *B. populneus* showed that the maximum mean value of chlorophyll-a and chlorophyll-b were significantly achieved from the seedlings grown in the lath house and received 4 g NPK.pot^{-1} (L1F4). However, the minimum mean value of both chlorophyll contents were statistically observed from those present in the open area and no treated with the fertilizer (L2F0) (Figs. 2 and 3). Moreover, these two figures (2 and 3) explained that the chlorophyll-a and chlorophyll-b in leaves of *B. populneus* were increased by increasing NPK fertilizer and reducing light intensity. Results of chlorophyll content in the present study concur with that addressed by Sherzad *et al.* (2015) as they investigated that the increased shade ratio and applied NPK fertilizer play

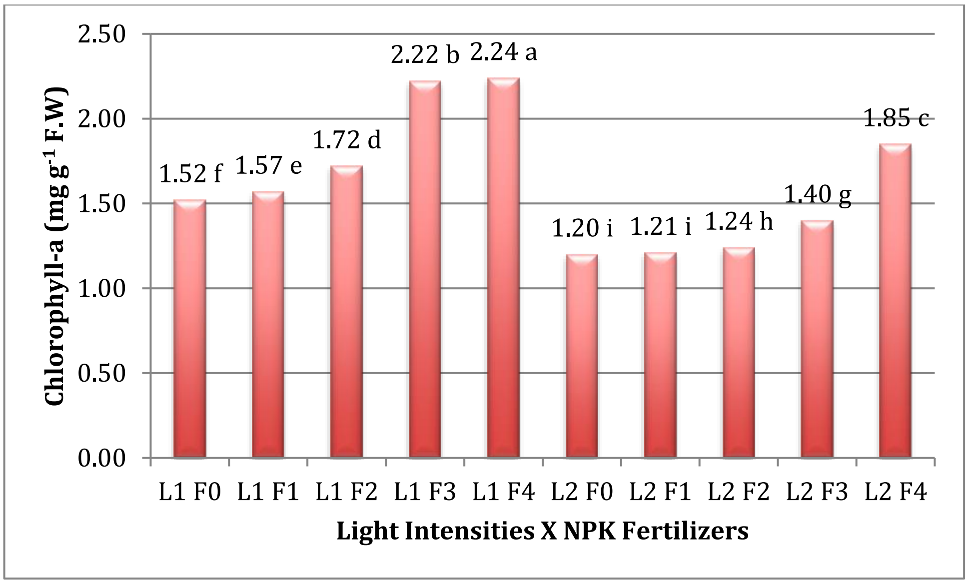

Fig. (2): Interaction effect of the light intensities (the lath house (L1) and the open area (L2)) and NPK fertilizers (0 (F0), 1 (F1), 2 (F2), 3 (F3), 4 (F4) g.pot^{-1}) on chlorophyll-a of *B. populneus* seedlings.

