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The effect of different growing environments on seedling development in transplanting paddy production

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ABSTRACT

In the world, the transplanting planting method comes into prominence to save on irrigation water due to climatic changes, to increase the yield per unit area with lengthy vegetation varieties, and to reduce chemical input in pest and disease control. The basic element of being successful in transplanting paddy production is to grow healthy and quality seedlings. For machine seedling, it is necessary to grow in a special viol environment. For paddy seedlings in trays, it is required to prepare special mortars rich in plant nutrients and economical. In this research, four replications were carried out in an unheated polyethylene greenhouse of Ondokuz Mayıs University Agricultural Research and Application Center in 2020 with 20 different mortar media and three paddy varieties (Baldo, Vasco and Tosya Gunesi). To determine the seedling quality, seedling length, seedling stem diameter, leaf number, root length, root number, above ground and root wet weight, above ground, and root dry matter ratio values were examined 21 days after planting. According to the research results, the effect of different medium crosses, cultivars, and environment x cultivar combinations used on the seedling quality characteristics was statistically significant. The results showed that seedling length was 68.39-218.19 mm, seedling stem diameter was 0.97-2.64 mm, number of leaves was 2.0-4.0, root length was 16.95 - 98.35, number of roots was 4.25-10.75, shoot wet weight 5.40-131.55 mg, root wet weight 3.03-104.28, shoot dry weight ratio was 5.95-27.42 %, and root dry weight ratio was 1.37-15.13 %. The biplot analysis results showed that the Vasco variety had the best quality of seedlings in growth media numbers 13 and 18. The evaluation of growth media's quality, economically and ecologically, showed that growth media number 13 was the best media, and media numbers 18 and 19 could be used as alternatives.

Anahtar Sözcükler:
Animal Manure
Oryza sativa L.
Paddy husk ash
Peat
Perlite
Tobacco Dust

Fideleme çeltik üretiminde farklı yetiştirme ortamlarının fide gelişimine etkisi

ÖZET

Dünya da iklimsel değişikliklerden dolayı; sulama suyundan tasarruf sağlamak, uzun vejatasyon süresine sahip çeşitler ile birim alan verimini artırmak ve hastalık zararlı mücadelesinde kimyasal girdileri azaltmak amacıyla fideleme ekim yöntemi ön plana çıkmaktadır. Fideleme çeltik üretiminde başarılı olmanın temel unsuru sağlıklı ve kaliteli fide yetiştirmektir. Makineli fideleme için, özel viyol ortamında yetiştiricilik yapılması gereklidir. Viyollerde çeltik fidesi için, bitki besin maddelerince zengin ve ekonomik özel harçların hazırlanması gerekmektedir. Bu araştırmada, 20 farklı harç ortamı ve 3 çeltik çeşidi (Baldo, Vasco ve Tosya Güneşi) kullanılmıştır. 2020 yılında Ondokuz Mayıs Üniversitesi Tarımsal Araştırma ve Uygulama Merkezine ait ısıtmasız polietilen serasında, tesadüf parsellerinde 4 tekerrürlü olarak yürütülmüştür. Fide kalitesinin belirlenmesi amacıyla fideler ekimden itibaren 21 gün sonra fide uzunluğu, fide gövdesi çapı, yaprak sayısı, kök uzunluğu, kök sayısı, toprak üstü ve kök yaş ağırlığı, toprak üstü ve kök kuru madde oranı değerleri incelenmiştir. Araştırma sonuçlarına göre, incelenen fide kalite özellikleri üzerine kullanılan farklı ortam harçlarının, çeşitlerin ve ortam x çeşit

Keywords:
Hayvan Gübresi
Oryza sativa L.
Çeltik Kavuz Külü
Torf
Perlit
Tütün Tozu

kombinasyonlarının etkisi istatistiki olarak çok önemli çıkmıştır. Fide uzunluğu 68.39 ile 218.19 mm, yaprak sayısı 2.0 ile 4.0 adet, kök uzunluğu 16.95 ile 98.35 mm, kök sayısı 4.25 ile 10.75 adet, gövde çapı 0.97 ile 2.64 mm, gövde yaş ağırlığı 5.40 ile 131.55 mg, kök yaş ağırlığı 3.03 ile 104.28 mg, toprak üstü aksam kuru madde oranı % 5.95 ile 27.42 ve kök kuru madde oranı % 1.37 ile 15.13 arasında değişmiştir. Yapılan biplot analiz sonucunda Vasco çeşidi ile 13 ve 18 numaralı ortamlar ön plana çıkmaktadır. Farklı materyaller, ekonomik ve ekolojik bakımdan yetiştirme ortamı olarak değerlendirildiğinde 20 ortam içerisinde en iyi fide kalitesi 13. ortamda ön plana çıkmıştır. Ayrıca 18. ve 19. ortamlar alternatif olarak kullanılabilecektedir.

1. Introduction

Paddy is 40 % of the world's food source, which meets about 80 % of the basic calorie needs for 2 billion people. 90 % of world paddy production and consumption are in Asian countries (Sezer et al., 2011). Paddy production in various Asian countries is carried out by the seedling method (IRRI, 2002). Especially in recent years, it has been done with a machine instead of hand transplanting. The change in cultivation method in Asian countries, which are accepted as the homeland of paddy, affects the countries that produce paddy in the world.

