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EFFECT OF COLORED COVER MATERIAL ON SOME NUTRIENT CONCENTRATIONS OF RADISH PLANT (*Raphanius sativa* L.)

RENKLİ ÖRTÜ MALZEMESİNİN TURP BİTKİSİNİN (Raphanius sativa L.) BAZI BESIN KONSANTRASYONLARINA ETKISI

Prof. Dr. İbrahim ERDAL

Isparta University of Applied Sciences, Faculty of Agriculture, Department of Soil Science and Plant Nutrition, 32260, Isparta, Turkey

Prof. Dr. Atılgan ATILGAN

Isparta University of Applied Sciences, Faculty of Agriculture, Department of Agricultural Structures and Irrigation 32260, Isparta, Turkey

Prof. Dr. Hakan AKTAŞ

Isparta University of Applied Sciences, Faculty of Agriculture, Department of Horticulture 32260,

Isparta, Turkey

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ABSTRACT

In this study, it was aimed to investigate the effects of different colored cover materials on some nutrient concentrations of radish plants. The study was conducted in 3 plastic, tunnel ventilated greenhouse at the research center of agriculture faculty, IUAS in 2019. Greenhouses were covered with blue, red and transparent PE (as control) materials to examine the effects of coverage materials. The three greenhouses used in the application are named as follows: Blue colored (BlueG), Red colored (RedG) and Transparent control (ConG) greenhouses. The study was carried out in the spring term of 2019. At the end of the growth season, leave and tuber samples were taken to make potasium (K), magnessium (Mg), calcium (Ca), copper (Cu), zinc (Zn), manganese (Mn) and iron (Fe) analyses. Results revealed that colored coverage materials significantly affected, except Zn, leaf and tuber mineral nutrient concentrations. At the end of the experiment, it was determined that the colored cover material did not only affect Zn concentrations in the leaf and tuber. In addition, especially in the leaves, colored materials led to increasing all nutrient concentrations when compared to the control greenhouse. Specially, leaves of the plants grown under blue coverage had considerably higher Ca, Mg, Fe, Mn, and Cu when compared to the others. In particular, it has been determined that BlueG application increases Fe, Mn, Cu, Mg and Ca concentration in leaves. Similarly, blue covered resulted in increases of K, Fe and Cu concentrations in tubers of plants. Likewise, it was determined that the BlueG application increases the Fe, Cu and K concentration in the tuber of the radish plant. As a result, it was concluded that the use of blue cover material for the growing of radish plants in greenhouses is the most appropriate color application since it increases the content of nutrients specified in the study.

Keywords: Colored material, Greenhouse, Nutrient elements, Radish

ÖZET

Bu çalışmada, farklı renkli örtü maddelerinin turp bitkilerinin bazı besin konsantrasyonları üzerindeki etkilerinin araştırılması amaçlanmıştır. Araştırma, 2019 yılında ISUBÜ, Ziraat Fakültesi Araştırma Merkezinde tünel havalandırmalı 3 adet plastik serada gerçekleştirilmiştir. Örtü malzemelerin etkilerini incelemek için seralar mavi, kırmızı ve şeffaf PE (kontrol olarak) çrtü malzemeleri ile kaplanmıştır. Uygulamada kullanılan seralar şu şekilde adlandırılmıştır: Mavi renkli (BlueG), Kırmızı renkli (RedG) ve Şeffaf kontrol (ConG) seralar. Çalışma 2019 bahar döneminde gerçekleştirilmiştir. Büyüme sezonu sonunda potasyum (K), magnezyum (Mg), kalsiyum (Ca), bakır (Cu), çinko (Zn ve demir (Fe) analizleri için yaprak ve yumru örnekleri alınmıştır. Sonuçlar, renkli örtü malzemelerinin, yaprak ve yumru mineral besin konsantrasyonlarını Zn dışında önemli ölçüde etkilediğini ortaya koymuştur. Uygulama sonunda, renkli örtü malzemesinin yaprak ve yumrudaki sadece Zn konsantrasyonlarını etkilemediği belirlenmiştir. Ayrıca özellikle yapraklarda, renkli örtü malzemesinin, kontrol serasına göre tüm besin konsantrasyonlarının artmasına neden olmuştur. Özellikle mavi örtü altında yetişen turp bitkisinin yapraklarının diğerlerine göre oldukça yüksek Ca, Mg, Fe, Mn ve Cu içeriği bulunmuştur. Özellikle BlueG uygulamasının yapraklarında Fe, Mn, Cu, Mg ve Ca konsantrasyonunu arttırdığı belirlenmiştir. Benzer şekilde, mavi renkli örtü malzemesinin bitki yumrularında K, Fe ve Cu konsantrasyonlarında artışa neden olmuştur. Sonuç olarak seralarda turp bitkilerinin yetiştirilmesinde mavi örtü malzemesi kullanımının çalışmada belirtilen besin maddelerinin içeriğini artırması nedeniyle en uygun renk uygulaması olduğu sonucuna varılmıştır.