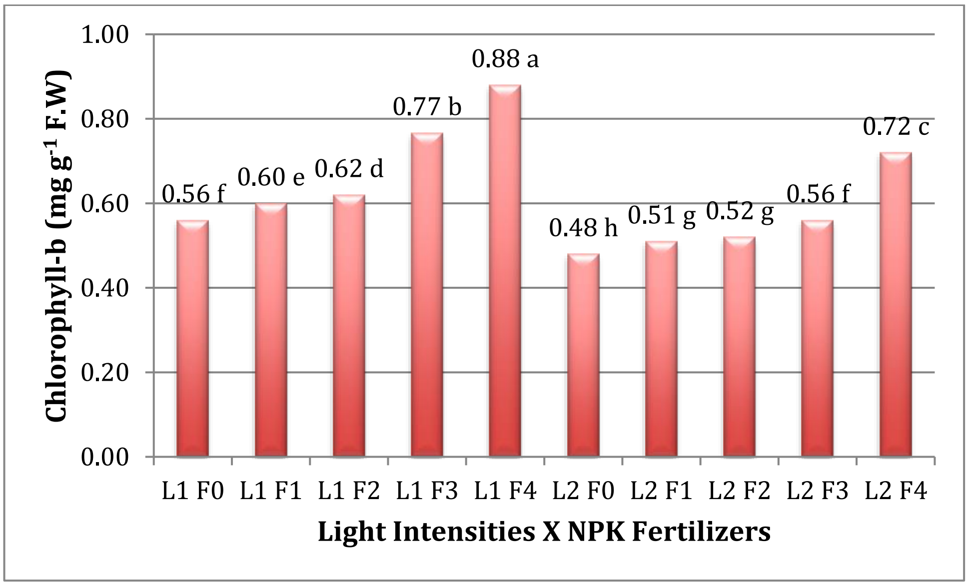

Fig. (3): Interaction effect of the light intensities (the lath house (L1) and the open area (L2)) and NPK fertilizers (0 (F0), 1 (F1), 2 (F2), 3 (F3), 4 (F4) g.pot^{-1}) on chlorophyll-b of *B. populneus* seedlings.

a major role in rising chlorophyll content of *S. materialis* seedlings.

Table (5) illustrates that the stem, leaf and root dry weight were significantly influenced by different light intensities, fertilizer amounts and their interactions. In addition, table (6) demonstrates that both the stem dry weight and leaf dry weight of the seedlings grown in the open area condition were statistically higher than those grown under the shade (the lath house) condition. However, root dry weight of the seedlings grown under the shade (the lath house) condition was significantly higher than those grown in the open area condition. These outcomes confirmed the results that discovered by Paz (2003), as investigated that light-demanding species allocate more biomass to the stem and less to the roots when the species planted in the open area. In addition, Minotta & Pinzauti (1996) demonstrated that stem dry weight, leaf dry weight, root dry weight and total plant dry weight of *Fagus sylvatica* seedlings were significantly increased by the increasing of light intensity.

Perrin & Mitchell (2013) demonstrated that plant biomass of *Taxus baccata* saplings was significantly influenced by different light intensities (3, 7, 27 and 100 % relative light intensity), where an increase of light played a significant role on the stimulation of total dry weight and root to shoot ratio of the studied species. Giertych *et al.* (2015) explored that masses of leaves, stems, total roots, coarse roots, and fine roots in light-demanding (*Sorbus aucuparia* and *Betula pendula*), intermediate (*Carpinus betulus* and *Quercus robur*), and shade- tolerant (*Acer platanoides* and *Fagus sylvatica*) trees seedlings were greater values under the full-sunlight conditions than under the shade conditions. Elliott & White (1994) demonstrated that seedlings of *Pinus resinosa* grown in high light had four to five times more biomass than those in the low light condition.

Furthermore, table (6) also elucidates that NPK fertilizer plays an important role in increasing plant biomass of *B. populneus* seedlings where the greatest masses of stem (84.15 g) and leaf (21.40 g) were obtained at 4g NPK.pot^{-1} and the highest root dry weight (149.93 g) was obtained at 3g NPK.pot^{-1}. Conversely, the lowest weight of the three biomass parameters was observed in the seedlings that did not treated by fertilizer NPK. Our results concur with the previous literatures. For instance, Elliott & White (1994) reported that nitrogen supply had a significant effect on biomass components of *Pinus resinosa* seedlings. Upadhyaya & Marak (2014) showed that NPK application especially 1 g.seedling^{-1} was significantly stimulated growth and biomass of *Tamarindus indica* seedlings compared to control. Han *et al.* (2016) investigated that fertilization treatments significantly increased stem dry weight and leaves dry weight of yellow poplar (*Liriodendron tulipifera* L.), compared to the control.

Figs. (4) and (5) represent combination effect of the light intensity and NPK fertilizer on the stem dry weight and leaf dry weight of *B. populneus* seedlings, where the highest mean value of the mentioned characters were significantly achieved from the seedlings grown in the open area and received 4 g NPK.pot^{-1} (L2F4). On the other hand, the lowest mean value of the stem dry weight was statistically achieved from those grown in the lath house and unfertilized (L1F0); the lowest mean value of the leaf dry weight was attained from unfertilized seedlings in both the lath house (L1F0) and the open area (L2F0).