Climate change is having a significant impact on paddy fields around the world. So it is necessary to have a more water-efficient transplanting growth method, but the transplanting produced are still able to produce high and healthy so that they can reduce the input of chemicals in controlling pests and diseases (Sezer and Mut, 2004; Sezer et al., 2011). In many studies, several ways to increase paddy production have also been described, such as saving at least 30 % water in the transplanting growth method (Pin et al., 2012), delaying planting time, and using long day productive varieties (Faghani et al., 2011), control of paddy blight disease by cultural methods (Farmia, 2008), prevents the occurrence of felling in paddy plants (Birhane, 2013), and performs crop rotation (Abou-Khadrah et al., 2014).

Production of quality seedlings is an important problem in planting methods using transplanting machines (De Datta, 1981). Transplanting high-quality paddy seedlings is essential to minimize abiotic stress factors. Many studies recommend that seedlings be planted by transplanting machines should have 2-3 leaves, and seedling length should be 120-150 mm (Matsushima, 1980; Kitagawa et al., 2004; Manjunatha et al., 2009). Strong paddy seeds will produce high-quality tillers and grain yields (Yamamoto et al., 1995; Randriamiharisoa and Uphoff, 2002; Horie et al., 2005). It is also important for healthy and uniform plant growth and development (Matsuo and Hoshikawa, 1993). The media for growing seedlings will determine the seedling's quality and health (TeKrony and Egli, 1991).

Several growth methods are used globally, such as wet, dry, mat, modified mat, and tray method. In addition to the method using trays, paddy growth is also carried out in seedling boxes or directly in paddy planting areas (Kim et al., 1991). For planting seedlings with a transplanting machine, farmers must prepare the seeds in a special tray. Growth media to be prepared in trays must be rich in nutrients and economical (Kundu et al., 1993).

Changes in paddy production culture around the world have greatly influenced the culture of paddy production in Turkey. So that in recent years it has led to an increase in the use of transplanting machines, the use of long-day productive varieties, to the widespread problem of irrigation water (Sezer et al., 2017). This study was conducted to determine the composition of quality, economical and sustainable planting media in producing paddy seedlings for use in transplanting machines.

2. Material and Method

2.1 Plant material

This study used three registered cultivars, namely Baldo, Vasco, and Tosya Gunesi. Paddy consumers preferred Baldo, Vasco has high productivity, and Tosya Gunesi was chosen because it is widely used in Turkey.

2.2 Growth media

This study used six different growth media; soil (S), tobacco dust (TD), commercial peat (CP), animal manure (AM), paddy husk ash (RHA), perlite (P). The soil (S) used comes from the field around the place where conducted the study. After analyzing the soil used had a pH value 8.0-8.1, EC value 0.59-0.63 dS m^{-1}, organic matter ratio of 1.1-1.2 %, N content 0.06-0.07 %, K_2O content 3.8-3.9 kg and P_2O_5 content 125.5-135.2 kg da^{-1}. Tobacco dust (TD) was obtained from oriental tobacco leaves filtered by international private companies operating in Izmir. The results of the tobacco dust analysis showed; pH value 5.45-5.88, EC value 0.7-11.0 dS m^{-1}, organic matter ratio 41-68 %, organic carbon 38.4-42.4 %, N content 2.1-2, 3 %, P levels 0.1-0.2, K levels 1.9-2.0 %. Commercial peat (CP) has a pH value 6.8-7.8, an EC value 1.06-1.41 dS m^{-1}, organic matter content 80-85 %, N content 1.0-1.7 %, and P content 0.1- 0.2 %. Animal manure (AM) has a pH value 8.0-8.1, EC value 1.02-1.10 dS m^{-1}, organic matter content 28-31 %, N content 2.2-2.3 %, P content 1.1-1.2 %, and K content 2.2-2.3 %. Rice husk ash content (RHA) pH value of

7.8-7.9, EC value 0.50-0.51 dS m^{-1}, organic matter content 28-31 %, N content 0.40-0.41 %, P 10.40-0.42 %, K content 0.37-0.39 % and Si content 86-88 %.

2.3 Method

This study was carried out in the polyethylene (PE) greenhouse of Ondokuz Mayıs University Agricultural Research and Application Center according to a randomized plot design of four replications in 2020. Special seedling PE viyols (58 x 28 x 4 cm) are used for paddy seedling (Mitchell et al., 2004). The mixing of the growth media was carried out after filtering on a 0.5 mm sieve with the composition shown in Table 1 (Figure 1).

Paddy seeds were soaked for 15 minutes at 52 °C to avoid attack by white tip nematode (Elekcioglu and Tulek, 2009). The prepared growth media is filled into trays with a depth of 2.5-3 cm, and after the paddy seeds are planted, they are compacted to 0.5-1 cm. Paddy seeds sown in trays are based on the weight of 1000 grains, namely 3500-4000 seeds/m^2 (Sezer et al., 2017). Furthermore, the seeds that have been planted in the tray are watered until the growth is submerged in water and then stored in the dark for 2-3 days.

The trays are transferred to the greenhouse and irrigated to keep the growth media in a saturated water condition. The variables observed to determine seedling quality were seedling length, seedling stem diameter, number of leaves, root length, number of roots, shoot wet weight, root wet weight, and shoot dry weight ratio, and root dry weight ratio in the period when the seedlings had 2.5-3 leaves (21 days since planting) (Pirdashti et al., 2009). Length and diameter measurements were made with the help of digital calipers and fresh weights were measured on an analytical scale with 0.0001 precision (Akay et al., 2013). To determine the dry matter ratio, plant parts were dried in blotter paper at 70 °C for 24-36 hours (Atak et al., 2006) and wet weight and dry weight were proportioned. The data were analyzed using JMP (2007) statistical package program.