Anahtar Kelimeler: Renkli materyal, sera, besin elementleri, turp

1.INTRODUCTION

The agricultural area is decreasing day by day in the world. However, more agricultural crops are needed for the increasing world population. Therefore, different production techniques and methods are getting more and more importance day by day in order to obtain higher efficiency from the unit area. In order to ensure sustainability in agriculture, new developments in the greenhouse should be followed (Baytorun ve Gügercin, 2015; Eğilmez, 2019). Vegetables occupy an important place in human nutrition. One of these is a radish plant. Radish is one of the most preferred vegetables for dietitians because of its fiber content (Kartal, 2007; Eğilmez, 2019). The radish, which belongs to the Brassicaceae family, has a wide variation and growing area in Asian countries, such as China and Japan. Radish production in our country is increasing day by day. Our total radish production, which was 158 thousand tons in 2011, reached 219 thousand tons in 2019 and increased by approximately 39% (TUİK, 2020). Radish, a winter vegetable, is also grown in protected cultivation during very cold periods in winter. Numerous factors such as nutrient uptake, type, age, root growth, physical, chemical and biological properties of the soil, and the type and amount of the beneficial elements in the soil are influential on yield and quality (Kacar ve Katkat, 2010; Bolat ve Kara, 2017).

In addition, fertilization, irrigation, agricultural control, tillage, hoeing, etc. various human interventions, such as, affect the mineral feeding capacities of plants. In recent years, it is possible to come across many studies on the effects of plastics used in different colors on yield and quality (Egilmez and Atilgan, 2019; Atilgan et al., 2019). In this study, the effects of plastics used in different colors on the mineral nutrition of radish plants were investigated.

2.MATERIALS AND METHODS

The study was carried out in the research greenhouses (blue (BlueG), red (RedG) and transparent colored control (ConG) plastic greenhouses) located in the experimental area of the Faculty of Agriculture, Isparta University of Applied Sciences in the spring of 2019. Arc-roofed plastic greenhouses with tunnel ventilation, 3 m width, 6 m length, side wall height 2 m and ridge height 2.8 m were used. Some characteristics of the soil in the experimental area were indicated in Table 3. Available ($NaHCO_3$) P, exchangeable (CH_3COONH_4) cations (K, Ca, Mg) and extractable (DTPA) micro elements were determined as described by Olsen *et al*, (1954), Jackson (1967) and Lindsay and Norvell (1969), respectively. Organic matter content of the soil was measured according to Walkley and Black (1965). Soil texture class and $CaCO_3$ content were found as described by Bouyoucos (1954) and (Allison and Moodie 1965). Soil pH was measured with pH mater in soil/water (1/2.5) suspension.

