

# 铅对油麦菜和四季菜心幼苗生长的影响

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**摘要:** 为了解铅对油麦菜和四季菜心生长的影响, 通过无土栽培的方法, 用不同浓度的硝酸铅溶液对 2 种植物的幼苗进行了胁迫处理, 分析不同浓度铅处理对植物生长的影响。结果表明: 铅处理不同程度的影响了 2 种植物的生长, 降低了其生长速度。但是, 除茎叶鲜重和干重外, 各指标仍呈现增加趋势。在相同处理时间内, 高浓度的铅处理使油麦菜叶片数、叶面积、株高和茎叶鲜重、干重指标明显下降, 根系鲜重、干重则呈增加趋势。在高浓度铅处理下, 四季菜心的各项指标呈现降低趋势。在 0.005 mg/L 的铅处理时, 四季菜心各项指标略好于对照, 油麦菜各项指标则略有降低; 表明在低浓度下油麦菜对铅更敏感。在 0.015 mg/L 处理时, 油麦菜和四季菜心各项生长指标均明显降低, 四季菜心降低的更多; 在 0.045 mg/L 铅高浓度处理下, 油麦菜和四季菜心各项指标变化最大, 生长受到明显抑制; 高浓度铅对四季菜心的生长影响更大。

**关键词:** 铅; 叶数; 叶面积; 株高; 干重; 鲜重

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随着工农业生产的发展, 三废的排放、开矿和化肥的施用等, 使土壤、水体和大气受到严重污染, 其中, 重

金属污染就是很重要的一个方面<sup>[1]</sup>。目前, 我国受重金属污染的耕地大约 200 万  $\text{hm}^2$ , 约占总耕地面积的  $1/5^{[2-4]}$ , 尤其是铅对蔬菜的污染较普遍<sup>[2,5]</sup>。铅严重危害人体的神经系统、造血系统及肾脏, 对儿童的生长发育也有一定的毒害作用<sup>[6]</sup>, 因而铅污染已经受到人们的极大关注。

该试验通过无土盆栽的方法, 以油麦菜和四季菜心为材料, 研究了不同浓度铅处理对其生长的影响, 为筛选优质、高产、低铅积累的蔬菜提供依据。

## 1 材料与方法

### 1.1 试验材料

盆栽试验所使用的油麦菜 (*Lactuca sativa* L.) 和四

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**Abstract:** As apple tree had a big and tall crown, it was difficult for fruit sampling and analysis. In order to facilitate comparison and accurate analysis fruit quality, 'Red Fuji' apple tree that grafted on vigorous rootstock, planted in north-south row, in full productive stage were selected as a sampling tree in Weibei Plateau, Shaanxi Province. The fruit that grown in different crown parts had been collected, and its quality had been measured and analyzed, so as to determine a reasonable parts in the crown for sampling and fruit quality analysis. The results showed that the fruit shape index, color index, clearness index, peel anthocyanin contents, firmness, soluble solids contents, soluble sugar contents, vitamin C contents of the fruit that grown in upper crown were higher than that grown in lower crown, grown in outer crown were higher than that grown in inner crown. The average fruit weight, fruit rust index, peel chlorophyll contents, titratable acid contents that grown in upper crown were lower than that grown in lower crown, and in outer crown were lower than that grown in inner crown. Fruit quality that grown in east, south, west, and north in outer crown, in same height, had no significant difference. The average of fruit quality that grown in middle-outer crown and lower-outer crown were close to the average of fruit quality that grown in different parts of the crown. The part between middle-outer crown and lowe-outer crown could be used as a reasonable part for sampling and fruit quality analysis.

**Key words:** apple; quality analysis; crown; sample part

季菜心(*Brassica campestris* L. ssp)种子分别购买于四川种都种业有限公司和哈尔滨金龙农业有限公司。

## 1.2 试验方法

将种子播种在蛭石苗床上,长出2片真叶后,上10 cm盆,缓苗1周后用0、0.005、0.015、0.045 mg/L的硝酸铅溶液对苗期植株进行处理,每周处理1次,每次50 mL,油麦菜每盆4株,7次重复,四季菜心每盆4株,6次重复,每周测定1次植株叶片数、叶面积(方格网法)和株高。处理1个月后将植株从基质中取出,洗净,称茎叶和根系鲜重,再在105℃下烘干90 min称干重。

## 2 结果与分析

### 2.1 重金属铅对油麦菜叶片数的影响

由图1可知,随处理时间的延长,各处理浓度下油麦菜叶片数均在持续增加。但到处理的第3周,植株叶数增加较少,显示出叶片的生长受到了明显的抑制。铅处理前各植株生长一致,重复间无差异。处理1周后,不同浓度铅处理间略有差异。

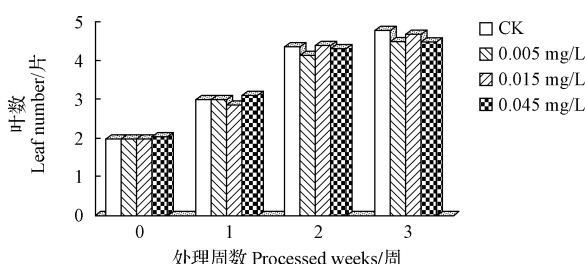


图1 不同浓度铅处理对油麦菜叶片数的影响

Fig.1 Effect of different concentration of Pb on the leaf number of *Lactuca sativa* L.

