Pak. J. Agri. Sci., Vol. 58(3), 771-777;2021
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
DOI: 10.21162/PAKJAS/21.440
http://www.pakjas.com.pk

THE INFLUENCE OF GEOTEXTILE MATERIALS USED FOR LANDSCAPE DESIGN ON THE GROWTH OF PLANTS

Handan Çakar*

Ege University, Bayındır Vocational Training School, Bayındır-İzmir, Turkey
***Corresponding author's e-mail: handan.cakar@ege.edu.tr**

In these days where environmental problems increase, environment-friendly landscape project are designed to protect ecological balance. Accordingly, landscape designs which do not need chemical usage, water-saving minimizes the costs of its maintenance. The need of diverge to xeriscaping designs which also holds eco-friendly alternatives rather than landscapes with high water consumption is quite obvious. The stone garden landscape designs not only save water but also control weeds with the geotextile materials laid underneath the stones. Plant usage in stone garden landscape designs is also considered as an option. In such cases, it is important to know whether the geotextile materials that are laid underneath the stones have a limiting impact on the development of plants or not from this point of view, geotextile material's (polypropylene) impacts on the development of plant (*Tagetes erecta* L.) is researched as to set an example about stone garden landscape designs in the experiment fields at Ege University Bayındır Vocational Training School Campus (four-month summer period of year 2019). The research was conducted according to the randomized block experimental design carried out in three replications. In the research conducted as open field plots experiment. The results obtained revealed increase in weed control and plant development in stone garden landscape designs supported by the ornamental plants. As a result of this research, it is recommended to use polypropylene cover under stone material for weed control in stone garden landscape designs as it did not create a restriction on plant growth rather affected plant growth positively.
Keywords: Geotextile; landscape design; weed control, *Tagetes erecta* L., marigold.

INTRODUCTION

Weed control plays an important role in agricultural production and landscape designs' continuity.

Weeds which are important parts of the ecosystem have been a problem since the beginning of agriculture. Researchers developed and practiced techniques that today we named as cultural, mechanical, physical, chemical, biological and integrated. Following the development of agricultural chemicals, the usage of herbicide increased rapidly and as a result, unwanted side effects arose like herbicide resistance and residue problems (Uygur and Uygur, 2016). Although, herbicide that contains no eco-friendly approach has been used for several years as the most effective way to overcome weed in landscape designs and agricultural production. On account of the high percentage of herbicide usage and some mistakes that are made applying the herbicides, herbicide toxicity arises. Herbicide toxicity harms both the environment and living organisms, becomes a threat for next generations (Mengüç, 2018).

In today's conditions where environmental problems happen intensely, eco-friendly methods should be chosen. One of the as effective as herbicides and more eco-friendly method are mulching. Mulching, defined as the process of covering the soil surface with a light-proof material, is one of the most effective weed control methods (Kitiş, 2011). In weed control, organic and non-organic mulching provides an important method as a non-chemical control option (Kazemi and Safar, 2018).

Technical textiles which can be used in non-organic mulching has been supporting agriculture for several years (Mecit *et al.*, 2007). Technical textiles are stated, based on their connective qualifications that unites performance, decorative characteristics and functions of the textile products that rapidly increases, "Textile materials and products produced primarily for their technical performances and functional characteristics rather than their aesthetic and decorative characteristics" as definition (Özdizdar, 2004).

From the packaging of agricultural products to the prevention of weed growth, agricultural technical textiles are used in many implementations such as erosion and drainage (Özdizdar, 2004; Fung, 2004). Geotextiles that are placed in agricultural technical textiles area because of the fact that their suitability of the functions that are expected from agricultural technical textiles and usage of agricultural purposes, can also be used in drainage and soil reclamation (Mecit *et al.*, 2007). At the same time, geotextile materials' usage as a mulch is seen as an eco-friendly implementation because chemical usage is not needed in weed control.