Table 1. Some characteristics of the soil used for the experiment

Properties	**Value**
Organic matter (%)	1.8
CaCO3 (%)	18
Texture	CL
pH (1/2 soil/water)	7.5
Available P (mg kg^{-1})	30
Exchangeable Ca (cmol kg^{-1})	30
Exchangeable K (cmol kg^{-1})	4.0
Exchangeable Mg (cmol kg^{-1})	3
DPTA Extractable Fe (mg kg^{-1})	10
DPTA Extractable Mn (mg kg^{-1})	30
DPTA Extractable Zn (mg kg^{-1})	2.5
DPTA Extractable Cu (mg kg^{-1})	5

At the end of the experiment, plants were taken up from the soils then leaf and tubers were separated. Both plant parts were washed with fountain water, dilute acid (0.2 N HCl) and distilled water. Before drying, tubers were sliced thinly and they were put in air flow oven at 65± 5 ^{0}C until stable weight. Also, leaves were dried under the same drying conditions. After drying, samples were grounded to prepare the mineral analysis. Then, plant samples were wet-digested using a microwave digesting unit and filled up to 50 ml with distilled water in order to determine K, Ca, Mg, Fe, Zn, Mn, and Fe concentrations. Finally, nutrient concentrations were determined using atomic absorption spectrophotometer (Jones et al., 1991).

3.RESULTS AND DISCUSSION

The analysis of variance test results relating to the effects of different coverage materials on leaf and tuber mineral nutrient concentrations is given in Table 2. As indicated there, different color coverage materials had a significant effect on mineral nutrient concentrations generally. The only Cu in the leaf and Mn in the tubers did not vary with the cover color.

Table 2. Analysis of variance for leaf nutrient concentrations

Source	F values Leaf results							
	Df	K	Ca	Mg	Fe	Cu	Zn	Mn
Color	2	12**	11**	59***	11.4**	ns	7.2*	9.28**
Mean	11							
Source	F values Tuber results							
	Df	K	Ca	Mg	Fe	Cu	Zn	Mn
Color	2	19**	7.8*	24***	39***	4.9*	14.8**	ns
Mean	11							

*P<0.05, **P<0.01, ***P<0.001, ns: non significant

Variations of leaf K, Mg and Ca concentrations are given in Fig. 1. Potassium concentrations in leaves under BlueG and RedG treatments significantly higher (p<0.05) than the control treatment. As indicated there, the highest K level was reached in RedG. According to the sufficient ranges (3.5-4.5 %) indicated by Jones et al., (1991) for K in the leaves of radish plants, these values were reached only at RedG and ConG applications.

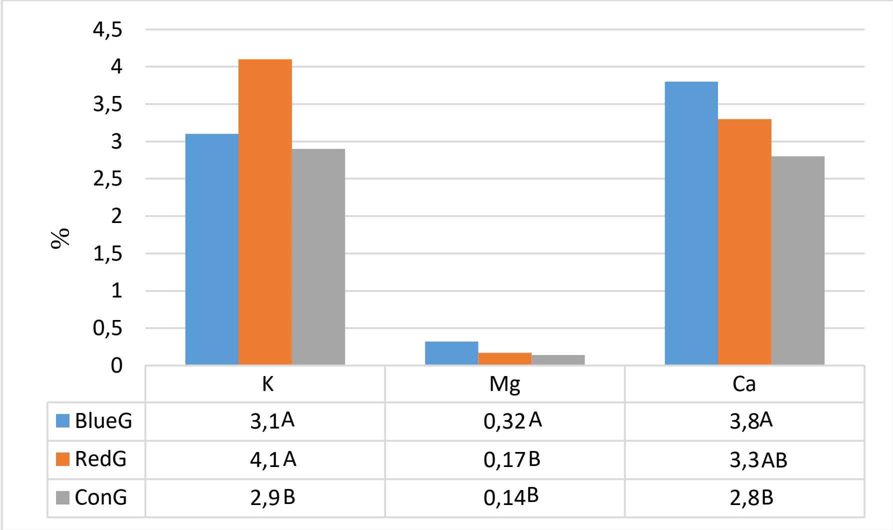


Figure 1. Leaf K, Mg and Ca variations of radish plant under different cover material