Figure 1. Growing medium.
Şekil 1. Büyüme ortamları.

Table 1. Growing medium and composition used
Çizelge 1. Kullanılan yetiştirme ortamları ve kompozisyonları

Growth Medium (%)	Soil (S)	Tobacco Dust (TD)	Commercial Peat (CP)	Animal Manure (AM)	Paddy Husk Ash (PHA)	Perlite (P)
1	100	-	-	-	-	-
2	-	100	-	-	-	-
3	-	-	100	-	-	-
4	-	-	-	100	-	-
5	-	-	-	-	100	-
6	50	50	-	-	-	-
7	50	-	-	-	50	-
8	50	-	50	-	-	-
9	50	-	-	50	-	-
10	50	25	25	-	-	-
11	50		25	-	25	-
12	25	25	25	25	-	-
13	-	25	25	25	25	-
14	-	-	25	25	25	25
15	25	25	-	25	25	-
16	20	-	20	20	20	20
17	20	20	20	20	-	20
18	20	20	20	20	20	-
19	20	20	-	20	20	20
20	25	15	15	15	15	15

3. Results and Discussion

Seedling quality is the most important factor affecting the success of seedling paddy production. In the research investigating the effect of different growth mediums on paddy seedling properties, significant differences were found in terms of variety, environment and variety × growth medium interaction in all of the characters examined (Table 2). The paddy seeds did not germinate in the second growth medium (100 % Tobacco dust).

Table 2. Variance results of the characters examined in the study *
*Çizelge 2. Araştırmada incelenen karakterlerin varyans sonuçları**

SV	*DF*	MEANS OF SQUARES								
		SL	**RL**	**NL**	**NR**	**SBD**	**AGCW**	**RAW**	**AGDW**	**RDM**
GM	18	10994.65**	2884.32**	0.53**	19.26**	1.781**	0.0065**	0.0031**	129.75**	101.34**
Variety	2	34970.20**	1543.28**	3.41**	30.86**	0.441**	0.0095**	0.0019**	20.88**	23.37**
GM×V	36	934.15**	461.94**	0.81**	4.37**	0.1308*	0.0014**	0.0007**	55.48**	17.36**
Error	171	189.70	163.52	0.18	1.81	0.081	0.00057	0.00012	1.71	0.57
CV %		10.30	20.77	14.33	18.53	14.16	36.17	30.81	9.16	13.58

* SL= Seedling Length; RL= Root Length; NL= Number of Leaves; NR= Number of Roots; SBD= Seedling Body Diameter; AGCW= Above Ground Component Wet Weight; RAW= Root Age Weight; AGDW= Above Ground Part Dry Matter; RDM= Root Dry Matter; SD= Degrees of Freedom; VK= sources of variation; GM×V Int.= growth medium-variety interaction; CV%= Coefficient of Variation.

Seedling length and number of leaves are important parameters that become indicators when using transplanting machines in paddy cultivation. Paddy seedlings to be used with the transplanting machine are expected to be 120-150 mm long with three leaves (Kitagawa et al., 2004; Manjunatha et al., 2009).

Table 3. The average value of seedling length and number of leaves of 3 paddy varieties in 20 different growth media*

*Çizelge 3. 20 farklı ortamlarda 3 çeltik çeşidine ait fide uzunluğu ve yaprak sayısı ortalama değerleri**

Growth Medium	Seedling Length (mm)				Number of Leaves (pieces)			
	Baldo	Vasco	T. Güneşi	Average	Baldo	Vasco	T. Güneşi	Average
1	190.27 abc	132.90 g-r	148.08 d-n	**157.08 ab**	3.00 a-e	3.00 a-e	3.00 a-e	**3.00 abc**
2	-	-	-	**-**	-	-	-	**-**
3	194.01 ab	149.34 d-m	162.73 b-j	**168.69 a**	2.75 b-e	2.75 b-e	3.25 a-d	**2.92 abc**
4	129.78 h-t	80.82 wxy	94.40 r-y	**101.67 ef**	3.00 a-e	2.00 e	3.00 a-e	**2.67 abc**
5	108.97 n-x	84.16 v-y	109.44 n-x	**100.86 ef**	3.25 a-d	2.25 de	2.00 e	**2.50 c**
6	166.14 b-h	161.47 b-j	168.13 b-h	**165.25 a**	2.25 de	3.25 a-d	3.00 a-e	**2.83 abc**
7	137.33 f-p	92.03 t-y	93.32 s-y	**107.56 def**	3.00 a-e	2.00 e	2.75 b-e	**2.58 bc**
8	107.13 o-y	68.39 y	96.60 q-y	**90.71 ef**	3.50 abc	2.25 de	2.50 cde	**2.75 abc**
9	95.365 q-y	84.95 v-y	87.36 u-y	**89.22 f**	3.75 ab	2.50 cde	3.50 abc	**3.25 a**
10	217.69 a	142.40 e-o	158.43 b-k	**172.84 a**	3.25 a-d	3.00 a-e	2.50 cde	**2.92 abc**
11	110.69 m-x	83.03 wxy	98.06 p-y	**97.26 ef**	2.75 b-e	2.00 e	3.25 a-d	**2.67 abc**
12	134.57 g-q	118.54 l-w	152.15 c-l	**135.09 c**	3.00 a-e	3.75 ab	2.75 b-e	**3.17 ab**
13	218.19 a	152.24 c-l	143.09 e-o	**171.17 a**	3.00 a-e	3.25 a-d	3.00 a-e	**3.08 abc**
14	171.75 b-g	142.37 e-o	180.12 a-e	**164.74 a**	2.75 b-e	3.00 a-e	3.00 a-e	**2.92 abc**
15	175.2 b-f	115.22 l-w	123.37 j-v	**137.93 bc**	3.00 a-e	3.25 a-d	3.00 a-e	**3.08 abc**
16	160.19 b-j	153.03 c-l	158.38 b-k	**157.20 ab**	3.00 a-e	2.50 cde	3.00 a-e	**2.83 abc**
17	187.45 a-d	124.72 ı-u	162.90 b-ı	**158.36 a**	3.25 a-d	2.50 cde	2.75 b-e	**2.83 abc**
18	160.82 b-j	101.00 p-y	131.40 h-t	**131.07 c**	4.00 a	2.25 de	3.00 a-e	**3.08 abc**
19	159.47 b-j	81.47 wxy	133.55 g-r	**124.83 cd**	3.00 a-e	3.00 a-e	3.50 abc	**3.17 ab**
20	132.12 h-s	74.59 xy	119.84 k-w	**108.85 de**	3.50 abc	2.50 cde	3.00 a-e	**3.00 abc**
Average	**155.64 a**	**112.77 c**	**132.70 b**	**133.70**	**3.11 a**	**2.68 c**	**2.93 b**	**2.91**

