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Magnesium's Impact on Cannabis sativa 'BaOx' and 'Suver Haze' Growth and Cannabinoid Production

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Abstract

Limited research exists on the fertility needs for industrial hemp (*Cannabis sativa*) and the impact of fertility on plant growth and cannabinoids. Optimizing floral production for cannabinoid production and especially cannabidiol (CBD) production, is an economic goal for growers. Magnesium (Mg) is an essential nutrient for plant growth and plays many key roles in plant growth and when deficient leads to suboptimal plant growth. Six Mg fertility rates (0.0, 12.5, 25.0, 50.0, 75.0, and 100.0 mg·L^{-1}) were evaluated to determine the optimal fertility for *C. sativa* on two High CBD-type cultivars 'BaOx; and 'Suver Haze'. Foliar Mg concentrations increased linearly for all life stages with the greatest foliar Mg concentrations being in the highest rate of 100.0 mg·L^{-1} Mg. Of the six rates, 50.0 and 75.0 mg·L^{-1} Mg optimized plant height, diameter, and plant total dry weight as well as having similar cannabinoid concentrations during the three life stages.

Keywords: hemp, deficiency, macronutrients, nutrition, fertility, fertilizers rates.

Introduction

Hemp (*Cannabis sativa*) has recently gained global popularity and recognition as a viable crop because of the products that contain hemp fibers, oils, and cannabinoids (Salentijn et al., 2019). Hemp, referred to as *Cannabis*, strains can legally only contain a concentration of tetrahydrocannabinol (THC) of no more than 0.3% of dry weight in any part of the plant (Congress 2014, 2018). Hemp contains cannabidiol (CBD), THC, and over 100 cannabinoids at varying concentrations. Medical and therapeutic benefits are reported by the non-THC cannabinoids, such as CBD, and this has created recent interest in hemp production.

Limited published research articles exist on the fertility needs of floral hemp and the impact of fertility on plant growth, total biomass, as well as the production of secondary metabolites such as cannabinoids. A high amount of energy and resources are a requirement for the plant to produce secondary metabolites, such as cannabinoids (Taura et al., 2007). These compounds are typically produced at very low concentrations by the plant (<1% of dry weight) and synthesis is dependent on the plant's physiological and developmental stage (Akula and Ravishankar, 2011). However, when plants are nutrient stressed, growth (mass) is inhibited to a greater extent than photosynthesis, and thus secondary metabolite concentrations are often increased (Seigler, 1998). Limited research has been conducted on the manipulation of macronutrients and their impact on growth and secondary metabolite production. A higher level of nitrogen (N) increased plant leaf weight and decreased leaf THC concentration in fiber hemp varieties (Bósca et al., 1997). Also, in a THC strain, increasing phosphorus (P) fertilization resulted in a greater bud weight and a higher THC concentration (Coffman, 1997). However, there is limited published research on the impacts of magnesium (Mg) fertility on cannabinoids and other secondary metabolites of hemp grown primarily for floral material.

The economic concern for optimizing cannabinoid production relies on optimizing floral production. As a result, any factor that limits the floral production of hemp, such as fertility level, would be a concern to all growers. It is well known that plants require macro and micronutrients to ensure proper development, growth, and yields. Although many of these essential nutrients for plants are not part of the cannabinoid structure, such as Mg. Magnesium still plays many key roles in plant development and if deficient could result in less plant growth.

There are two main reasons for Mg deficiency, absolute deficiency, and cation competition. Absolute deficiency is the result of low Mg content in the soil prior to any fertility treatments this can be caused by Mg losses from the soil by mobilization, leaching, or long-term unbalance crop fertilization practices result in depletion of Mg resources contained within soils (Gransee and Führs, 2013). Cation competition is a consequence of nutrient imbalances in soils. The uptake of Mg is strongly impacted by the availability of other cations such as ammoniacal-nitrogen (NH_4^+), calcium (Ca^{2+}), and potassium (K^+) (Fageria, 2001). Thus, growers must monitor these factors to supply a nutritionally balanced fertilizer program and adequate levels of Mg to *C. sativa.*

Within plants, Mg plays many vital roles in plant development. Magnesium is the central atom of the chlorophyll molecule and plays a key role in the 'light' and 'dark' steps of photosynthesis (Shaul, 2002). However, only one-fifth of leaf Mg is associated with chlorophyll pigments, while up to three-quarters are associated with protein synthesis, with the remainder stored in the vacuole (Verbruggen and Hermans, 2013). Magnesium is also utilized by plants in many ways including RNA polymerase, ATPases, protein kinases, and carboxylases (Shaul, 2002). However, excess Mg in leaf tissue can inhibit photosynthesis and plant growth (Rao et al., 1987). Magnesium is a phloem-mobile element and its remobilization occurs from older leaves to younger ones (Taiz and Zeiger, 2002). Magnesium deficiency disrupts the loading of sucrose into the phloem resulting in

carbon accumulation in the source leaves (Guo et al., 2016). This results in the optimum concentration of Mg in the plant being in the new and developing parts of the plant, such as floral buds (Gransee and Führs, 2013). Magnesium deficiency also impairs root growth which affects the acquisition of water and nutrient uptake (Marschner, 1995). Finding the optimum rate of Mg fertility to promote plant growth is essential to maximize profits for growers.

C. sativa plants require Mg for biomass production and secondary metabolites that are essential for growth such as chlorophyll. Leaf Mg concentrations in vegetative mother stock plants prior to when cuttings were harvested were determined in five hemp cultivars (Landis et al. 2019). Plants that appeared healthy and vigorous contained leaf tissue concentrations that ranged from 0.25-0.46 % Mg (Landis et al., 2019). These values were lower than previously published values of 0.40 and 0.81% Mg (Bryson and Mills, 2014). Other researchers studied the impacts of Mg deficiency on leaf tissue Mg accumulation of *C. sativa* and reported that plants provided with a modified Hoagland's solution accumulated 0.61% Mg, while plants grown without Mg contained 0.12% Mg (Cockson et al., 2019). However, there is currently no published literature on optimal Mg fertility rates and their subsequent impact on cannabinoids.

The purpose of this study was to investigate the effects of Mg fertilization on the growth and subsequent cannabinoid production of *C. sativa*. For growers, a fertility rate that maximizes floral yield, biomass, and cannabinoids while minimizing inputs are important.