Researchers indicate that water loss with transpiration decrease in K-sufficient plants (Foth, 1984; Brady, 1990; Boşgelmez et al.,2001; McCauley et al., 2009; Kacar and Katkat, 2010, Bolat and Kara, 2017). In K-deficient plants, it has been reported that the turgor pressure of the plants will decrease and the plants become hard textured when there is water stress (Aktaş and Ateş, 1998; Boşgelmez et al.., 2001; Bolat and Kara, 2017). While the highest leaf Mg concentration was found in BlueG, the lowest was measured in ConG (Fig.1). Magnesium concentration in the leaf plants under BlueG significantly higher than other plants grown under RedG and ConG ($p<0.001$). According to the sufficiency ranges only BlueG plants had sufficient Mg (Jones et al., 1991). It was reported that plants suffer from Mg deficiency, chlorophyll synthesis and photosynthesis rate decreases thus growth and yield losses occur (Marschner, 2011; Kacar and Katkat, 2008; Bolat and Kara, 2017). Also, Ca concentrations in leaves were the highest under BlueG, whereas was the lowest under ConG (Fig. 1). Variations in Ca levels were statistically significant. Leaf Ca concentrations under each condition were between sufficiency ranges (Jones et al., 1991). Tuber K, Mg and Ca concentrations were shown in Fig. 2. The highest tuber K level as in leaves was measured under RedG application. Tuber K concentrations under RedG significantly differed from the others. Tuber Mg concentrations under different color materials significantly varied from each other. The highest Mg was determined under control conditions, but the lowest was determined under the BlueG condition. Also, tuber Ca concentration under ConG treatment was significantly higher than other applications. Tuber Ca amounts obtained from the BlueG and RedG applications took place in the same statistical group.

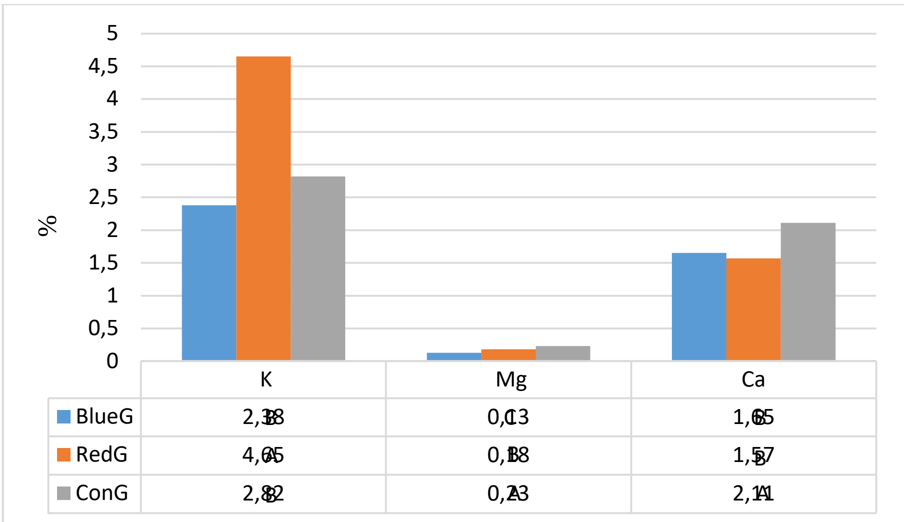
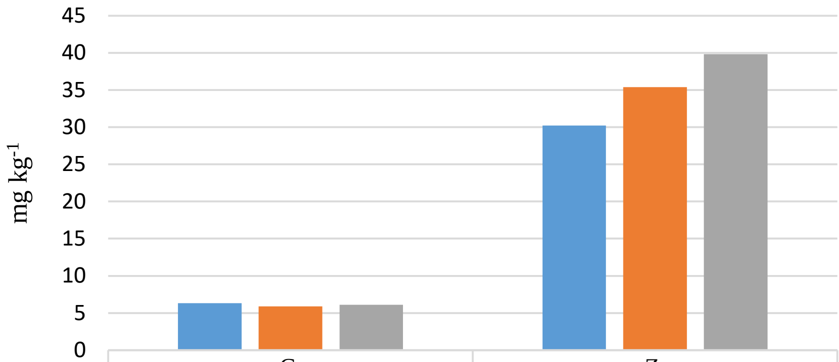