Kolören and Uygur in a research they made, tried different geotextile materials as abiotic mulch material with weed

control and proved geotextile materials' success in weed control rather than herbicides (Kolören and Uygur, 2015).

Çakar and colleagues, searched geotextile materials from different textures and structures picked as examples and their performances in weed control in stone garden landscape designs and suggested the usage of polypropylene in terms of drainage qualifications and weed control performance (Çakar *et al.,* 2019).

In the studies in which weeds effect on product productivity is searched, it is seen that weed control has high importance (Gökgöz, 2010; Işık *et al.,* 2010 and Çınar *et al.,* 2015). In landscape designs, on the other hand, weed control has high importance for designs to preserve their aesthetic effect and functionality for longer periods. Designs to lose their effectivity and ornamental plants to be affected negatively by the weed invasion are unwanted situations in landscape designs usually appear. To be able to eliminate these negativities especially in stone garden landscape designs, to prevent weed invasion, the usage of geotextile materials to be laid underneath the stones are suggested (Çakar *et al.,* 2019).

In this research, in the landscape designs made by using geotextile material, suggestions were made to determine the effects of geotextile material on plant development and to create long-lasting projects that are both environmentally friendly and require low maintenance in order to have an idea when plant use is required.

MATERIALS AND METHOD

***Material*:** The research was conducted including four-month summer period of year 2019 at Ege University Bayındır Vocational Training School (Sonmez *et al.,* 2017). In the research conducted as an open area experiment, polypropylene; one of the most preferred geotextile materials in practice for weed control, was used (Çakar *et al.,* 2019). As geotextile material creates a layer that is laid underneath the stone in stone garden landscape designs, stone material was also tested to be able to detect its effects. To be laid above the geotextile material volcanic tuff, a stone material commonly preferred in stone garden landscape designs, was used. In this purpose, polypropylene (weight: 240 g m^{-2}, density: 0.94 g cm^{-3}, black) as geotextile material, volcanic tuff (grain size: 1.2-1.8 cm, dark colour) as stone material was tested as surface seal. A control group was set without laying a cover material above the soil or removing the weeds. In addition to this, with the other group also without a cover material above soil but in which the weeds were removed; it was expected to evaluate the performance of geotextile material without weed effect.

To be able to detect plant growth in the research, marigold *(Tagetes erecta* 'Proud Mari Yellow'*)* which has a high importance in trade because of its flowers, in landscape designs, medicine, cosmetics and textile industry, fowl breeding, keeps its flower during summer, annual, summer-growing plant was used as the vegetal material in each research topic (Patel *et al.,* 2019).

***Research Subjects*:** Surface with geotextile laid (C1): Just Polypropylene laid surface subject was tested.

Surface without cover material laid, with weed removal (C2): In the research no geotextile material was used, on the tested surface weed removal done once a week by hand.

Surface with geotextile and stone laid (C3): Polypropylene laid surfaces sealing with volcanic tuff subject was tested.

Surface without cover material and weed removal (C4): Control group was set in the research. Polypropylene or volcanic tuff was not used, weed removal was not done.

Method: The research was conducted according to the randomized block experimental design carried out in three replications (Alpaslan *et al.,* 2005) (Fig. 1). In the research conducted as open field plots experiment, 100x100 cm size experiment plots were formed.

1st Replication	C3	C1	C4	C2
2nd Replication	C4	C2	C3	C1
3rd Replication	C1	C4	C2	C3

Figure 1. Experimental Design

First of all, weed removal was done by ploughing the area that has national soil structure on which 12experimentplots that are accepted to the research would be located. After refinishing with the help of a rake, locations of the plots were determined by a measuring tape in a way to form $1m^2$ areas. Plot borders were became apparent by driving stakes on four corners, was encircled with plastic tapes.

Later, cover materials were laid on plots so as to create research subjects (C1 and C3). Cover materials were pegged to the ground with metal wires from four sides for endurance against the wind. With a planting distance of 35 cm with 15 cm from the sides, 108 *Tagetes erecta* L. were planted in 12 plots with 9 plants in each plot. In order to make planting in the plots laid with polypropylene cover, two 8-cm cross-cuts were formed at the planting points with the help of a utility knife and plants were planted in the pits opened in the middle of these cuts by means of planting wooden seedling hand tools.