Materials and Methods

Two high CBD hemp cultivars 'BaOx' and 'Suver Haze' (*Cannabis sativa*) cuttings were obtained from 12-week-old mother stock plants. Terminal vegetative exterior canopy cuttings were taken and stuck on 7 Jan. 2020 into 13-cell foam wedge strips (dimensions: HxWxW (5x3.25x2.5 tapering to 1.5 cm)) (#87-50010, Oasis; Kent, OH). The plants were placed under a mist bench in

a glass greenhouse (35.78 °N latitude with 23.9°C/18.3°C (75 and 65°F) day/night temperatures) and rooted until the first roots appeared on the outside of the plugs (~2 weeks). After root emergence, the plants were irrigated with a nurse solution (33.4 g KNO_3, 33.4 g $CA(NO_3)_2 \cdot H_2O$, 6.6 g KH_2PO_4, 13.2 g $MgSO_4 \cdot 7H_2O$ in 20L H_2O). After three weeks from sticking, rooted plugs were transplanted on 6 Feb. 2020 into 3.76L plastic pots filled with a custom substrate mix to prevent Mg nutrient contamination that would occur by using a pH adjusted and fertilizer charged commercial substrate. The substrate was a 70:30 (v:v) mix of Canadian sphagnum peat moss (Conrad Fafard, Agawam, MA) and horticultural coarse perlite (Perlite Vermiculite Packaging Industries, North Bloomfield, OH), amended with calcium hydroxide [$Ca(OH)_2$ (Southern Lime, Calera, AL)] at 2.3 $kg \cdot m^{-3}$ for pH adjustment to 6.0 and wetting agent (AquaGro 2000 G; Aquatrols, Cherry Hill, NJ) at 600 $g \cdot m^{-3}$. Plants were provided night interruption lighting between 22:00 and 2:00 during the vegetative stage to prevent floral initiation.

Fertilization Treatments

All fertilizers were custom blends of the following individual technical grade salts (Fisher Scientific, Pittsburgh, PA): calcium nitrate tetrahydrate [$Ca(NO_3)_2 \cdot 4H_2O$], potassium nitrate (KNO_3), monopotassium phosphate (KH_2PO_4), potassium sulfate (K_2SO_4), magnesium sulfate heptahydrate ($MgSO_4 \cdot 7H_2O$), magnesium nitrate [$Mg(NO_3)_2$], monopotassium phosphate (KH_2PO_4), sodium phosphate heptahydrate ($NaH_2PO_4 \cdot 7H_2O$), iron chelate (Fe-DTPA), manganese chloride tetrahydrate ($MnCl_2 \cdot 4H_2O$), zinc chloride heptahydrate ($ZnCl_2 \cdot 7H_2O$), copper chloride dihydrate ($CuCl_2 \cdot 2H_2O$), boric acid (H_3BO_3), and sodium molybdate dihydrate ($Na_2MoO_4 \cdot 2H_2O$).

Fertilization treatments began the day of transplant for each cultivar. Six fertilizer concentrations of 0.0, 12.5, 25.0, 50.0, 75.0, 100.0 mg·L^{-1} Mg were mixed using the previously described salts held constant and only Mg varying when possible (Table 1). Fertilizers were mixed in 100-L barrels and applied through drip irrigation as needed at every irrigation with an estimated 10% leaching fraction. The solution was delivered via pumps (model 1A; Little Giant Pump Co., Oklahoma City, OK) connected to 1.9-cm-diameter irrigation tubing fitted with circular drip emitters (Dramm USA, Manitowoc, WI). The solution and substrate pH were monitored to ensure values were within the recommended range of 5.5 to 6.5 (Whipker et al., 2019).

Each cultivar was arranged on a separate greenhouse bench using a completely randomized design. At the start of the treatment, there were 18 single-plant replicants grown for each of the six fertilizer concentrations (0.0, 12.5, 25.0, 50.0, 75.0, and 100.0 mg·L^{-1} Mg). After four weeks of vegetative growth, four plants were sampled before the initiation of short days on 13 March. Night interruption lighting was also curtailed to induce floral initiation. The remaining plants were grown to document symptoms and nutritive stresses into the remaining physiological stages of pre-flowering (4 April) and flowering (30 April), at which times four replicates were sampled.

Plant Materials

For each life-stage harvest, the most recently matured leaves were sampled to evaluate the critical micronutrient and macronutrient leaf tissue concentrations for each Mg treatment. Plants were destructively harvested, and the most recently matured leaves were initially rinsed with deionized water (DI), then washed in a solution of 0.5 M HCl for 1 min and again rinsed with DI water (Henry et al., 2018). The remaining shoot tissue was harvested separately, and roots were discarded.

Upon sampling, the plant tissues and the remaining above-ground plant biomass were dried at 70 °C for 96 hours, and the dry mass was weighed and recorded. After drying, leaf tissue was ground in a Foss Tecator Cyclotec™ 1093 sample mill (Analytical Instruments, LLC; Golden Valley, MN; $\leq$0.5 mm sieve). The ground tissue was then placed in vials containing ~8 g of tissue and analyzed at the North Carolina Department of Agriculture & Consumer Services (NCDA) testing lab (Raleigh, NC). Plant material (0.5 g) was first rinsed in nitric acid (10 mLs of HNO_3 at 15.6N) and digested in a microwave digestion system for 30 minutes (MARS 6 Microwaves; Matthews, NC). After microwave digestion, the plant material was diluted with 50 mLs of deionized water and then vacuum filtered through acid-washed paper (Laboratory Filtration Group; Houston, TX). After dilution, plant mineral tissue concentration was determined using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) machine (Spectro Arcos EOP; Mahwah, NJ).

Cannabinoid Analysis

During the flowering harvest (8 weeks of critical photoperiod), the cola bud and four-terminal axillary buds were harvested creating a composite bud sample. The composite bud sample was then freeze-dried (Harvest Right; North Salt Lake, UT) for 30 hours. The bud sample dry mass was weighed and recorded. After drying, bud samples placed into vials ~8 g of dried tissue were then sent for cannabinoid analysis and terpene analysis (Avazyme Inc., Durham, NC). Upon arrival, buds were lyophilized, ground, and a 2 g (1.98 – 2.02 g) sub-sample from the composite buds obtained. Analysis for cannabinoids was accomplished through high-pressure liquid chromatography (SHIMADZU 8050 & 8040 Triple Quadrupole UHPLC/MS/MS analysis; Austin, TX). Exact testing methods are unavailable given Avazyme is a private company and their testing methods are proprietary.