* There is no 5% difference between the averages indicated with the same letter.

Seedling length in this study varied between 68.39-218.19 mm. When viewed from the average, found the highest seedling length of 172.84 mm in growth media number 10. It was not significantly different from the treatment of growth media numbers 1, 3, 6, 13, 14, 16, and 17. Meanwhile, the lowest seedling length is found in growth media number 9, with a length of 82.22 mm. The interaction between treatments showed the highest seed length in the interaction between Baldo variety and growth media numbers 10 and 13. About the varieties' response to the growth media, the highest seedling length was shown by the Vasco variety in growth media number 6 and the Tosya Gunesi variety in the growth media number 14. Baldo variety showed the highest average seedling length (133.70 mm) in 60 % of the growth media used in the study. This indicates that the Baldo variety is more selective in adapting to the growth media than the Vasco and Tosya Günesi varieties. In this case, the Baldo variety shows a positive response to different growth media from an economic and ecological perspective. Meanwhile, the Vasco and Tosya Günesi varieties only had an average seedling length of 30 % and 45 % of the growth media, respectively.

Table 4. The average value of root length and number of roots of 3 paddy varieties in 20 different growth media *
*Çizelge 4. 20 farklı ortamlarda 3 çeltik çeşidine ait kök uzunluğu ve kök sayısı ortalama değerleri**

Growth	Root Length (mm)				Number of Roots (pieces)			
Medium	Baldo	Vasco	T. Güneşi	Average	Baldo	Vasco	T. Güneşi	Average
1	58.84 d-p	61.74 a-o	61.89 a-o	**60.82 c-f**	9.75 a-d	8.25 a-ı	9.25 a-f	**9.08 ab**
2	-	-	-	**-**	-	-	-	**-**
3	69.13 a-m	66.09 a-n	49.99 f-q	**61.73 c-f**	7.25 a-j	6.75 b-j	7.50 a-j	**7.17 b-f**
4	95.68 abc	81.52 a-g	59.51 c-p	**78.90 abc**	9.50 a-e	5.25 g-j	5.25 g-j	**6.67 c-h**
5	74.67 a-k	64.90 a-o	76.58 a-ı	**72.05 a-d**	8.75 a-h	7.50 a-j	7.00 a-j	**7.75 b-e**
6	16.95 r	36.07 l-r	23.57 pqr	**25.53 h**	9.25 a-f	7.75 a-j	8.75 a-h	**8.58 abc**
7	68.08 a-m	52.37 e-q	49.00 f-q	**56.48 def**	6.50 b-j	5.50 f-j	6.50 b-j	**6.17 d-g**
8	79.86 a-g	64.16 a-o	58.95 d-p	**67.66 b-e**	6.50 b-j	5.50 f-j	4.25 j	**5.42 fg**
9	65.08 a-o	78.33 a-h	45.48 g-q	**62.96 cde**	8.00 a-j	8.25 a-ı	7.25 a-j	**7.83 b-e**
10	33.55 m-r	38.26 k-q	61.74 a-o	**44.52 fg**	9.50 a-e	10.75 a	10.00 abc	**10.08 a**
11	98.35 a	87.55 a-e	75.10 a-j	**87.00 a**	5.50 f-j	5.00 hıj	4.75 ıj	**5.08 g**
12	40.68 ı-q	28.78 o-r	31.14 n-r	**33.53 gh**	7.00 a-j	4.75 ıj	6.75 b-j	**6.17 d-g**
13	59.20 c-p	62.63 a-o	39.93 j-q	**53.92 def**	8.50 a-ı	8.75 a-h	7.50 a-j	**8.25 abc**
14	82.74 a-f	90.26 a-d	71.52 a-l	**81.50 ab**	5.75 e-j	7.50 a-j	6.50 b-j	**6.58 c-g**
15	59.81 c-p	53.85 d-p	55.32 d-p	**56.33 def**	7.75 a-j	7.75 a-j	7.50 a-j	**7.67 b-e**
16	59.49 c-p	58.90 d-p	70.83 a-l	**63.07 cde**	5.75 e-j	5.25 g-j	6.50 b-j	**5.83 efg**
17	55.53 d-p	42.22 h-q	61.36 b-o	**53.04 ef**	10.00abc	6.00 d-j	6.25 c-j	**7.42 b-f**
18	78.46 a-h	62.99 a-o	58.09 d-p	**66.51 b-e**	7.00 a-j	5.75 e-j	8.25 a-ı	**7.00 c-g**
19	73.01 a-k	97.26 ab	56.43 d-p	**75.57 abc**	9.00 a-g	5.75 e-j	6.00 d-j	**6.92 c-g**
20	75.91 a-j	59.75 c-p	70.17 a-l	**68.61 b-e**	10.25 ab	7.00 a-j	6.75 b-j	**8.00 bcd**
Average	**65.53 a**	**62.51 a**	**56.66 b**	**61.56**	**7.97 a**	**6.79 b**	**6.97 b**	**7.25**