Table (5): Analysis of variance for the effect of different light intensities, NPK fertilizer amounts and their interactions on, stem dry weight, leaf dry weight, and root dry weight of *B. populneus* seedlings.

Source of Variation	DF	P- Value		
		Stem dry weight	Leaf dry weight	Root dry weight
Light intensity (L)	1	0.000	0.000	0.000
NPK Fertilizer (F)	4	0.000	0.000	0.000
L * F	4	0.000	0.000	0.000

Significant occurs when P- value is ≤ 0.05. DF = degree of freedom.

Table (6): Effect of different light intensities and NPK fertilizer amounts on means of stem dry weight, leaf dry weight, and root dry weight of *B. populneus* seedlings.

Factors	Stem dry weight (g)	Leaf dry weight (g)	Root dry weight (g)
Light Intensity			
Lath house (50% of the sunlight)	39.61 b	12.52 b	100.86 a
Open area (100% of the sunlight)	68.91 a	17.75 a	87.54 b
NPK Fertilizer (g)			
0	19.66 e	4.79 d	61.93 e
1	45.02 d	11.56 c	72.19 d
2	50.56 c	16.74 b	78.11 c
3	71.89 b	21.15 a	149.93 a
4	84.15 a	21.40 a	108.83 b

Means with the same letter in a column for each factor are not significantly different by Duncan at p ≤ 0.05.

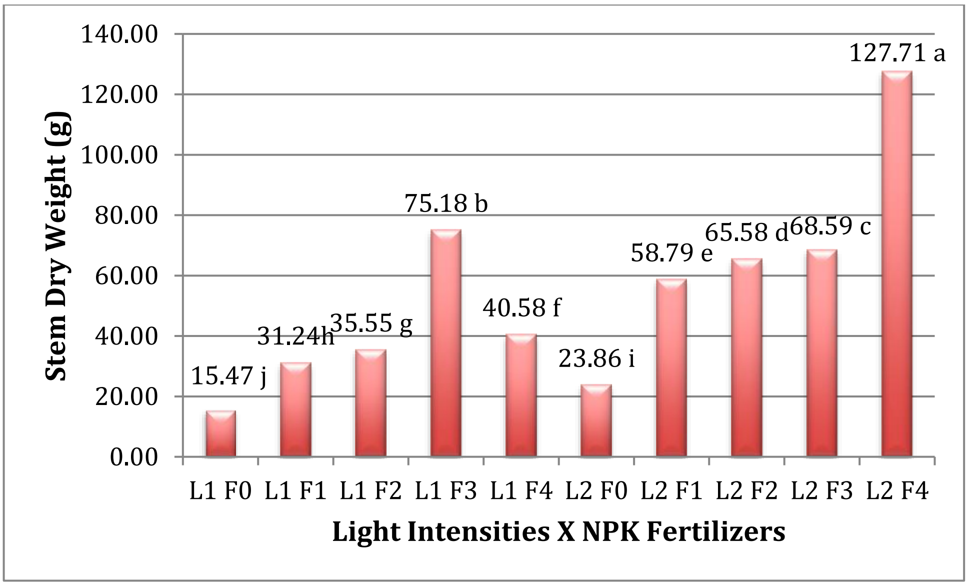

Fig. (4): Interaction effect of the light intensities (the lath house (L1) and the open area (L2)) and NPK fertilizers [0 (F0), 1 (F1), 2 (F2), 3 (F3), 4 (F4) g.pot^{-1}] on stem dry weight of *B. populneus* seedlings.