C. sativa sativa has multiple different cannabinoids and molecular types within each cannabinoid. The active forms of the cannabinoids are cannabigerol (CBG), cannabidiol (CBD), cannabichromene (CBC), and **Δ^9-**tetrahydrocannabinol (Δ^9 THC). These forms are typically considered active given they have been decarboxylated. The other forms are the acid pools of the above cannabinoids which need to be decarboxylated to become the active form (cannabidiolic acid (CBDA), tetrahydrocannabinolic acid (THCA), cannabichromenic acid (CBCA), and cannabigerolic acid (CBGA) (Brighenti et al. 2017 and Welling et al., 2016). Additional cannabinoids and forms exist but are not reported here, (cannabidivarin (CBDV) and tetrahydrocannabivarin (THCV)), given their concentrations were either too low to detect, were not tested for, or were present in the same concentrations regardless of Mg treatment . Total CBD and THC were calculated by the following equations:

$$\Delta^9 \text{ THC} + (0.877 \text{ x THCA}) = \text{Total THC}$$

$$\text{CBD} + (0.877 \text{ x CBDA}) = \text{Total CBD}$$

Statistical analysis

Statistical analysis was conducted using SAS (version 9.4; SAS inst., Cary, NC). Plant growth metrics, leaf nutrient values, and bud weights were analyzed for differences within each data collection regarding Mg concentration as the explanatory variable using PROC GLM. Where the *F*-test was significant, LSD with a Tukey Kramer adjustment ($P < 0.05$) was used to compare differences among means. Deviations in plant metrics, total plant dry weights, leaf tissue values, and bud weights were calculated on a percentage basis from the controls.

Results and Discussion

Vegetative Stage

During the vegetative stage, no visual symptoms of Mg deficiencies occurred at any of the tested rates (Fig. 1). 'BaOx' plants grown at 50.0 mg·L^{-1} Mg produced the greatest diameter of 18.28 cm, and 75.0 mg·L^{-1} Mg produced the greatest plant height (34.23 cm) and plant biomass (7.58 g) (Table 2). These rates were statistically higher from the two lowest Mg rates of 0.0, 12.5 and 25.0   mg·L^{-1} Mg. For 'Suver Haze', a rate of 50.0 mg·L^{-1} Mg produced the greatest plant height, diameter, and total biomass of, 31.80 cm, 47.91 cm, and 8.98 g, respectively, and was significantly greater than the lowest rate of 0.0 mg·L^{-1} Mg (Table 3).

To determine the relationship of Mg fertility and plant uptake, leaf tissue analysis was conducted on the most recently matured leaves (MRML) after four weeks of vegetative growth. A linear relationship was observed in the accumulation of Mg based on fertility concentration (Tables 4 and 5). Foliar Mg-concentrations for both cultivars were maximized at 100.0 mg·L^{-1} Mg. 'BaOx' plants grown at 100.0 mg·L^{-1} Mg foliar concentrations were significantly greater than plants grown at all other rates and accumulated 2X more Mg than plants grown at the lowest rate of 0.0 mg·L^{-1} Mg (Table 4). 'Suver Haze' plants grown at 75.0 and 100.0 mg·L^{-1} Mg accumulated significantly more Mg than plants grown at any other rate. Plants grown at 100.0 mg·L^{-1} Mg accumulated 2.6X more Mg in the MRML than plants grown at the lowest rate of 0.0 mg·L^{-1} Mg (Table 5).

Although accumulation in the MRML is still increasing linearly and a plateau was not reached for foliar nutrient accumulation. However,   a plateau in growth metrics was observed between a fertility rate of 50.0 and 75.0 mg·L^{-1} Mg. These results show that Mg plays an important role in

clone establishment and rates of 50.0 to 75.0 mg·L^{-1} Mg should be provided and 100.0 mg·L^{-1} Mg would be considered in the upper range of Mg by the plant and thus may be too high.

Preflower Stage

'BaOx' plants fertilized with 50.0 mg·L^{-1} Mg exhibited the largest plant height, diameter, and total plant biomass of 56.33 cm, 62.09 cm, and 44.38 g, respectively (Table 6), and this rate was statistically different from both the 0.0 and 100.0 mg·L^{-1} Mg rates. During the preflower stage, the pump for the rate of 75.0 mg·L^{-1} Mg malfunctioned and did not properly deliver fertility applications for 'Suver Haze'. Thus, the rate of 75.0 mg·L^{-1} Mg is not reported for the preflower, and flower harvest. 'Suver Haze' plant height during the preflower stage was not statistically different amongst any Mg rate. However, plant diameter was maximized at a rate of 25.0 mg·L^{-1} Mg resulting in a diameter of 52.51 cm. Plant biomass was maximized at 38.45 g with a rate of 12.5 mg·L^{-1} Mg (Table 7). Plants did not exhibit Mg deficiency symptoms during the preflower stage (Fig. 2). The limited statistical significance of plant height and diameter for 'Suver Haze' as compared to 'BaOx' can be explained by a difference in growth habit between the two cultivars (Fig. 2). Both 'BaOx' and 'Suver Haze' have a conical architecture. However, 'Suver Haze' produces more foliage and allocates fewer resources into lateral and horizontal growth as compared to 'BaOx'. *C. sativa* has a large variation of growth habit and architecture amongst cultivars (Whipker et al., 2020).

In both cultivars, similar trends of foliar nutrient accumulation continued in the preflower stage in which the rate of 100.0 mg·L^{-1} Mg was significantly greater than all other rates. The greatest Mg-foliar concentration occurred at a rate of 100.0 mg·L^{-1} Mg and was 2.86X greater than the plants grown at 0.0 mg·L^{-1} Mg, which had the lowest Mg-foliar concentration (Table 8). For 'Suver Haze' plants grown at 100.0 mg·L^{-1} Mg contained Mg-foliar concentrations of 1.00% Mg, and

were 2.44X greater than plants grown at the lowest rate of 0.0 mg·L^{-1} Mg, which exhibited the lowest Mg-foliar concentrations (Table 9).

Flowering Stage

Visual symptoms of Mg deficiency manifested on 'Suver Haze' plants at the three lowest rates (0, 12.5, and 25 mg·L^{-1} Mg). Initial symptoms were expressed as slight yellowing of the interveinal regions of the lower and older foliage (Fig. 3). As symptoms progressed, the interveinal yellowing became more pronounced and intensified on the lower foliage. Necrotic spotting also developed as symptoms progressed (Fig. 4). In severe cases, interveinal chlorosis developed into total leaf necrosis and abscission. 'BaOx' plants did not exhibit foliar Mg deficiency symptoms during the flowering stage (Fig. 5). Magnesium deficiency symptoms often develop after bud formation has begun. With Mg being a mobile element, the symptoms often are induced with the formation of buds acting as a sink for the plant, and the Mg that is present in the lower leaves is translocated to the developing buds. This can be observed in 'Suver Haze' plants at the 25.0 Mg rate in which plants were not   exhibiting Mg deficiency symptoms during the flowering stage, however, symptoms were observed during the flowering stage (Fig 6).