* There is no 5% difference between the averages indicated with the same letter.

The number of leaves in the growth varies from 2.00-4.00 in the nursery's various varieties and media. In general, the number of leaves was directly proportional to the length of the seedlings shown by the Baldo variety in growth media number 18 (4.00 leaves/seedling). However, the highest average number of leaves was demonstrated by the Baldo variety in growth media number 9 (Table 3). A strong root system was needed to prevent stress, both during transplanting and after transplanting seedlings. It could minimize post-planting losses by building good plant-water relationships (McKee, 1981; Davies et al., 1990). A suitable growth method should produce seedlings with a high number and length of roots. High root density provided an advantage when seedlings are transferred to the field (Sistani and Reddy, 1997). In this case, paddy seedlings' root characteristics can be used as an essential parameter to determine paddy varieties' ability to adapt to different growth media. The present results showed that the average root length was 61.56 mm, and the average number of roots was 7.25 roots/seedlings. Growth media treatment sequentially showed the highest average root length in growth media numbers 11, 4, 5, 14, and 19, and each was not significantly different.

Meanwhile, found the highest root length in the treatment of Baldo variety with growth media number 11, and the found lowest root length in growth media number 6. The results showed that the number of roots paddy seedlings varied between 4.75-10.75 roots/seedlings, with the highest number of roots indicated in growth media 1, 6, 10, and 13. Whereas in growth media number 11, the lowest number of roots was obtained where the highest root length was found (Table 4).

Table 5. The average value of seedling stem diameter of 3 paddy varieties in 20 different growth media *
*Çizelge 5. 20 farklı ortamlarda 3 çeltik çeşidine ait gövde çapı ortalama değerleri**

Growth Medium	Seedling Body Diameter (mm)			
	Baldo	**Vasco**	**T. Güneşi**	**Average**
1	1.85 a-n	1.78 b-o	1.77 c-o	**1.80 efg**
2	-	-	-	-
3	1.45 k-o	1.35 l-o	1.95 a-m	**1.58 g**
4	2.46 a-e	2.56 a-d	2.32 a-h	**2.45 a**
5	2.26 a-k	2.16 a-l	1.94 a-n	**2.12 cd**
6	1.78 b-o	2.07 a-m	1.66 e-o	**1.84 ef**
7	2.45 a-e	2.16 a-l	2.23 a-k	**2.28 abc**
8	2.37 a-g	2.07 a-m	2.02 a-m	**2.15 bcd**
9	2.27 a-j	2.23 a-k	2.54 a-d	**2.35 abc**
10	2.28 a-j	1.62 f-o	2.07 a-m	**1.99 de**
11	2.42 a-f	2.54 a-d	2.44 a-e	**2.47 a**
12	1.13 no	1.27mno	0.97 o	**1.12 h**
13	1.74 d-o	1.56 h-o	1.39 l-o	**1.56 g**
14	1.73 d-o	1.48 ı-o	1.92 a-n	**1.71 fg**
15	2.37 a-g	2.37 a-g	2.59 ab	**2.44 a**
16	1.59 g-o	1.62 f-o	1.88 a-n	**1.69 fg**
17	1.87 a-n	1.47 j-o	1.73 d-o	**1.69 fg**
18	2.29 a-ı	1.98 a-m	2.16 a-l	**2.14 bcd**
19	2.58 abc	2.13 a-l	2.40 a-g	**2.37 ab**
20	2.64 a	2.24 a-k	2.42 a-f	**2.43 a**
Average	**2.08 a**	**1.93 b**	**2.02 ab**	**2.01**

* There is no 5% difference between the averages indicated with the same letter.

In this study, the average seedling stem diameter was 2.01 mm. The highest seedling stem diameter was shown in growth media number 11 with a value of 2.47 mm and was not significantly different statistically in growth media 4, 7, 9, 11, 15, 19, and 20. The lowest seedling stem diameter was shown in growth media 12. Baldo variety demonstrated its adaptability with the highest average seedling stem diameter value compared to other varieties in 20 different growth media treatments. In growth media number 12, there was no RHA and P media mixture, and the Tosya Gunesi variety showed the lowest seedling stem diameter (Table 5). Likewise, the lowest values were determined in the wet shoot weight and root wet weight variables, respectively 5.40 mg and 3.03 mg for the Tosya Gunesi variety in growth media number 12. The paddy seedlings' variable shoot wet weight increased 25 fold between 5.40-131.55 mg in all growth media variations. Meanwhile, paddy seedlings' variable root wet weight showed a weight between 5.40-131.55 mg, which increased 35 times in all growth media variations. Like seedling stem diameter, shoot and roots wet weight Baldo variety determined the highest values in 20 different growth media treatments (Table 6).