Figure 2. Tuber K, Mg and Ca variations depending on different cover material

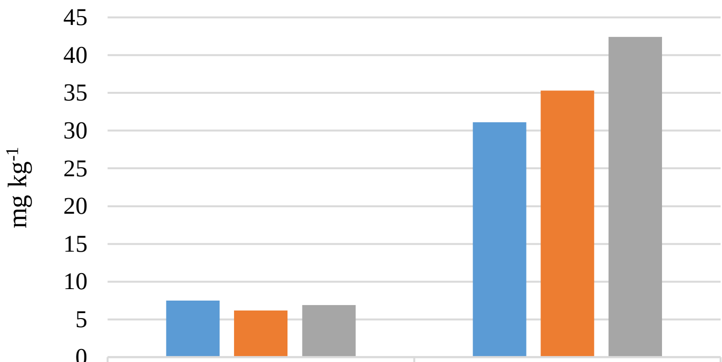
Although leaf Cu concentration did not vary with the coverage color, the highest Cu concentration (6.3 mg kg^{-1}) was measured from the BlueG treatment. According to Jones et al., (1991) the values from the BlueG and ConG were over the deficiency level. But under RedG condition, leaf Cu concentration was lower the critical concentration (Fig. 3). It is stated that deficiencies such as chlorosis in young leaves, stunted development, and delay of maturation can be observed in the absence of copper. In addition, it is stated that copper deficiency reduces the resistance of plants against diseases caused by fungi (Bolat and Kara 2017). Sarı (2009) stated that copper is an important nutrient in the plant because it is involved in many enzyme activations, carbohydrate, and lipid metabolism.



	Cu	Zn
BlueG	6,3 A	30,2 B
RedG	5,9 A	35,4 A B
ConG	6,1 A	39,8 A

Figure 3. Leaf Cu and Zn variations depending on different cover material

Looking at the results, we say that RedG treatment is not suitable in terms of Cu nutrition. Leaf Zn concentrations significantly varied between 30.2 and 39.8 mg kg^{-1}. The highest Zn concentration was measured from ConG, whereas the lowest was obtained from BlueG treatment. Although all Zn values were between the sufficiency ranges (Jones et al., 1991; Sarı 2009), it can be said that color coverage materials negatively affected leaf Zn concentration when compared to control. Tuber Cu and Zn concentrations significantly affected by the coverage color (Fig.4). Tuber Cu concentration under BlueG was higher than the others. The lowest value was obtained from the plants grown under RedG. Unlike Cu, tuber Zn concentration in the plants under BlueG was the lowest (31.1 mg kg^{-1}) and the highest (42.4 mg kg^{-1}) was determined from the control treatment.



	Cu	Zn
BlueG	7,5 A	31,1 B
RedG	6,2 B	35,3 B
ConG	6,9 AB	42,4 A

Figure 4. Tuber Cu and Zn variations depending on different cover material

If an evaluation was made depending on the leaf Mn and Fe concentrations, it can be seen that the highest Mn and Fe were measured from the plant growing under BlueG treatment with the values of 137.0 mg kg^{-1} and 276.6 mg kg^{-1}, respectively. The lowest Mn and Fe values were obtained from the control treatments for both nutrients. Both nutrient concentrations under each coverage material were over the critical deficiency levels (Jones et al., 1991; Sarı 2009).