### 2.2 铅对油麦菜叶面积的影响

由图2可知,随处理时间的延长,各处理浓度下油麦菜叶面积均在持续增加,处理第1周不同浓度的铅处理植株叶面积差异不明显,处理第2和3周差异明显增大,且呈相同变化规律;即在相同处理时间内,随着处理浓度的增加,叶面积呈下降趋势,处理铅浓度最高的叶面积最小。0.045 mg/L铅处理的植株出现一定程度的

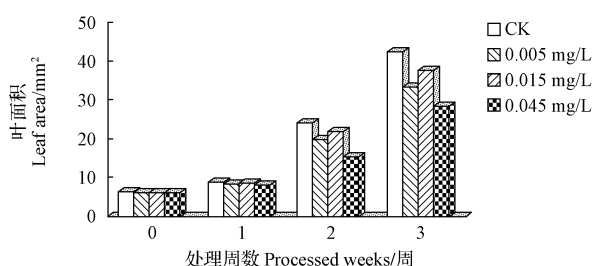


图2 不同浓度铅处理对油麦菜叶面积的影响

Fig.2 Effect of different concentration of Pb on the leaf area of *Lactuca sativa* L.

植株萎缩。说明此浓度不仅影响了它的生长量,减少了叶片数和叶面积,也使植株中毒。严重萎蔫会导致植株死亡。

### 2.3 铅对油麦菜株高的影响

由图3可知,随处理时间的延长,除0.045 mg/L处理的植株变化不大外,其它处理浓度下油麦菜植株均继续长高,处理第1周的植株株高无差异,处理第2周差异增大,第3周差异最大,且呈相同规律,即在相同处理时间内,随着处理浓度的增加,株高呈下降趋势,处理浓度最高的植株最矮。

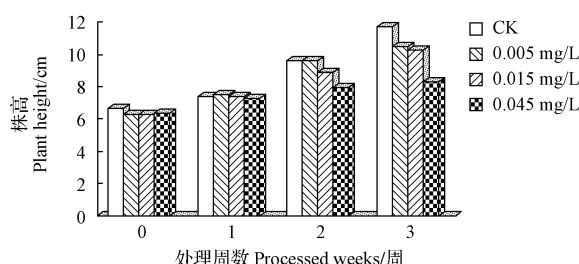


图3 不同浓度铅处理对油麦菜株高的影响

Fig.3 Effect of different concentration of Pb on the plant height of *Lactuca sativa* L.

### 2.4 铅处理对油麦菜鲜重和干重的影响

由图4、5可知,铅处理后油麦菜茎叶鲜重和干重均减少,其中最高浓度的0.045 mg/L处理后,茎叶干鲜重减少最多;铅处理后油麦菜根系鲜重和干重呈现上升趋势。根系鲜重在低浓度0.005 mg/L处理后增加速度最快,此后,铅处理浓度增加对根系鲜重影响不大。根系干重在0~0.005 mg/L铅处理下没有明显变化,但0.015 mg/L以上浓度处理使根干重明显增加。说明铅处理抑制了油麦菜茎叶鲜重和干重增加,但促进了根系的生长。一般植株鲜重中75%~90%是由水分组成<sup>[7]</sup>,因而茎叶鲜重和干重的下降可能与铅胁迫下植物茎叶生长量降低,组织中水分和干物质积累显著降低<sup>[8]</sup>有关;这一现象与前人对车前草的研究相类似<sup>[9]</sup>。铅处理油麦菜根系鲜重在0.005 mg/L就开始增加,可能是在铅胁迫下刺激了根系的生长,与植物的避逆性相关<sup>[7]</sup>,根

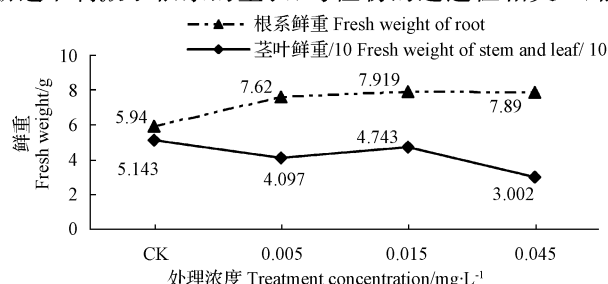


图4 铅处理后油麦菜茎叶和根系鲜重

Fig.4 The fresh weight of stem leaf and root of *Lactuca sativa* L. after Pb treatment