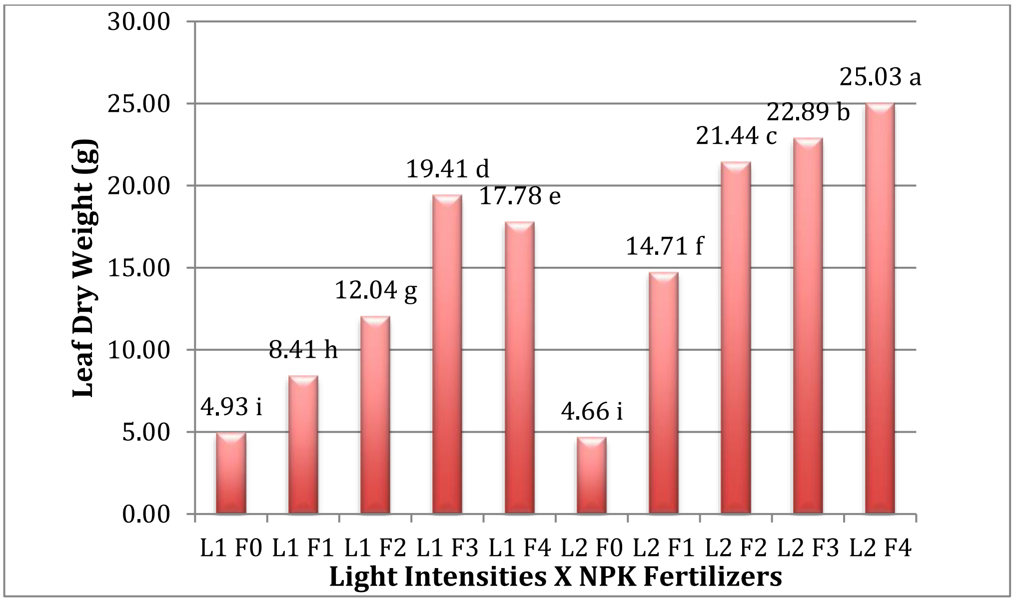

Fig. (5): Interaction effect of the light intensities (the lath house (L1) and the open area (L2)) and NPK fertilizers [0 (F0), 1 (F1), 2 (F2), 3 (F3), 4 (F4)] g.pot^{-1} on leaf dry weight of *B. populneus* seedlings.

Furthermore, fig. (6) indicate that root dry weight of the species in both environment conditions was increased with increased fertilizer until 3 g NPK.pot^{-1}. Moreover, the highest mean value of the root dry weight were obtained from the seedlings grown under both the lath house condition and the open area and fertilized with 3 g NPK.pot^{-1} and the open area condition with 3 g NPK.pot^{-1} (L1F3 and L2F3), while the lowest mean value were obtained from control treatment in the open area condition (L2F0). The above results of plant biomass indicated that a suitable amount of nutrients is the most important factor to promote biomass of *B. populneus* seedlings under both light intensities. The result also revealed that an adequate of light intensity is a significant factor in determining biomass response to fertilizer addition. Our findings concur with the previous literatures. For example, Fetcher *et al.* (1996) reported that early successional and pioneer tree species grown under high light condition responded well to the N and P application compared with shade-tolerant and non-pioneer species. Brown *et al.* (1999) stated that fertilizer application under an adequate of light condition stimulated growth of *Shorea johorensis* and *Dryobalanops lanceolata*. Lawrence (2001) exhibited that relative growth rate of *Persea romosa* (shade-tolerant species) and *Macaranga gigantea* (light demanding species) enhanced with the addition of both N and P under 18% relative light intensity. Portsmuth & Niinemets (2007) revealed that relative growth rate of some tree species (*Acer platanoides*, *Betula pendula*, *B. pubescence*, *Populus tremula* and *Quercus robur*) in temperate forest was dramatically enhanced with increasing light intensity and nutrient application.