Table 6. The average value of wet above ground part and wet root weight of three paddy varieties in 20 different growth media*

*Çizelge 6. 20 farklı ortamlarda 3 çeltik çeşidine ait gövde ve kök yaş ağırlığı ortalama değerleri**

Growth	Above Ground Part Wet Weight (mg)				Root Wet Weight (mg)			
Medium	Baldo	Vasco	T. Güneşi	Average	Baldo	Vasco	T. Güneşi	Average
1	39.00 c-l	23.95 g-l	16.65 h-l	**26.53 e**	24.35 g-q	21.70 ı-q	16.33 k-q	**20.79 fgh**
2	-	-	-	**-**	-	-	-	**-**
3	31.80 e-l	27.53 f-l	31.73 e-l	**30.35 e**	17.10 k-q	22.33 h-q	20.60 ı-q	**20.01 gh**
4	102.23 a-d	70.85 a-k	65.65 a-l	**79.58 ab**	41.33 b-n	37.48 d-o	24.40 g-q	**34.40 d-g**
5	127.13 ab	54.00 c-l	58.73 c-l	**79.95 ab**	44.68 b-l	26.28 g-q	28.25 f-q	**33.07 d-g**
6	44.55 c-l	70.93 a-k	40.33 c-l	**51.93 b-e**	19.95 j-q	31.43 f-q	11.93 m-q	**21.10 fgh**
7	99.03 a-e	67.80 a-l	58.00 c-l	**74.94 abc**	58.30 b-f	32.55 f-p	36.33 d-o	**42.39 bcd**
8	93.28 a-f	57.20 c-l	52.33 c-l	**67.60 a-d**	46.43 b-k	36.35 d-o	19.15 j-q	**33.98 d-g**
9	102.23 a-d	78.38 a-ı	89.98 a-g	**90.19 a**	65.88 b-e	52.08 b-ı	54.00 b-h	**57.32 ab**
10	131.55 a	78.78 a-ı	71.68 a-k	**94.00 a**	50.28 b-j	44.40 b-l	41.48 b-n	**45.38 bcd**
11	73.23 a-k	76.45 a-j	83.80 a-h	**77.83 ab**	73.05 ab	39.23 d-o	40.18 c-o	**50.82 bc**
12	9.65 jkl	54.40 c-l	5.40 l	**23.15 e**	8.78 opq	4.00 pq	3.03 q	**5.27 ı**
13	34.38 d-l	14.63 ı-k	55.03 c-l	**34.68 de**	11.53m-q	11.58m-q	9.73 n-q	**10.94 hı**
14	61.90 b-l	66.50 a-l	80.53 a-ı	**69.64 abc**	38.53 d-o	41.10 c-n	71.30 bc	**50.31 bc**
15	71.65 a-k	94.45 a-f	85.58 a-g	**83.89 ab**	17.75 k-q	59.35 b-f	67.70 bcd	**48.27 bcd**
16	82.33 a-ı	80.43 a-ı	81.35 a-ı	**81.37 ab**	46.80 b-k	37.18 d-o	45.00 b-l	**42.99 bcd**
17	62.30 b-l	25.10 g-l	41.30 c-l	**42.90 cde**	35.88 e-o	14.55 l-q	30.35 f-q	**26.93 efg**
18	106.20 abc	54.00 c-l	72.95 a-j	**77.72 ab**	40.23 c-o	24.88 g-q	52.35 b-ı	**39.15 cde**
19	98.05 a-e	56.40 c-l	70.68 a-k	**75.04 ab**	45.53 b-l	28.03 f-q	34.15 e-p	**35.90 c-f**
20	127.58 ab	62.33 b-l	82.73 a-h	**90.88 a**	104.28 a	43.05b-m	54.18 b-g	**67.17 a**
Average	**78.84 a**	**58.64 b**	**60.23 b**	**65.90**	**41.61 a**	**31.97 b**	**34.76 b**	**36.11**

* There is no 5% difference between the averages indicated with the same letter.

Shoot and root dry weight ratios varied between 5.95-27.42 % and 1.37-15.32 % respectively. The highest shoot and root dry weight ratios were in growth media number 6 and growth media number 15. Meanwhile, found the lowest value in growth media 13 and growth media number 12. Baldo variety had the highest shoot dry weight ratio than other varieties but had the lowest root dry weight ratio. Vasco and Tosya Gunesi varieties' shoot dry weight ratio showed the same value and was not significantly different. The highest shoot dry weight ratio in Baldo variety was found in growth media number 14 was 22.47 %, Vasco variety in growth media number 15 was 24.01 %, and Tosya Gunesi variety in growth media number 6 was 27.42 % (Table 7). This shows that study results regarding the shoot and root dry weight ratio variables are the same as those reported by Atılgan and Tolay (2008).