Sprinkler system was used in irrigation of research subjects. For this purpose, one fixed type sprinkler with 7.50 m wetting radius placed on a 0.50 m lifter with one inch entrance was used. Irrigations were arranged as every two days; taking

account of early in the morning and late in the evening by taking account of climate data and according to the observation of the plant growth period.

For increasing growth and both marigold species' flower production 0.75 litres water per 7 kg soil is suggested (Ojo *et al.,* 2019). According to this; in all plots where the experiment was carried out, 51.43 litres water was given per plot in total so as to continue throughout the production season. The average amount of irrigation water applied per plant is 5.71 litres/ plant per irrigation. In the research, during the season 342.6 litres irrigation water in total was applied to all subjects. Equal amounts of water were applied to the subjects that forms the research and control groups.

Physical measurements of the plants were made in particular periods during the experiment to be able to determine the influence of geotextile materials used for weed control on the growth of plant. Plants germinated from seed in the production greenhouse reached the desired seedling size on the 21st day.108 plants with 3 leaves, 4 cm plant diameter and 5 cm plant height were included in the experiment in order to be standard in planting in order to follow the plant growth and development without any physical difference at the beginning.

In the first measurement after planting (1 month later), 5 healthy plants were selected from each plot having 9 plants and 60 of these plants were measured during the experiment.

For four months long experiment, once a month, the development criteria of plants (plant diameter, plant height, number of leaves, number of flowers, flower diameter, total fresh weight, upper component fresh weight, flower fresh weight, leaf fresh weight, root fresh weight and root length) were measured and recorded.

The data obtained from the measurements were entered into the computer by using Microsoft Office 2010 Excel program. Afterwards, the necessary statistical analyses were performed with Kruskal Wallis Test in SPSS program and the data obtained as a result of the analysis were interpreted.

RESULTS AND DISCUSSION

In this research, the influence of geotextile material used for weed control on the growth of plant were analysed in accordance with plant growth criteria.

The research findings were given in four different groups as "plant diameter, plant height and number of leaves", "number of flowers and flower diameter" and "total fresh weight, upper component fresh weight, flower fresh weight, leaf fresh weight, root fresh weight and root length" and "weed control". In this research, the effects of polypropylene, volcanic tuff-covered polypropylene and weeds on plant growth and development were determined.

- The plant diameter, plant height and number of leaves were evaluated with the data obtained from 5 measurements including the one in planting.
- The number of flowers and the diameter of the flowers were evaluated with the data obtained from the third measurement due to the absence of flowering in the first two measurements.
- Total fresh weight, upper component fresh weight, flower fresh weight, leaf fresh weight, root fresh weight and root length group's evaluation could only be made after dismantling, was carried out only with the data obtained from this measurement.
- The weed group was evaluated with the data obtained from the observations.

Plant Diameter, Plant Height and Number of Leaves

When Kruskal-Wallis test results were examined in terms of plant diameter, plant height and number of leaves; The plant diameter was statistically significant at %10 (sig.0.083) and number of leaves at %1 (sig.0.005) (Table 1). Therefore, it can be said that there is a significant difference between the

Table 1. Effects of research subjects on plant diameter, plant height and number of leaves.

Variable	Research subject	N	Minimum	Maximum	Mean Rank	Chi-Square	Degree of Freedom	P Value
Plant diameter (cm)	C1	75	33.00	47.00	32.73	6.670	3	0.083***
	C2	75	28.00	42.00	28.77			
	C3	75	45.00	55.00	38.20			
	C4	75	21.00	34.00	22.30			
Plant height (cm)	C1	75	35.00	42.00	35.43	5.224	3	0.156
	C2	75	28.50	38.50	27.13			
	C3	75	36.00	41.50	35.57			
	C4	75	26.00	34.50	23.87			
Number of leaves (piece)	C1	75	16.00	20.00	39.87	12.869	3	0.005*
	C2	75	7.00	10.00	24.90			
	C3	75	10.00	17.00	36.77			
	C4	75	6.00	10.00	20.47			

%1 significant,*%10 significant*

research subjects in terms of plant diameter and number of leaves.