During the Flowering stage, 'BaOx' growth was similar across fertility rates except for plant diameter for 75.0 mg·L^{-1} Mg, which was statistically greater than the 0.0 and 12.5 mg·L^{-1} Mg rates (Table 10). 'Suver Haze' plants grown at the 50.0 mg·L^{-1} Mg rate, had significantly greater plant diameter, total plant, dry weight, and total bud weight of 61.88 cm, 98.20 g, and 45.65 g, respectively when compared with the lowest rate of 0.0 mg·L^{-1} Mg and the highest rate of 100.0 mg·L^{-1} Mg (Table 11).

Magnesium foliar concentrations were maximized for both cultivars at 100.0 mg·L^{-1} Mg and were significantly greater than plants grown at the lowest rate of 0.0 mg·L^{-1} Mg. At 100.0 mg·L^{-1}

Mg, Mg-foliar concentration was 1.44% Mg for 'BaOx' and 1.31% Mg for 'Suver Haze' (Tables 12 and 13). This is significantly greater than the recommended ranges of 0.25-0.46% Mg for vegetative stock plants (Landis et al., 2019) and 0.40-0.81% Mg (Bryson and Mills, 2014). With the maximum growth being observed with a fertility rate between 50.0 and 75.0 mg·L^{-1} Mg, during the flower stage growers should target foliar concentrations of 0.93-1.28% Mg.

Cannabinoid Production

When using Mg fertility rates as the explanatory variable, there were no statistically significant trends, given the *p*-value of these cannabinoids was ≥ 0.05. However, when using cultivar as the explanatory variable all cannabinoids evaluated were statistically significant between cultivars (Table 14 and 15). 'BaOx' constantly produced higher cannabinoid concentrations when compared to 'Suver Haze', while neither cultivar showed significant trends in cannabinoid production in regard to the variation of Mg fertility rate. Thus, cultivar genetics can play a larger role in cannabinoid concentrations than Mg fertility rates.

Conclusions

Growing 'BaOx' and 'Suver Haze' *C. sativa* with a fertility rate of 50.0 to 75.0 mg·L^{-1} provided maximum plant height, diameter, and total plant dry weight. These rates optimized plant growth without deficiency symptoms or stunting growth due to an over or under application. Although a plateau was not reached for the foliar accumulation of Mg, a plateau in which growth metrics were maximized occurred at a rate between 50.0 and 75.0 mg·L^{-1} Mg. Magnesium fertility had no impact on cannabinoid concentrations in which overall trends were not significant (Tables 12 and 13). Thus, growers can optimize yield and limit economic inputs between these rates or above if a more liberal fertility regime is desired.

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Figure 1. Effect of magnesium (mg·L^{-1}) on 'BaOx' and 'Suver Haze' growth during the vegetative stage (four weeks of growth).
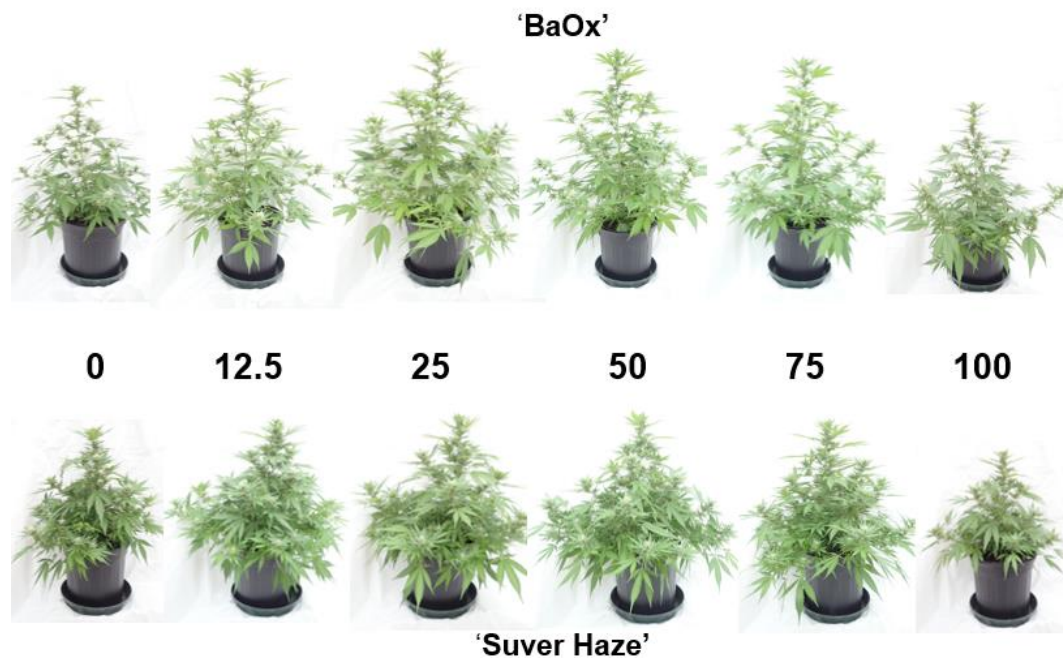
Figure 2. Effect of magnesium ($mg \cdot L^{-1}$) on 'BaOx' and 'Suver Haze' growth during the preflower stage (4 weeks of vegetative growth and 4 weeks of reproductive growth).

Figure 3. The initial symptomology of a magnesium deficiency on 'Suver Haze' cannabis cultivar.

Figure 4. Severe Mg deficiency symptoms developing on a 12-week-old *Cannabis sativa* 'Suver Haze' plant. Note the interveinal yellowing and the necrotic spotting forming as symptoms progressed.

Figure 5. Effect of magnesium (mg·L^{-1}) on 'BaOx' and 'Suver Haze' growth during the flower stage (4 weeks of vegetative growth and 8 weeks of reproductive growth). Note the difference in foliage production between the two cultivars.

Figure 6. Development of Mg deficiency symptoms often occurs during bud development, both plants are 'Suver Haze' and are grown at 25.0 mg·L^{-1} Mg. The plant on the left is at 4 weeks of bud development compared to the plant on the right which was documented at 8 weeks of bud development which is exhibiting Mg-deficiency symptoms.

Table 1. Macro- and micronutrient fertilizer concentrations by magnesium (Mg) treatment.

Macronutrients (mg·L^{-1})						
Mg (mg· L^{-1})	N	P	K	Ca	Mg	S
0	200.2	30.4	234.4	185.6	0.0	15.5
12.5	200.1	30.4	234.5	185.6	12.5	30.0
25	200.2	30.0	234.6	185.6	25.0	33.0
50	200.2	30.0	234.6	185.6	50.1	66.1
75	200.2	30.0	234.6	185.6	75.1	99.1
100	200.2	30.0	234.6	185.6	100.1	132.13
Micronutrients (mg·L^{-1})						
	Fe	Mn	Cu	Zn	B	Mo
All Mg rates	4.02	0.99	0.19	0.20	0.49	0.01

Table 2. The impacts of magnesium fertility on plant growth metrics of *Cannabis sativa* 'BaOx' after four weeks of vegetative growth.