Table 7. The average value of dry above ground part and dry root weight of three paddy varieties in 20 different growth media*

*Çizelge 7. 20 farklı ortamlarda 3 çeltik çeşidine ait gövde ve kök kuru madde oranı ortalama değerleri**

Growth	Above Ground Part Dry Matter (%)				Root Dry Matter (%)			
Medium	Baldo	Vasco	T. Güneşi	Average	Baldo	Vasco	T. Güneşi	Average
1	21.73 bcd	12.76 m-v	9.81 vwx	**14.76 de**	6.57 g-l	4.50 k-s	3.76 m-w	**4.94 g**
2	-	-	-	-	-	-	-	-
3	18.40 d-g	9.44 v-y	5.95 y	**11.27 gh**	4.77 j-o	4.62 j-q	4.90 ı-n	**4.76 gh**
4	18.27 d-h	14.74 g-q	15.82 f-m	**16.27 cd**	7.97 efg	10.87 bc	11.93 b	**10.25 ab**
5	13.80 j-u	14.43 ı-r	15.42 f-o	**14.55 de**	7.21 fgh	12.23 b	8.16 d-g	**9.20 bc**
6	21.36 bcd	15.53 f-n	27.42 a	**21.44 a**	3.53 n-x	3.02 n-x	4.58 j-r	**3.71 hı**
7	10.27 u-x	14.03 j-t	15.65 f-m	**13.32 ef**	7.42 e-h	6.58 g-l	9.57 cde	**7.86 de**
8	12.09 m-v	9.68 v-y	18.02 d-ı	**13.26 ef**	9.19 c-f	6.68 g-j	6.63 g-k	**7.50 ef**
9	9.24 v-y	11.73 o-v	11.79 n-v	**10.92 gh**	5.72 h-m	7.70 e-h	8.02 d-g	**7.15 ef**
10	9.48 v-y	11.84 n-v	14.22 j-s	**11.85 fg**	2.36 s-x	3.29 n-x	4.02 m-v	**3.22 ıj**
11	10.41 t-x	10.81 r-x	12.54 m-v	**11.25 gh**	7.26 fgh	4.68 j-p	8.25 d-g	**6.73 f**
12	7.33 xy	11.19 q-w	12.52 m-v	**10.35 gh**	1.37 y	1.63wxy	2.10 v-y	**1.70 k**
13	11.02 q-x	7.83 wxy	9.73 vwx	**9.53 h**	7.02 ghı	4.40 m-t	4.29 m-u	**5.24 g**
14	22.47 bc	16.52 e-l	15.12 g-p	**18.04 bc**	2.61 o-x	2.46 r-x	2.37 s-x	**2.48 jk**
15	18.07 d-ı	24.01 ab	10.63 s-x	**17.57 bc**	2.59 p-x	15.32 a	15.13 a	**11.01 a**
16	12.26 m-v	13.86 j-u	14.54 h-r	**13.55 ef**	2.56 p-x	2.69 o-x	2.51 q-x	**2.59 jk**
17	16.67 e-k	14.10 j-t	12.86 l-v	**14.54 de**	2.34 t-x	4.45 l-t	2.75 o-x	**3.18 ıj**
18	19.84 cde	18.90 c-f	12.97 k-v	**17.24 c**	2.22 u-x	3.44 n-x	2.35 s-x	**2.67 ıjk**
19	19.69 cde	16.83 e-j	21.32 bcd	**19.28 b**	2.38 s-x	2.95 n-x	3.13 n-x	**2.82 ıj**
20	9.97 vwx	15.00 g-p	11.59 p-v	**12.19 fg**	8.36 d-g	10.17bcd	7.29 fgh	**8.60 cd**
Average	**14.86 a**	**13.85 b**	**14.10 b**	**14.27**	**4.92 b**	**5.88 a**	**5.88 a**	**5.56**

* There is no 5% difference between the averages indicated with the same letter.

There were few studies on the effect of different growing media on seedling quality in paddy production. In this respect, determining the correlations between the studied characters will reveal important information for farmers and researchers. Correlation analysis results showing the relationships between the examined features are given in Table 8. There is a positive and significant relationship between seedling length and root number, stem diameter, aboveground part wet weight, and root wet weight. Positive between leaf number and root length and aboveground part dry matter ratio; The relationship between stem diameter, aboveground part wet weight, and root wet weight is negatively significant. Positive between root length and leaf number; It has been determined that there is an important negative relationship among the aboveground dry matter ratio. A significant positive relationship was found between root number and seedling length, root number, aboveground part wet weight, root wet weight, and aboveground part dry matter ratio, and these results were found in previous studies (Yamamoto et al., 1995; Randriamiharisoa and Uphoff, 2002; Akay et al., 2013). In previous studies (Karakoy et al., 2014; Kumar et al., 2014), a significant positive and negative relationship between seedling stem diameter and seedling length, root number, aboveground wet weight, and rootage weight was determined. There was a positive correlation between the wet weight of the aboveground parts and seedling length, root number, seedling stem diameter, and root wet weight; there is a significant negative relationship with the number of leaves. Inayatullah et al. (1989) also reported a positive and negative relationship between root wet weight and seedling length, root number, seedling stem diameter, aboveground part wet weight, and root dry matter ratio. Also, as Atılgan and Tolay (2008) also reported, the aboveground part is positive between the dry matter ratio and the number of roots and leaves; There is a significant negative relationship with the root dry matter ratio.