Plant height: It is observed that there is no statistically significant difference in plant height.

Plant diameter: According to the mean ranks, the research subject with the highest plant diameter was determined as "Geotextile and stone laid surface" (C3). In other words, the polypropylene laid and volcanic tuff covered surface have the highest average value. The lowest average value was determined as "Surface without cover material and weed removal" (C4).

Number of leaves: The highest numbers of leaves were found in "Surface with geotextile laid" (C1). But, it can be said that the numbers of "Surface with geotextile and stone laid" (C3) are quite close to "Surface with geotextile laid". The lowest numbers of leaves were found in "Surface without cover material and weed removal" (C4).

Number of Flowers and Flower Diameter

In the 6th week of the research, budding was started in the research subjects where geotextile material was used whereas in the research subject where geotextile material was not used, buds started to be seen after one week, in the 7th week of the research.

When Kruskal-Wallis test results were examined in terms of flower number and flower diameter, the number of flowers was statistically significant at %10 (sig.0,097) and flower diameter at %1 (sig.0,001) (Table 2). It can be said that there is a significant difference between the research subjects in terms of number of flowers and diameter of flowers.

According to the mean ranks, the research subject which has the highest number of flowers and diameter of flowers has been determined as "Surface with geotextile and stone laid" (C3).

Total Fresh Weight, Upper Component Fresh Weight, Flower Fresh Weight, Leaf Fresh Weight, Root Fresh Weight and Root Length

When Kruskal-Wallis test results are examined in terms of total fresh weight, upper component fresh weight, flower fresh weight, leaf fresh weight, root fresh weight and root length, it is seen that there is a statistically significant difference between the research subjects in all other criteria except root length.

Total fresh weight %5 (sig. 0.041), upper component fresh weight %10 (sig. 0.057), flower fresh weight %5 (sig. 0.041), leaf fresh weight %5 (sig. 0.039) and root fresh weight %5 (sig. 0.041) are statistically significant (Table 3).

The results obtained shows that "Geotextile and stone laid surface" (C3) has the highest average rate in terms of total fresh weight, upper component fresh weight, flower fresh weight, leaf fresh weight and root fresh weight. For the same criteria, it is seen that "Surface without cover material and weed removal" (C4) has quite low results.

Weed control

No weed was observed in the research subjects using geotextile material. In "Surface without cover material laid, with weed removal" (C2), weeds were removed from the environment without being allowed to grow.

In "Surface without cover material and weed removal" (C4), however, and average of 2.7 pieces amaranthus (*Amaranthus retroflexus* L.), 3.7 pieces cockspur grass (*Echinochloa crus-galli*), 7.3 pieces bathua (*Chenopodium album* L.), 20.3 pieces sedge plant (*Cyperus rotundus*), 22 pieces purslane *(Portulaca oleracea)* per square meter were detected.

In this research, it is aimed to determine whether the geotextile material constitutes a restriction of plant growth when plant use is required in stone garden landscape designs. In this direction, polypropylene was used as geotextile material and volcanic tuff was used as stone material.

Volcanic tuff contains CaO, SiO2, MgO and in addition also contains FeO, MnO and P2O5 as fertilizer components. In addition, volcanic tuff, which has the property of improving the acidity of the soil due to its alkali property, is used in a wide range for agricultural purposes (Yi *et al.*, 2012). Volcanic tuff, which is used as an aesthetic material in stone garden landscape designs, is also used for weed control. When used alone, the volcanic tuff cannot achieve the desired performance, even if it reduces the formation of weeds (Çakar *et al.*, 2019).