	Four Weeks of Growth					
Mg (mg·L⁻¹)[1]	Height[2]		Diameter[2]		Total Above Ground Dry Weight[2]	
	Mean	SD[3]	Mean	SD	Mean	SD
0.0	27.30 C	0.82	14.39 C	0.54	2.58 C	0.26
12.5	27.83 C	1.49	14.69 B	0.84	3.68 C	0.88
25.0	29.55 BC	2.90	15.43 B	1.32	3.70 C	0.80
50.0	33.95 AB	2.79	18.28 A	1.64	5.90 B	0.59
75.0	34.23 A	2.83	18.27A	1.31	7.58 A	1.14
100.0	31.25 ABC	5.36	16.63 BC	2.41	3.38 C	1.18
Significance[4]	*		***		***	

[1] Magnesium fertility rates based on mg·L⁻¹.

[2] All height and diameter measurements based on cm. The diameter was calculated by taking the widest two points on a plant taken 90º from each other. These numbers were then added together and divided by 2 to get the diameter measurement. All dry weights were in grams and taken based on oven-dried material.

[3] All standard deviation values assumed to be $\pm$ of the given value.

[4] *, **, or *** indicates statistically significant differences between sample means based on F test at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the F test difference between sample means was $P > 0.05$. Where the F-test was significant, LSD with a Tukey Kramer adjustment ($P < 0.05$) was used to compare differences among means.

[v] Statistically significant based on F test at $P \leq 0.05$

Table 3. The impacts of magnesium fertility on plant growth metrics of *Cannabis sativa* 'Suver Haze' after four weeks of vegetative growth.

	Four Weeks of Growth					
Mg (mg·L^{-1})[1]	Height[2]		Diameter[2]		Total Above Ground Dry Weight[2]	
	Mean	SD[3]	Mean	SD	Mean	SD
0.0	24.78 B	3.45	36.68 C	2.80	5.03 C	0.85
12.5	26.90 AB	3.31	39.40 BC	4.69	5.18 C	1.53
25.0	29.95 AB	5.98	42.86 ABC	5.43	5.95 BC	0.68
50.0	31.80 A	1.76	47.91 A	5.51	8.98 A	1.91
75.0	30.65 A	1.84	46.53 AB	7.60	7.85 AB	1.88
100.0	29.25 AB	4.66	40.83 ABC	1.86	6.68 BC	1.52
Significance[4]	NS		*		**	

[1] Magnesium fertility rates based on mg·L^{-1}.

[2] All height and diameter measurements based on cm. The diameter was calculated by taking the widest two points on a plant taken 90° from each other. These numbers were then added together and divided by 2 to get the diameter measurement. All dry weights were in grams and taken based on oven-dried material.

[3] All standard deviation values assumed to be $\pm$ of the given value.

[4] *, **, or *** indicates statistically significant differences between sample means based on F test at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the F test difference between sample means was $P > 0.05$. Where the F-test was significant, LSD with a Tukey Kramer adjustment ($P < 0.05$) was used to compare differences among means.

[v] Statistically significant based on F test at $P \leq 0.05$

Table 4. The impacts of magnesium fertility on the nutrient accumulation in leaf tissue of *Cannabis sativa* 'BaOx' after four weeks of vegetative growth.

Mg (mg·L⁻¹)[1]	N[2]	P[2]	K[2]	Ca[2]	Mg[2]	S[2]	Fe[3]	Mn[3]	Zn[3]	Cu[3]	B[3]
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0.0	5.83 AB	0.63 A	3.59 AB	8.21 A	0.57 E	0.34 A	112.25 AB	253.50 A	53.53 CD	5.61 AB	88.55 B
12.5	5.85 AB	0.61 AB	3.67 A	7.49 AB	0.70 DE	0.36 A	106.95 AB	210.75 BC	56.80 BC	9.75 A	82.18 BC
25.0	6.05 A	0.56 B	3.23 C	6.79 BC	0.79 CD	0.35 A	119.75 A	180.75 D	48.35 D	4.12 B	69.08 C
50.0	5.88 AB	0.58 AB	3.53 AB	6.79 BC	0.88 BC	0.36 A	116.75 AB	228.50 B	55.93 BC	6.99 AB	108.85 A
75.0	5.76 B	0.57 B	3.53 AB	6.32 C	0.99 B	0.37 A	106.83 AB	196.25 CD	59.53 AB	7.56 AB	94.55 AB
100.0	5.89 AB	0.61 AB	3.30 BC	6.67 C	1.15 A	0.37 A	95.33 B	219.50 BC	63.60 A	7.90 AB	73.13 C
Significance[4]	NS	NS	*	**	***	NS	NS	***	***	NS	**

‘BaOx’ Nutrient Accumulation After Four Weeks of Growth

[1] Magnesium fertility concentrations based on mg · L⁻¹.

[2] All macronutrient concentrations are a percentage of leaf tissue dry weight.

[3] All micronutrient concentrations are listed as ppm or mg · kg⁻¹.

[4] *, **, or *** Indicates statistically significant differences between sample means based on F-test (proc GLM) at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the F-test difference between sample means was $P > 0.05$. Values with the same letter indicate a lack of statistical significance while values with different letters indicate statistically significant results.

Table 5. The impacts of magnesium fertility on the nutrient accumulation in leaf tissue of *Cannabis sativa* 'Suver Haze' after four weeks of vegetative growth.

Mg (mg·L^{-1})[1]	'Suver Haze' Nutrient Accumulation After Four Weeks of Growth										
	N[2]	P[2]	K[2]	Ca[2]	Mg[2]	S[2]	Fe[3]	Mn[3]	Zn[3]	Cu[3]	B[3]
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0.0	5.61 AB	0.61 AB	3.74 A	4.83 B	0.42 D	0.37 A	64.63 C	137.00 A	67.50 A	7.52 B	56.63 BC
12.5	5.69 AB	0.66 A	3.54 AB	5.89 AB	0.57 C	0.35 A	76.75 BC	151.00 ABC	65.78 A	6.94 B	56.43 BC
25.0	5.80 A	0.60 AB	3.48 AB	4.89 B	0.62 BC	0.35 A	70.53 BC	124.50 C	66.35 A	5.19 C	48.95 C
50.0	5.71 AB	0.68 A	3.71 A	5.07 B	0.71 B	0.37 A	87.10 AB	163.50 AB	70.90 A	9.22 A	84.18 A
75.0	5.32 A	0.53 B	3.54 AB	5.67 AB	1.01 A	0.37 A	71.15 BC	141.75 BC	71.88 A	7.84 AB	90.83 A
100.0	5.43 AB	0.60 AB	3.24 B	6.15 A	1.11 A	0.34 A	100.50 A	173.50 A	63.63 A	7.05 B	66.03 B
Significance[4]	NS	NS	NS	NS	***	NS	*	*	NS	***	***

[1] Magnesium fertility concentrations based on mg · L^{-1}.