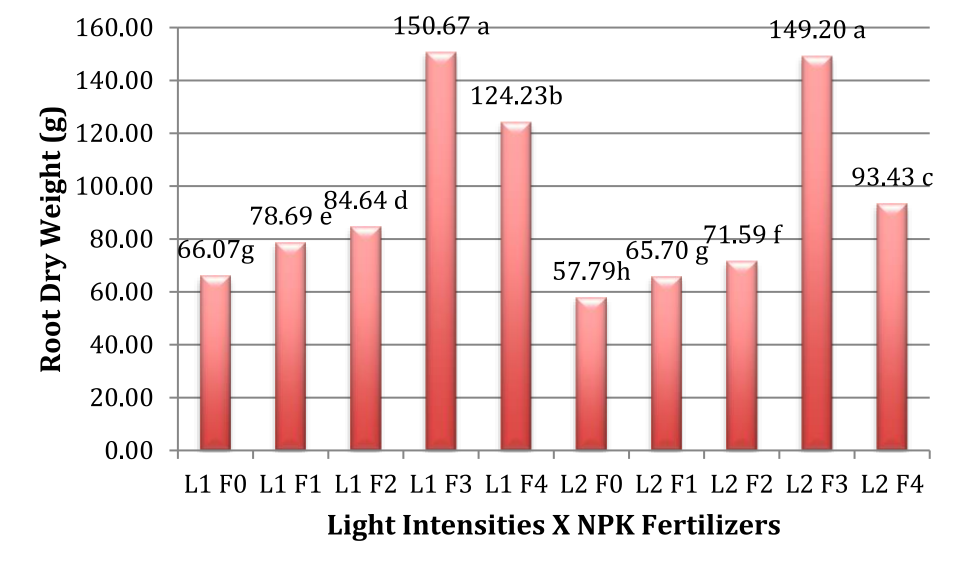

Fig. (6): Interaction effect of the light intensities (the lath house (L1) and the open area (L2)) and NPK fertilizers [0 (F0), 1 (F1), 2 (F2), 3 (F3), 4 (F4)] g.pot^{-1} on root dry weight of *B. populneus* seedlings.

Conclusion

Results of the current investigation concluded that the optimum fertilizer amount and light intensity to enhance growth and development of *B. populneus* potted seedlings are 3 or 4 g NPK.pot^{-1} every two months and the open area (100% of the sunlight). Furthermore, Chlorophyll-a and chlorophyll-b were increased by increased NPK fertilizer amounts while they were declined by increased light intensity. The best value of the stem and leaf dry weight were achieved in the open area and 4 g NPK fertilizer. However, the highest value of root dry weight was attained under the lath house (50% of the sunlight) and 3 g NPK fertilizer. Our results will help nursery man to produce healthy and a high quality of *B. populneus* seedlings to meet plantation programme.

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Conflicts of interest

The authors declare that they have no conflict of interests.

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تأثير الإضاءة وكمية الأسمدة على نمو شتلات *Brachychiton populneus* (Schott & Endl.)

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المستخلص: يعد استخدام السماد و شدة الاضاءة عاملين غير حيويين مهمين يؤثران على نمو النبات وتطوره. أجريت هذه الدراسة لتحديد تأثير كميات مختلفة من السماد (NPK) ، بمعنى. 0 ، 1 ، 2 ، 3 و 4 غم. وعاء$^{-1}$، وشدة الإضاءة المختلفة وهما و 50٪ شدة الاضاءة داخل ظلة الخشبية و 100٪ شدة الاضاءة في بيئة المفتوحة و تداخلاتهما على النمو ومحتويات الكلوروفيل والكتلة الحيوية لشتلات *Brachychiton populneus*. في نهاية التجربة، تم قياس صفات النمو ومحتويات الكلوروفيل والوزن الجاف لأجزاء مختلفة من الشتلات المدروسة. أوضحت النتائج أن أكبر زيادة في ارتفاع الساق، وزيادة قطر الساق، وزيادة عدد الورقة، والوزن الجاف للساق، والوزن الجاف للورقة تم الحصول عليها من الشتلات المزروعة في البيئة المفتوحة. ومع ذلك، تمت ملاحظة أعلى محتوى من الكلوروفيل والوزن الجاف للجذور من الشتلات المزروعة داخل الظلة الخشبية. بالإضافة إلى ذلك ، سجلت أعلى الصفات النمو، والمحتوى الكلوروفيل والوزن الجاف من الشتلات المسمدة بـ 3 و / أو 4 غم NPK كل شهرين. وهكذا، تشير الدراسة الحالية إلى أنه من أجل الحصول على النمو الأمثل لشتلات *B. populneus*، يجب زراعتهن في المنطقة المفتوحة وتسميدهن بـ 3 أو 4 غم NPK كل شهرين.

الكلمات المفتاحية: *Brachychiton populneus*، سماد NPK ، شدة الأضاءة، الصفات النمو، المحتوى الكلوروفيل.