It is known that in agriculture, geotextile materials of different

Table 2. Effects of subjects of research to flower number and flower diameter.

Variable	Research subject	N	Minimum	Maximum	Mean Rank	Chi-square	Degree of Freedom	P Value
Number of flower (piece)	C1	45	14.00	55.00	20.22	6.322	3	0.097***
	C2	45	11.00	41.00	15.83			
	C3	45	38.00	80.00	24.78			
	C4	45	10.00	30.00	13.17			
Diameter of flower (cm)	C1	45	7.00	8.50	21.50	16.196	3	0.001*
	C2	45	5.00	7.00	12.78			
	C3	45	7.00	9.50	28.61			
	C4	45	5.50	7.00	11.11			

%1 significant,*%10 significant*

Table 3 Effects of research subjects on total fresh weight, upper component fresh weight, flower fresh weight, leaf fresh weight, root fresh weight and root length.

Variable	Research subject	N	Minimum	Maximum	Mean rank	Chi-Square	Degree of freedom	P-value
Total fresh weight (gr)	C1	15	135.00	410.00	7.67	8.231	3	0.041**
	C2	15	55.00	240.00	5.00			
	C3	15	190.00	635.00	10.67			
	C4	15	40.00	190.00	2.67			
Upper component fresh weight (gr)	C1	15	95.00	320.00	7.33	7.513	3	0.057***
	C2	15	45.00	185.00	5.00			
	C3	15	150.00	505.00	10.67			
	C4	15	25.00	155.00	3.00			
Flower fresh weight (gr)	C1	15	35.00	130.00	6.67	8.231	3	0.041**
	C2	15	20.00	95.00	5.67			
	C3	15	50.00	230.00	11.00			
	C4	15	5.00	90.00	2.67			
Leaf fresh weight (gr)	C1	15	60.00	195.00	8.33	8.363	3	0.039**
	C2	15	25.00	90.00	4.67			
	C3	15	100.00	275.00	10.33			
	C4	15	20.00	90.00	2.67			
Root fresh weight (gr)	C1	15	35.00	90.00	8.17	8.273	3	0.041**
	C2	15	10.00	75.00	4.33			
	C3	15	40.00	130.00	10.50			
	C4	15	10.00	35.00	3.00			
Root length (cm)	C1	15	15.20	32.10	6.00	2.663	3	0.447
	C2	15	15.50	26.90	5.83			
	C3	15	13.00	34.60	9.33			
	C4	15	13.10	29.10	4.83			

%1 significant, **%5 significant, *% 10significant*

quality are used in weed control (Kitiş, 2011 and Kolören and Uygur, 2015). On the other hand, in landscaping areas where ornamental plants are used, it is seen that only volcanic tuff is used without using geotextile material. In such cases where weed formation cannot be prevented completely, landscape designs lose their effectiveness and the negative effects of ornamental plants are frequently affected with an undesirable frequency.

In the research, it was observed that the polypropylene cover lay under the volcanic tuff completely prevented weed formation. Moreover, thanks to the permeable structure of polypropylene, the contact of the fertilizer properties of the volcanic tuff with the soil was supported and it was concluded that its use together with the volcanic tuff, especially in the stone garden landscape designs, had an effective role in plant development.

Among the research subjects "Geotextile and stone laid surface" (C3) had the highest value in all other criteria except for the number of leaves. The highest value in the number of leaves was determined in "Surface with geotextile laid" (C1) which is also the subject of the research using geotextile material (Fig. 2).