[2] All macronutrient concentrations are a percentage of leaf tissue dry weight.

[3] All micronutrient concentrations are listed as ppm or mg · kg^{-1}.

[4] *, **, or *** Indicates statistically significant differences between sample means based on *F*-test (proc GLM) at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the *F*-test difference between sample means was $P > 0.05$. Values with the same letter indicate a lack of statistical significance while values with different letters indicate statistically significant results.

Table 6. The impacts of magnesium fertility on plant growth metrics of *Cannabis sativa* 'BaOx' at the preflower stage (eight weeks of total growth, four weeks after critical photoperiod).

Mg (mg·L^{-1})[1]	Eight Weeks of Growth					
	Height[2]		Diameter[2]		Total Above Ground Dry Weight[2]	
	Mean	SD[3]	Mean	SD	Mean	SD
0.0	46.05 B	3.63	45.68 D	4.67	20.55 D	7.92
12.5	51.10 AB	4.63	53.20 BC	2.38	38.25 AB	11.82
25.0	52.08 AB	4.36	59.85 A	3.40	30.85 BCD	3.12
50.0	56.33 A	5.76	62.09 A	2.97	44.38 A	12.58
75.0	52.25AB	2.64	57.70 AB	4.69	35.18 ABC	6.18
100.0	45.80 B	4.76	50.46 D	5.64	24.13 CD	7.94
Significance[4]	*		***		*	

[1] Magnesium fertility rates based on mg·L^{-1}.
[2] All height and diameter measurements based on cm. The diameter was calculated by taking the widest two points on a plant taken 90° from each other. These numbers were then added together and divided by 2 to get the diameter measurement. All dry weights were in grams and taken based on oven-dried material.
[3] All standard deviation values assumed to be $\pm$ of the given value.
[4] *, **, or *** indicates statistically significant differences between sample means based on F test at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the F test difference between sample means was $P > 0.05$. Where the F-test was significant, LSD with a Tukey Kramer adjustment ($P < 0.05$) was used to compare differences among means.
[v] Statistically significant based on F test at $P \leq 0.05$

Table 7. The impacts of magnesium fertility on plant growth metrics of *Cannabis sativa* 'Suver Haze' at the preflower stage (eight weeks of total growth, four weeks after critical photoperiod).

	Eight Weeks of Growth					
Mg (mg·L^{-1})[1]	Height[2]		Diameter[2]		Total Above Ground Dry Weight[2]	
	Mean	SD[3]	Mean	SD	Mean	SD
0.0	34.75 AB	3.72	43.71 BC	2.15	26.63 BC	5.31
12.5	38.78 AB	2.45	52.06 A	4.42	38.45 A	9.29
25.0	39.40 A	4.77	52.51 A	5.86	37.85 AB	8.80
50.0	35.65 AB	2.48	49.28 AB	4.31	32.65 ABC	7.48
75.0	NR	NR	NR	NR	NR	NR
100.0	33.65 B	3.80	42.31 C	1.83	22.60 C	7.12
Significance[4]	NS		**		*	

[1] Magnesium fertility rates based on mg·L^{-1}.

[2] All height and diameter measurements based on cm. The diameter was calculated by taking the widest two points on a plant taken 90° from each other. These numbers were then added together and divided by 2 to get the diameter measurement. All dry weights were in grams and taken based on oven-dried material.

[3] All standard deviation values assumed to be ± of the given value.

[4] *, **, or *** indicates statistically significant differences between sample means based on *F* test at $P \leq$ 0.05, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the *F* test difference between sample means was $P > 0.05$. Where the *F*-test was significant, LSD with a Tukey Kramer adjustment ($P < 0.05$) was used to compare differences among means.

[v] Statistically significant based on *F* test at $P \leq 0.05$

Table 8. The impacts of magnesium fertility on the nutrient accumulation of *Cannabis sativa* 'BaOx' at the preflower stage (eight weeks of total growth, four weeks after critical photoperiod).

Mg (mg·L⁻¹)[1]	N[2]	P[2]	K[2]	Ca[2]	Mg[2]	S[2]	Fe[3]	Mn[3]	Zn[3]	Cu[3]	B[3]
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0.0	3.96 A	0.53A	2.57 A	6.21 A	0.37 D	0.31 ABC	153.25 AB	461.50 A	77.65 A	6.49 AB	174.75 A
12.5	3.26 B	0.40 C	2.39 AB	4.68 AB	0.40 D	0.29 C	169.75 A	317.50 A	66.25 A	5.51 BC	147.25 A
25.0	3.48 AB	0.49 ABC	2.58 A	5.14 ABC	0.63 C	0.32 ABC	157.75 AB	361.75 A	75.33 A	5.07 C	145.25 A
50.0	3.17 B	0.42 BC	2.22 B	3.85 C	0.59 C	0.30 BC	123.23 BC	332.25 A	68.30 A	6.35 ABC	132.58 A
75.0	3.59 AB	0.52 AB	2.48 AB	4.82 ABC	0.89 B	0.36 A	110.93 C	399.25 A	77.28 A	6.77 AB	139.25 A
100.0	3.77 AB	0.57 A	2.35 AB	5.52 AB	1.06 A	0.35 AB	108.70C	452.50 A	83.58 A	6.95 A	156.50 A
Significance[4]	NS	*	NS	NS	***	NS	**	NS	NS	NS	NS

Under header: **'BaOx' Nutrient Accumulation After Eight Weeks of Growth**

[1] Magnesium fertility concentrations based on mg · L⁻¹.

[2] All macronutrient concentrations are a percentage of leaf tissue dry weight.

[3] All micronutrient concentrations are listed as ppm or mg · kg⁻¹.

[4] *, **, or *** Indicates statistically significant differences between sample means based on *F*-test (proc GLM) at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the *F*-test difference between sample means was $P > 0.05$. Values with the same letter indicate a lack of statistical significance while values with different letters indicate statistically significant results.

Table 9. The impacts of magnesium fertility on the nutrient accumulation of *Cannabis sativa* 'Suver Haze' at the preflower stage (eight weeks of total growth, four weeks after critical photoperiod).