Table 8. Correlation coefficients between variable *
*Çizelge 8. Özellikler arasındaki korelasyon katsayıları**

	SL	RL	NL	NR	SBD	AGCW	RAW	AGDW
RL	-0.16							
NL	-0.22	0.33*						
NR	0.58**	-0.22	-0.21					
SBD	0.40**	-0.02	-0.38**	0.60**				
AGCW	0.63**	-0.17	-0.44**	0.59**	0.69**			
RAW	0.48**	-0.08	-0.30*	0.37**	0.48**	0.52**		
AGDW	0.18	-0.40**	0.28*	0.52**	0.08	-0.04	-0.08	
RDM	0.03	-0.02	-0.16	-0.06	0.08	0.15	0.23*	-0.27*

* SL= Seedling Length; RL= Root Length; NL= Number of Leaves; NR= Number of Roots; SBD= Seedling Body Diameter; AGCW= Above Ground Component Wet Weight; RAW= Root Age Weight; AGDW= Above Ground Part Dry Matter; RDM= Root Dry Matter

Biplot analysis helps to define the relationships between the traits of the studied characters in a positive and/or negative way and to identify them in the selection of other traits (Yan and Tinger, 2006). In this research, a biplot chart was created to determine the multiple varying relationships between seedling quality and varieties in 20 different growing environments of 3 paddy varieties (Figure 2).

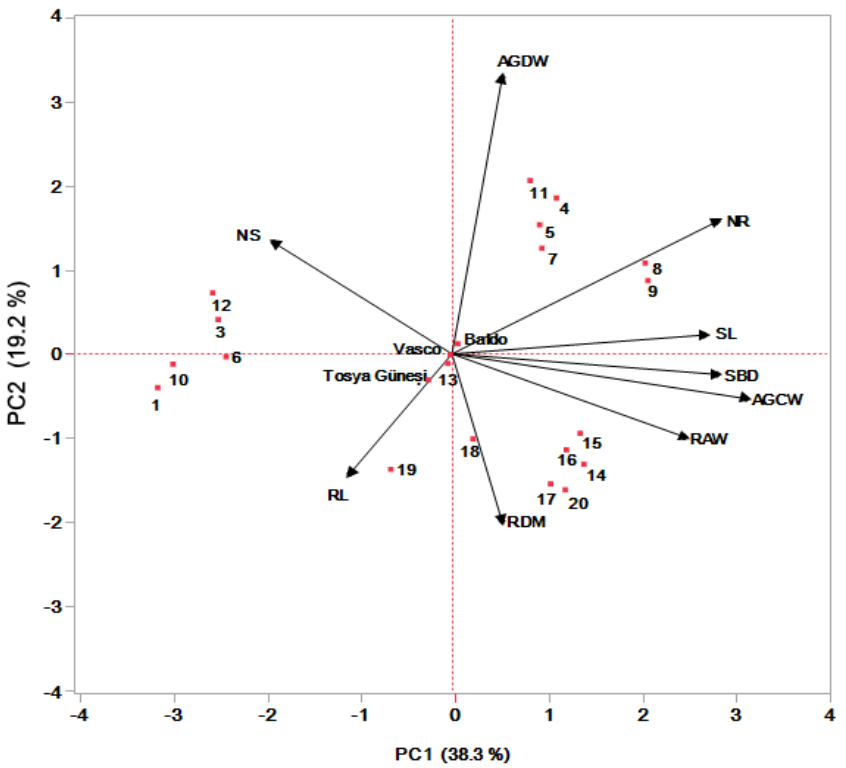

Figure 2. Classification of the variables tested using the biplot analysis method and the relationship between varieties and the variables examined.
Şekil 2. İncelenen özelliklerin biplot analiz yöntemi ile gruplandırılması ve çeşitlerin incelenen özelliklerle ilişkisi.

When the biplot chart was examined, the value of main component 1 was 38.3 % and the value of main component 2 was 19.2 %, and these two components constituted 57.5 % of the total variation. If the angle between the vectors forming the biplot chart is equal to 90˚, it means that the examined character is better than the average, the angle between the vectors is lower than 90˚, and it means that it is close to the average (Yan and Tinker, 2006).

Based on Figure 2, the results of observations on paddy varieties, the variables of seedling length and seedling stem diameter, shoot wet weight, and root wet weight ratio showed a strong positive correlation (<90˚). Similar to the variable root dry weight ratio, shoot dry weight ratio and number of roots, root length and root dry weight, number of leaves and shoot dry weight ratio is also a negative relationship between the variable number of roots and root length, because, in Figure 2 between seedling length, number of leaves and root length, the angle formed is greater than 90˚. Of all the variables observed, the root length has the shortest vector compared to other variables so that it appears as the variable that differentiates the least. The number of roots and shoot dry weight ratio has values above the average in the growth media numbers 4, 5, 7, 8, 9, and 11. Figure 2 shows that several treatments stand out among the other treatments, affecting paddy seedling quality, which is close to the graph's center. It can see that the Vasco variety, growth media numbers 13 and 18 stood out the most among the other treatments because it approached the center of the graph. However, it can also be considered all varieties are observed through their background and the variables that influence them. Meanwhile, in terms of growth media, growth media numbers 13 and 18 show the best performance (Figure 2).

4. Conclusion

The most important part of paddy seedling production is getting good quality and healthy seedlings. For seedlings to be used with a transplanting machine, seedling length, stem diameter, and root density (number of roots and root length) are important parameters that must be considered. Although there are statistical differences between the varieties studied, we can see that good seedling quality has the same results in all observed variables. So that in the study of seedling with growth media with the use of different varieties at this time will cause a loss of energy and time efficiency. Based on this study, the root length variable emerged as the most prominent parameter representing seedling quality. When evaluating the use of 20 growth media from different materials based on ecology and economics, the best quality of seedlings is found in growth media number 13. Besides, growth media numbers 18 and 19 can be used as alternative seedling media.

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