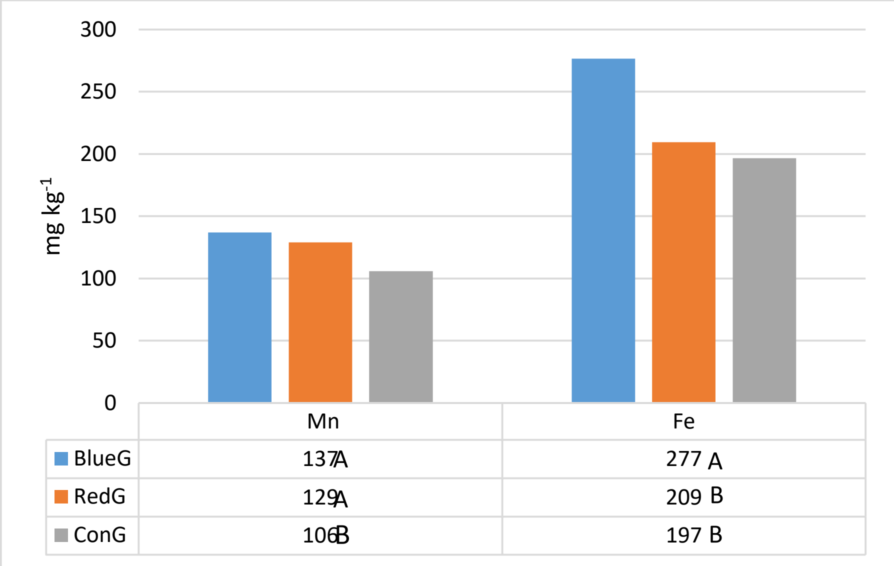


Figure 5. Leaf Cu and Zn variations depending on different cover material

According to Mn and Fe results, it was seen that colored materials increased both nutrients in leaf. When the concentration of Fe in the tuber is examined, it was determined that the highest Fe value was found under BlueG treatment (Fig. 6). The Fe concentrations obtained from RedG and ConG took place at the same statistical classification. Tuber Mn concentrations did not vary significantly with the coverage color (Fig. 6).

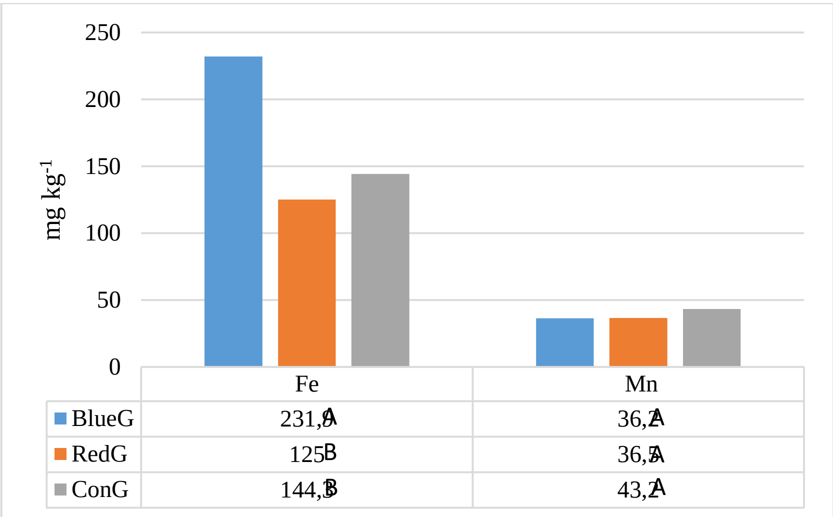


Figure 6. Tuber Fe and Mn variations depending on different cover material

4.CONCLUSIONS

After the cultivation of the radish plant in greenhouse conditions, the effects of the cover material of different colors on the leaf and tuber contents of the nutrients were examined. At the end of the experiment, it was determined that the colored cover material does not only affect the zinc element on the leaf and tuber nutrient contents. The highest value of copper element content in both leaf and tuber levels was achieved in BlueG application, while the highest values of the Manganese element in leaf content were obtained in BlueG and in terms of tuber content in ConG application. When looking at the iron contents, it was determined that the highest value in both leaf and tuber content was in the BlueG application. Both leaf and tuber values of the potassium percentage content of macro nutrients were determined to be highest in the RedG application. In terms of magnesium content, the highest values were obtained in BlueG in leaf and ConG in tubers. In addition, the highest value in terms of calcium content was found to be BlueG in leaf and ConG in tubers. Therefore, it is determined that the nutrient content of iron, manganese, copper, magnesium, and calcium are most suitable for BlueG application on leaves. Similarly, BlueG application has been determined to increase the iron, copper, and potassium nutrient content in the tuber part of the radish plant. As a result, it was concluded that the use of blue cover material for the growing of radish plants in greenhouses is the most appropriate color application since it increases the content of nutrients specified in the study.

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