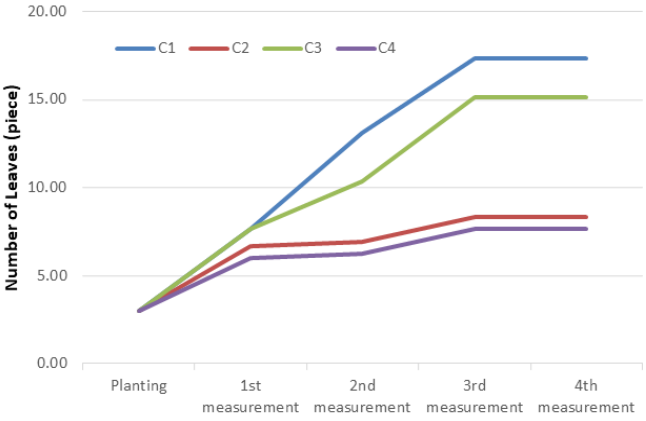

Figure 2. Number of leaves according to the research subjects

"Polypropylene laid surface" which has the highest value in the number of leaves, is followed by "polypropylene cover laid under the volcanic tuff surface". According to the results of the analysis, it was determined that the first two rows belong to the research subjects using geotextile material. As a result of the observations, it was observed that the budding in

the plants took place one week ago again in these research subjects. These results show that geotextile material has a supporting effect on plant growth.

In "Surface without cover material laid, with weed removal" plant development remained weaker than the research subject using geotextile material. According to the results of the analysis, it was found that the geotextile material not only prevented weed formation but also supported the development of the plant by preserving the moisture in the soil.

In "Surface without cover material and weed removal" plant development has the lowest rates among all research subjects. At the end of the experiment, It was found out that the plant growth in this research was negatively affected due to the weeds (*Amaranthus retroflexus* L., *Echinochloa crus-galli, Chenopodium album* L., *Cyperus rotundus, Portulaca oleracea*) determined by their amount. These weeds are invasive and are difficult to fight in irrigated areas. Sometimes they survive despite all kinds of precautions and can cause great damage to the yield of the product (Vila *et al.,* 2004; Tan *et al.,* 2012; Bajwa *et al.,* 2015; Qadeer *et al.,* 2016). In this research, it is thought that plant growth is prevented due to insufficient amount of water required for plant development because of the use of irrigation water by weeds.

***Conclusion*:** The preparation of environmentally sensitive landscape projects have great importance in today's world where environmental problems are increasing. Continuity has great importance in landscape projects that are prepared with environmentally friendly approaches aiming effective water usage, which are far from chemicals, do not require much maintenance. Landscape designs should not lose their effectiveness and should be able to maintain their initial impact for a long time. Especially in stone garden landscape designs, sustaining this effect depends on weed control. In these landscape areas, the use of geotextile materials is necessary to maintain weed control without maintenance. Plants can also be used in stone garden landscape designs at the same time. It was observed that the geotextile material (polypropylene) used by laying under stone material (volcanic tuff) for weed control did not constitute a restriction of plant growth. By using polypropylene cover, weed control was ensured to protect the design and water consumption by weeds was prevented. Water loss due to evaporation on the soil surface is also minimized. In addition, thanks to the porous structure of polypropylene, the transfer of fertilizer properties of the volcanic tuff to the soil was not prevented. Thus, a suitable environment has been formed in terms of plant development and plant development has been positively affected. Polypropylene, which is used as a geotextile material, has an important role in the early flowering of the plant and attaining a more bulky structure.

As a result of this research, it is recommended to use polypropylene cover under stone material for weed control in stone garden landscape designs since it does not create a restriction on plant growth and affects plant growth positively.

Acknowledgement: No.

REFERENCES

Alpaslan, M., A. Güneş and A. İnal. 2005. Deneme tekniği. Ders Kitabı: 496, Yayın No: 1543, Ankara Üniv. Ziraat Fak., Ankara.

Bajwa, A.A., J. Khawar, M. Shahid, H.H. Ali, B.S. Chauhan and Ehsanullah. 2015. Eco-biology and management of *Echinochloa crus-galli*, Elsevier. Crop Prot.75:151-162.

Çakar, H., Ö. Akat Saraçoğlu, H. Akat, C. Kılıç and Ö. Yücel. 2019. The performance analysis of geotextile materials used for irrigation water and weed control in stone garden landscape design. Tekst Konfeksiyon. 29:237-245.