Mg (mg·L^{-1})[1]	N[2]	P[2]	K[2]	Ca[2]	Mg[2]	S[2]	Fe[3]	Mn[3]	Zn[3]	Cu[3]	B[3]
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0.0	3.55 A	0.51 A	2.45 A	7.31 A	0.41 D	0.28 A	85.43A	399.25 A	98.98A	6.85 A	146.50 A
12.5	2.94 B	0.34 B	2.17 B	5.23 B	0.43 D	0.24 B	105.80 A	280.00 B	78.33 A	5.40 BC	120.60 AB
25.0	2.98 B	0.35 B	2.16 B	5.35 B	0.61 C	0.24 B	103.10 A	286.25 B	78.78 A	4.83 C	116.15 B
50.0	3.23 AB	0.48 A	2.42 A	5.63 B	0.80 B	0.27 AB	107.53 A	371.50 AB	89.93 A	6.91 A	130.00 AB
75.0	Nr	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
100.0	3.52 A	0.49 A	2.30 AB	5.66 B	1.00 A	0.28 A	92.30 A	343.25 AB	99.38 A	6.30 AB	140.25 AB
Significance[4]	NS	**	*	**	***	*	NS	NS	NS	**	NS

[1] Magnesium fertility concentrations based on mg · L^{-1}.

[2] All macronutrient concentrations are a percentage of leaf tissue dry weight.

[3] All micronutrient concentrations are listed as ppm or mg · kg^{-1}.

[4] *, **, or *** Indicates statistically significant differences between sample means based on *F*-test (proc GLM) at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the *F*-test difference between sample means was $P > 0.05$. Values with the same letter indicate a lack of statistical significance while values with different letters indicate statistically significant results.

Table 10. The impacts of magnesium fertility on plant growth metrics of *Cannabis sativa* 'BaOx' at the Flower stage (twelve weeks of total growth, eight weeks of flower induction).

	Twelve Weeks of Growth							
Mg (mg·L⁻¹)[1]	Height[2]		Diameter[2]		Total Above Ground Dry Weight[2]		Total Bud weight[2]	
	Mean	SD[3]	Mean	SD	Mean	SD	Mean	SD
0.0	50.58 A	1.72	58.38 B	1.42	59.23 A	8.50	31.70A	4.64
12.5	50.83 A	6.62	58.70 B	10.57	65.95 A	17.98	34.35A	6.33
25.0	54.53 A	5.21	61.06 AB	5.97	76.38 A	24.90	39.85A	10.14
50.0	56.18 A	4.05	68.16 AB	8.32	67.58 A	10.14	33.75A	2.70
75.0	55.73 A	9.25	70.99 A	10.17	82.70 A	22.37	41.83A	9.70
100.0	58.00 A	16.19	59.44 AB	8.70	65.80 A	25.92	33.85A	9.81
Significance[4]	NS		NS		NS		NS	

[1] Magnesium fertility rates based on mg·L⁻¹.

[2] All height and diameter measurements based on cm. The diameter was calculated by taking the widest two points on a plant taken 90º from each other. These numbers were then added together and divided by 2 to get the diameter measurement. All dry weights were in grams and taken based on oven-dried material.

[3] All standard deviation values assumed to be $\pm$ of the given value.

[4] *, **, or *** indicates statistically significant differences between sample means based on F test at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the F test difference between sample means was $P > 0.05$. Where the F-test was significant, LSD with a Tukey Kramer adjustment ($P < 0.05$) was used to compare differences among means.

[v] Statistically significant based on F test at $P \leq 0.05$

Table 11. The impacts of magnesium fertility on plant growth metrics of *Cannabis sativa* 'Suver Haze' at the Flower stage (twelve weeks of total growth, eight weeks of flower induction).

	Twelve Weeks of Growth							
Mg (mg·L^{-1})[1]	Height[2]		Diameter[2]		Total Above Ground Dry Weight[2]		Total Bud weight[2]	
	Mean	SD[3]	Mean	SD	Mean	SD	Mean	SD
0.0	39.93 B	0.97	43.11 C	2.66	66.35 BC	3.09	33.20B	4.01
12.5	43.65 AB	2.57	49.24 BC	6.61	81.13 AB	9.41	39.53AB	3.16
25.0	43.65 AB	4.36	52.76 B	5.87	74.75 BC	15.19	35.55AB	4.49
50.0	49.35 A	4.68	61.88 A	5.33	98.20 A	23.10	45.65A	6.39
75.0	NR	NR	NR	NR	NR	NR	NR	NR
100.0	45.78 AB	8.24	47.64 BC	2.42	57.08 C	12.81	31.1 B	6.35
Significance[4]	NS		***		*		***	

[1] Magnesium fertility rates based on mg·L^{-1}.

[2] All height and diameter measurements based on cm. The diameter was calculated by taking the widest two points on a plant taken 90° from each other. These numbers were then added together and divided by 2 to get the diameter measurement. All dry weights were in grams and taken based on oven-dried material.

[3] All standard deviation values assumed to be $\pm$ of the given value.

[4] *, **, or *** indicates statistically significant differences between sample means based on F test at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the F test difference between sample means was $P > 0.05$. Where the F-test was significant, LSD with a Tukey Kramer adjustment ($P < 0.05$) was used to compare differences among means.

Table 12. The impacts of magnesium fertility on the nutrient accumulation of *Cannabis sativa* 'BaOx' at the Flower stage (twelve weeks of total growth, eight weeks of flower induction).

Mg (mg·L⁻¹)[1]	'BaOx' Nutrient Accumulation After Twelve Weeks of Growth										
	N[2]	P[2]	K[2]	Ca[2]	Mg[2]	S[2]	Fe[3]	Mn[3]	Zn[3]	Cu[3]	B[3]
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0.0	2.86	0.39 A	2.17 A	9.47 A	0.46 D	0.35 B	217.50 A	633.00 A	63.48 A	6.50 AB	277.00 A
12.5	2.71 A	0.34 A	2.07 AB	8.76 A	0.60 D	0.34 B	205.25 A	610.75 A	64.55 A	5.19 AB	263.25 AB
25.0	2.90 A	0.34 A	2.09 AB	9.17 A	0.94 C	0.35 B	182.50 A	485.75 A	65.58 A	5.11 AB	263.50 AB
50.0	2.67 A	0.32 A	1.90 AB	8.00 A	1.17 BC	0.39 A	181.25 A	547.25 A	65.85 A	5.03 AB	242.75 AB
75.0	2.70 A	0.33 A	1.83 AB	7.61 A	1.28 AB	0.36 AB	152.00 A	448.75 A	64.98 A	7.41 A	242.00 AB
100.0	2.59 A	0.35 A	1.69 B	7.92 A	1.44 A	0.37 AB	157.00 A	500.75 A	62.38 A	4.51 B	220.75 A
Significance[4]	NS	NS	NS	NS	***	NS	NS	NS	NS	NS	NS

[1] Magnesium fertility concentrations based on mg · L⁻¹.