系干重在 0.015 mg/L 处理后干重增加,与铅刺激植物细胞壁的多糖合成,使植物干重相显著增加有关<sup>[10]</sup>,根系鲜重和干重的变化,表明植株鲜重变化更加敏感。

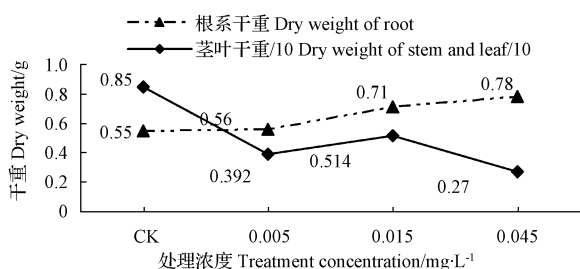


图 5 铅处理后油麦菜茎叶和根系干重

Fig. 5 The dry weight of stem leaf and root of *Lactuca sativa* L. after Pb treatment

由图 1~5 可知,铅处理后油麦菜叶数、叶面积、株高 3 项指标都呈下降趋势,低浓度的铅处理各指标变化较小,高浓度的铅处理各指标变化较大;其中茎叶和根系鲜重、干重在较低浓度下就表现出明显变化。说明铅处理对油麦菜茎叶和根系鲜重、干重影响更大。

## 2.5 铅处理对四季菜心叶片数的影响

由图 6 可知,随处理时间的延长,各处理浓度下四季菜心叶片数均在持续增加,处理第 1 周差异较小,处理第 2 周和第 3 周,不同铅浓度的处理出现叶数差异较大,对照组和 0.005 mg/L 处理植株的叶数均高于其它处理,且 0.045 mg/L 高浓度处理叶数增加最少,说明铅在达到一定浓度后降低了植株叶片的数量。

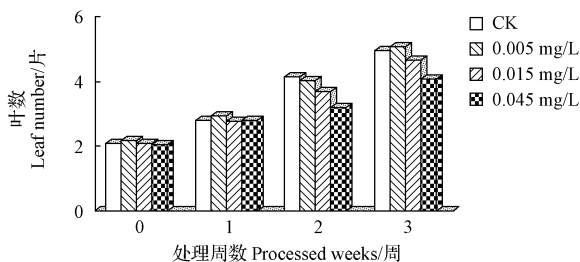


图 6 不同浓度铅处理对四季菜心叶片数的影响

Fig. 6 Effect of different concentration of Pb on the leaf number of *Brassica campestris* L. ssp

## 2.6 铅处理对四季菜心叶面积的影响

由图 7 可知,随处理时间的延长,各处理浓度下四季菜心叶面积均在持续增加,第 1 周不同浓度的铅处理植株叶面积差异较小,处理第 2 和 3 周差异较大,且呈相同规律,即相同处理时间内,对照和 0.005 mg/L 处理叶面积相近,0.015 和 0.045 mg/L 处理叶面积相近。但后 2 组较前 2 组叶面积明显减小。说明高浓度的铅处理明显影响了四季菜心叶面积的的增加。

## 2.7 铅处理对四季菜心株高的影响

由图 8 可知,随处理时间的延长,各处理浓度下四

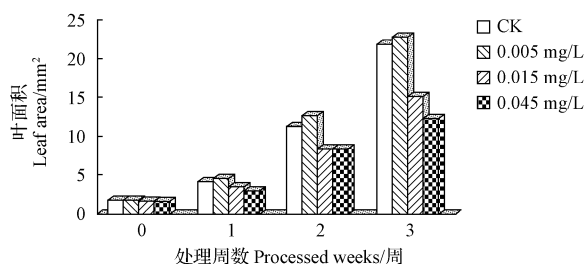


图 7 不同浓度铅处理对四季菜心叶面积的影响

Fig. 7 Effect of different concentration of Pb on the leaf area of *Brassica campestris* L. ssp

季菜心植株均长高,处理第 2 和 3 周出现较大差异,且呈相同规律,即对照和 0.005 mg/L 处理株高相近,0.015 和 0.045 mg/L 处理株高较前 2 组呈下降趋势,铅浓度最高的处理植株最矮。

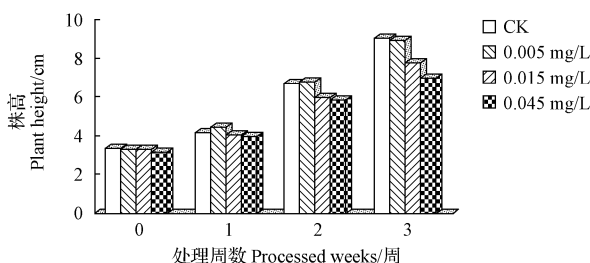


图 8 不同浓度铅处理对四季菜心株高的影响

Fig. 8 Effect of different concentration of Pb on the plant hight of *Brassica campestris* L. ssp