Çınar, S., R. Hatipoğlu and M. Avcı. 2015. Bazı yabancı ot mücadele yöntemlerinin Akdeniz bölgesi meralarında ot verimi, botanik kompozisyon ve ot kalitesi üzerine etkisi. Tarım Bilim Derg. 21:39-49.

Fung, W. 2004. Handbook of technical textiles. The Textile Institute, England. pp. 490-522.

Gökgöz, Ş. 2010. Samsun koşullarında atdişi mısırda (*Zea mays indentata sturt*.) yabancı ot kontrol yöntemlerinin verim ve verim unsurlarına etkisi. Y. Lisans Tezi, Tarla Bitkileri A.B.D., Namık Kemal Üniv., Türkiye.

Işık, D., H. Mennan, M. Dok and E. Kaya Altop. 2010. Koruyucu toprak işleme ve doğrudan ekim sistemlerinde yabancı ot mücadelesi. Batı Akdeniz Tarımsal Araştırma Enstitüsü, Derim. 27:45-57.

Kazemi, F. and N. Safar. 2018. Effect of mulches on some characteristics of a drought tolerant flowering plant for urban landscaping. Desert. 23:75-84.

Kitiş, Y.E. 2011. Yabancı ot mücadelesinde malç ve solarizasyon uygulamaları. GAP VI. Tarım Kongresi; Mayıs 9-12, 2011. Şanlıurfa. pp. 463-468.

Kolören, O. and F.N. Uygur. 2015. Cansız malçlama yöntemlerinin mandalina bahçesinde yabancı otlanma üzerine olan etkisi. Turkish Journal of Agriculture: Food Science and Technology. 3: 920-925.

Mecit, D., S. Ilgaz, D. Duran, G. Başal, T. Gülümser and I. Tarakçıoğlu. 2007. Teknik tekstiller ve kullanım alanları (Bölüm 2). Tekst Konfeksiyon, 3/2007. pp. 154-161.

Mengüç, Ç. 2018. Herbisit toksisitesi ve yabancı otlara karşı alternatif mücadele stratejileri. Turk J Weed Sci.21:61-73.

Ojo, O.O., I.O.O. Aiyelaagbe and A.R. Omolade. 2019. Growth and flowering response of two species of marigold (*Tagetes* spp.) to water stress department of horticulture. Federal Univ. of Agric., Nigeria. Available

online at https://www.academia.edu/8904979/Growth_and_Flowering_Response_of_Two_Species_of_Marigold_Tagetes_spp._to_Water_Stress.

Özdizdar, A. 2004. Teknik tekstiller sektör araştırması. İstanbul Ticaret Odası, Türkiye.

Patel, M.A., S.L. Chawla, S.K. Chavan, H.P. Shah and S.D. Patil. 2019. Genetic variability, heritability and genetic advance studies in marigold (*Tagetes Spp*.) under the south gujarat region. Electron. J. Plant Breed.10:272-276.

Qadeer, A., Z. Ali, H.M. Ahmad, M. Qasam and S. Toor. 2016. Invasion of different weeds on Gladiolus and their control by herbicides. Plant Gene and Trait. 7:1-9.

Sonmez, F., S. Alp and O. Yasar. 2017. The effects of humic acid application on the nutrient contents and heavy metals in organs of marigold (*Tagetes Erecta* L.). Fresenius Environ. Bull. 26:5340-5348.

Tan, M., Z. Dumlu Gül and İ. Çoruh. 2012. Horozibiği (*Amaranthus retroflexus L.*) ve sirken (*Chenepodium album L.*) yabancı otlarının silaj değerlerinin belirlenmesi. Atatürk Üniv. Ziraat Fak. Derg.43:43-47.

Uygur, S. and F. Uygur. 2016. Yabancı otların biyolojik mücadelesi. Türk. Biyo. Mücadele Derg.1:79-95.

[Received 15 April 2020; Accepted 14 Mar. 2021; Published (online) 25 Jun 2021]