[2] All macronutrient concentrations are a percentage of leaf tissue dry weight.

[3] All micronutrient concentrations are listed as ppm or mg · kg⁻¹.

[4] *, **, or *** Indicates statistically significant differences between sample means based on F-test (proc GLM) at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the F-test difference between sample means was $P > 0.05$. Values with the same letter indicate a lack of statistical significance while values with different letters indicate statistically significant results.

Table 13. The impacts of magnesium fertility on the nutrient accumulation of *Cannabis sativa* 'Suver Haze' at the Flower stage (4 of vegetative growth, 8 weeks of reproductive growth).

Mg (mg·L^{-1})[1]	'Suver Haze' Nutrient Accumulation After Twelve Weeks of Growth										
	N[2]	P[2]	K[2]	Ca[2]	Mg[2]	S[2]	Fe[3]	Mn[3]	Zn[3]	Cu[3]	B[3]
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0.0	2.04 A	0.22 AB	1.50 A	8.87 A	0.28 D	0.20 AB	80.88 BC	430.50 A	57.05 AB	3.53 A	185.75 A
12.5	1.37 B	0.11 B	1.40 A	6.66 BC	0.38 CD	0.16 B	63.90 C	256.75 B	36.70 C	2.37 BC	135.00 BC
25.0	1.28 B	0.09 B	1.48 A	6.14 C	0.57 C	0.16 B	72.18 C	205.33 B	33.33 C	2.15 C	122.00 C
50.0	1.64 AB	0.14 B	1.56 A	7.35 BC	0.93 B	0.21 A	99.85 A	292.75 AB	39.65 AB	3.07 AB	163.00 AB
75.0	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
100.0	2.13 A	0.32 A	1.36 A	8.15 AB	1.31 A	0.24 A	97.48 AB	460.50 A	68.45 A	3.41 A	175.75 A
Significance[4]	*	*	NS	*	***	**	**	*	**	**	**

[1] Magnesium fertility concentrations based on mg · L^{-1}.

[2] All macronutrient concentrations are a percentage of leaf tissue dry weight.

[3] All micronutrient concentrations are listed as ppm or mg · kg^{-1}.

[4] *, **, or *** Indicates statistically significant differences between sample means based on *F*-test (proc GLM) at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the *F*-test difference between sample means was $P > 0.05$. Values with the same letter indicate a lack of statistical significance while values with different letters indicate statistically significant results.

Table 14. A comparison of *Cannabis sativa* 'BaOx' and 'Suver Haze' floral material active cannabinoid pools on a dry matter basis (4 of vegetative growth, 8 weeks of reproductive growth).

Cultivar Comparison of Active Cannabinoid Pools After Twelve Weeks of Growth								
Cultivar	Δ^9 THC[1]		CBG[1]		CBD[1]		CBC[1]	
	Mean	SD[2]	Mean	SD[2]	Mean	SD[2]	Mean	SD[2]
BaOx	0.34	0.03	0.86	0.15	2.56	0.25	0.38	0.03
Suver Haze	0.29	0.03	0.41	0.08	2.26	0.31	0.27	0.05
Significance [3]	***		***		***		***	

[1] Abbreviations are as follows: Delta 9 Tetrahydrocannabinol (Δ^9 THC), Cannabigerol (CBG), Cannabidiol (CBD), Cannabichromene (CBC). Any variance of the above cannabinoids (CBDA, CBGA, THCA, CBCA, etc.) indicates the acid form of the molecule. The acidic version of the molecule is present in larger quantities in the plant and is converted to the non-acid forms through decarboxylation. Total CBD and THC are calculated on a concentration basis of $mg \cdot g^{-1}$ of a composite sample which had been lyophilized (1.98 – 2.02 g). The "Total" column indicates the concentration of cannabinoids calculated by the equations listed in the materials and methods. All values are expressed in terms of concentration ($mg \cdot g^{-1}$) of 2 g freeze dried composite weight.

[2] All standard deviation values assumed to be $\pm$ of the given value.

[3] *, **, or *** Indicates statistically significant differences between sample means based on *F*-test (proc GLM) at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the *F*-test difference between sample means was $P > 0.05$. Values with the same letter indicate a lack of statistical significance while values with different letters indicate statistically significant results.

Table 15. A comparison of *Cannabis sativa* 'BaOx' and 'Suver Haze' floral material cannabinoid pools, total THC, total CBD, and total cannabinoids on a dry matter basis (4 of vegetative growth, 8 weeks of reproductive growth).

Cultivar Comparison of Acid Cannabinoid Pools After Twelve Weeks of Growth

Cultivar	CBDA[1]		CBGA[1]		THCA[1]		Total THC[1]		Total CBD[1]		Total Cannabinoids[1]	
	Mean	SD[2]	Mean	SD[2]	Mean	SD[2]	Mean	SD[2]	Mean	SD[2]	Mean	SD[2]
BaOx	141.80	14.60	7.10	0.56	5.82	0.62	5.44	0.56	126.92	12.92	158.86	15.47
Suver Haze	121.00	18.56	1.98	0.61	4.98	0.80	4.66	0.73	108.38	16.55	131.18	20.26
Significance[3]	***		***		***		***		***		***	

[1] Abbreviations are as follows: Delta 9 Tetrahydrocannabinol (Δ^9 THC), Cannabigerol (CBG), Cannabidiol (CBD), Cannabichromene (CBC). Any variance of the above cannabinoids (CBDA, CBGA, THCA, CBCA, etc.) indicates the acid form of the molecule. The acidic version of the molecule is present in larger quantities in the plant and is converted to the non-acid forms through decarboxylation. Total CBD and THC are calculated on a concentration basis of mg · g^{-1} of a composite sample which had been lyophilized (1.98 – 2.02 g). The "Total" column indicates the concentration of cannabinoids calculated by the equations listed in the materials and methods. All values are expressed in terms of concentration (mg · g^{-1}) of 2 g freeze   -dried composite weight.

[2] All standard deviation values assumed to be $\pm$ of the given value.

[5] *, **, or *** Indicates statistically significant differences between sample means based on *F*-test (proc GLM) at $P \leq 0.05$, $P \leq 0.01$, or $P \leq 0.001$, respectively. NS (not significant) indicates the *F*-test difference between sample means was $P > 0.05$. Values with the same letter indicate a lack of statistical significance while values with different letters indicate statistically significant results.

[y] Statistically significant based on *F* test at $P \leq 0.05$