## 2.8 铅处理后对四季菜心茎叶和根系鲜重和干重的影响

由图 9、10 可知,四季菜心茎叶和根系鲜重、干重在 0.005 mg/L 铅处理后均呈现上升趋势,在 0.015 mg/L 处理后重量明显下降,在 0.015 和 0.045 mg/L 处理间下降趋势变缓。说明 0.005 mg/L 低浓度铅处理促进了四季菜心植株的生长,而 0.015 和 0.045 mg/L 高浓度处理抑制了生长。

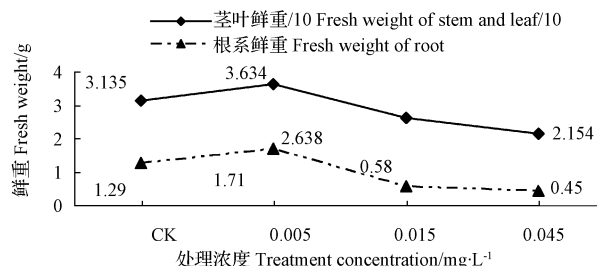


图 9 铅处理后四季菜心茎叶和根系鲜重

Fig. 9 The fresh weight of stem leaf and root of *Brassica campestris* L. ssp after Pb treatment

由图 6~10 可知,0.005 mg/L 铅处理的四季菜心植株叶片数、叶面积、株高及茎叶和根系的鲜重、干重均较对照组有所增加或与对照无明显差异,说明 0.005 mg/L

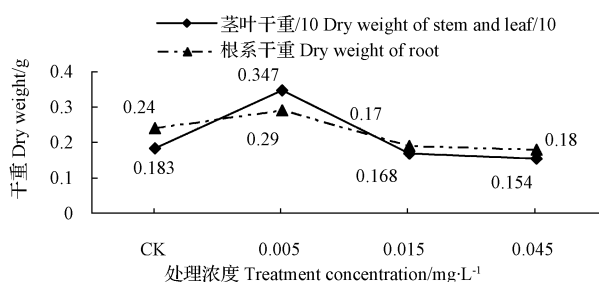


图 10 铅处理后四季菜心茎叶和根系干重

Fig. 10 The dry weight of stem leaf and root of *Brassica campestris* L. ssp after Pb treatment

铅溶液处理对四季菜心植株生长影响较小。0.015 和 0.045 mg/L 高浓度铅处理的四季菜心生长的各项指标均明显降低,且 2 个处理间的植株各项指标变化相似。可能是低浓度的铅对植株生长有一定的刺激作用,而高浓度的铅对植株起了毒害作用<sup>[11]</sup>。

### 3 结论

在 0.005 mg/L 的铅处理下,油麦菜就出现各项指标的降低,而四季菜心无明显变化。说明油麦菜在低浓度铅处理下对铅更加敏感。在高浓度铅处理中,四季菜

心的各项生长指标变化更大,说明高浓度对其影响更大。

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## Growth Effects of Pb on Seedling of *Lactuca sativa* L. and *Brassica campestris* L. ssp

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**Abstract:** In order to understand the effect of lead on the growth of *Lactuca sativa* L. and *Brassica campestris* L. ssp, the seedlings of the two plants with different concentration of lead nitrate solution through the method of soilless cultivation were conducted, and growth indexes were analyzed. The results showed that lead processing influenced the two kinds of plants' growth in different level, and reduced the rate of growth. However, all the indexes were still present the increasing trend, except the fresh weight, dry weight of stem leaf and root. In the same processing time, high levels of lead made the *Lactuca sativa* L. 's indexes of leaf number, leaf area, plant height and the fresh weight, dry weight of stem leaf declined obviously, and the fresh weight, dry weight of root increased. With high levels of lead processing, each index of *Brassica campestris* L. ssp trended to decrease. In 0.005 mg/L lead processing, each index of *Lactuca sativa* L. was slightly better than control, and each index of *Brassica campestris* L. ssp was slightly lower. It suggested that *Lactuca sativa* L. was more sensitive in low concentrations of lead. In 0.015 mg/L processing, each of the index of *Lactuca sativa* L. and *Brassica campestris* L. ssp reduced significantly, especially *Brassica campestris* L. ssp reduced more. In 0.045 mg/L high concentration lead, each index of *Lactuca sativa* L. and *Brassica campestris* L. ssp changed biggest, and the growth was obvious inhibition. So high concentrations of lead made more influence on the growth of *Brassica campestris* L. ssp.

**Key words:** Pb; leaf number; leaf area; plant height; dry weight; fresh weight