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Effects of Vermicompost on Some Germination Parameters in Paddy (*Oryza sativa* L.)

Gözde Hafize YILDIRIM ^{1*}, Nuri YILMAZ ¹

¹ Ordu University, Department of Field Crops, Faculty of Agriculture, Ordu, 52000, Türkiye.

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Abstract

This research was carried out in Ordu University Faculty of Agriculture Laboratory in 2020. Planting of rice by seedling method is a widely used method. In this method where stronger seedlings are generally preferred, it is desired that the seeds should be of good quality, healthy and have strong germination ability. In this context, it was aimed to determine the effects of five different vermicompost applications on some germination characteristics of three different paddy varieties. In this study, five different doses of soil-applied vermicompost (0-2-4-6-8 ml liquid manure/100 ml water) and three different paddy varieties (Aslı, Osmançık 97 and Baldo) were used. The study was conducted in glass petri dishes under laboratory conditions. The experiment was established according to the factorial experimental design in randomized plots with 3 replications. In the study, germination rate (strength) was 88-100%, average germination time was 3.15-3.96 days, germination index was 4.00%-4.55%, shoot length was 43.24-62.42 mm, root length was 64.62-85.03 mm, shoot wet weight was 4.16-5.27 mg, shoot dry weight was 0.03-0.04 mg, root wet weight was 4.00-5.79 mg and root dry weight was 0.03-0.04 mg. The effects of cultivars on germination rate, germination time and germination index were statistically significant. On the other hand, the effect of vermicompost doses on average germination time and shoot length was statistically significant.

Keywords: Paddy, Vermicompost, Pre-germination.

Vermikompostun Çeltik (Oryza Sativa L.)’De Bazı Çimlenme Parametrelerine Etkileri

Özet

Bu araştırma, 2020 yılında, Ordu Üniversitesi Ziraat Fakültesi Laboratuvarında kurulmuştur. Çeltiğin fideleme yöntemiyle dikimi yaygın olarak kullanılan bir yöntemdir. Genellikle daha güçlü fidelerin tercih edildiği bu yöntemde, tohumların kaliteli, sağlıklı ve güçlü çimlenme yeteneğine sahip olması istenmektedir. Bu bağlamda, beş farklı solucan gübresi uygulamasının, üç farklı çeltik çeşidinde, bazı çimlenme özellikleri üzerine etkilerinin belirlenmesi amaçlanmıştır. Bu çalışmada, topraktan uygulanan solucan gübresinin, beş farklı dozu (0-2-4-6-8 ml sıvı gübre/100 ml su) ve üç farklı çeltik çeşidi (Aslı, Osmancık 97 ve Terme Baldo) kullanılmıştır. Çalışma laboratuvar koşullarında cam petri kaplarında yapılmıştır. Deneme tesadüf parsellerinde faktöriyel deneme desenine göre 3 tekerrürlü olarak kurulmuştur. Çalışmada, çimlenme oranı (gücü) % 88-100, ortalama çimlenme süresi 3,96-3,15 gün; çimlenme indeksi %4,55-%4,00; sürgün uzunluğu 62,42-43,24 mm; kök uzunluğu 85.03-64.62 mm; sürgün yaş ağırlığı 5.27-4.16 mg; sürgün kuru ağırlığı 0.04-0.03 mg; kök yaş ağırlığı ise 5.79-4.00 mg ve kök kuru ağırlığı 0.04-0.03 mg olarak tespit edilmiştir. Çeşitlerin, çimlenme oranı, çimlenme süresi ve çimlenme indeksine etkisi istatistiksel olarak önemli çıkmıştır. Öte yandan Vermikompost dozlarının ise ortalama çimlenme süresi ve sürgün uzunluğuna etkisi istatistiksel olarak önemli bulunmuştur.

Anahtar Kelimeler: Çeltik, Solucan Gübresi, Ön Çimlendirme.

1. Introduction

The paddy plant is the only cereal that can germinate in a moist environment without spoiling and can take up oxygen dissolved in water through its roots (Yazlık et al., 2020). 90% of the world's paddy is produced and consumed in Asian countries (Unan et al., 2020). In Turkey, paddy cultivation area increased from 994,000 decares in 2011 to 16,205,593 decares in 2019 (URL-2, 2023). World paddy production amounted to 504.17 million tons in 2019 (URL-1, 2023).

Turkey ranks 37th in the world with 900 thousand tons of paddy production and 5th in the world thanks to its high yield per unit area. The preference and development of high-yielding varieties is shown as the reason for this yield increase (Naneli et al., 2020).

Rice is a very important food for countries with high population density. (Balasubramanian, 2019). Increasing population growth also increases the need for crop productivity. Therefore, it is now recommended to use more biological agents (such as earthworms, etc.) to overcome the negative environmental impact of increased agricultural practices (Singh et al., 2020). In this way, it may be possible to protect the soil in agricultural areas (Kumar & Balusamy, 2017). One of the most important stages in plant production is sowing the seed and germinating it under suitable conditions (Tüfekçi et al., 2017).

It is stated that the ideal temperature for germination of paddy is between 18°-35°C. Temperatures of 12°-15°C constitute the minimum limit for germination (Taşlıgil and Şahin, 2011). On the other hand, fertilization takes the most important share of the products used to obtain a quality

seedling and ensure production (Kant et al., 2006). Many types of fertilizers, both chemical and organic, are already used in agriculture. However, due to the environmental pollution caused by chemical substances and the endangerment of food safety, sustainable agricultural systems are attracting more attention worldwide in terms of soil and environmental pollution. For this reason, it is necessary to make a rapid transition to sustainable agriculture by utilizing vermiculture biotechnology in soil. Vermicomposting technology is also a good example for decomposing organic nutrients and maintaining soil fertility (Khobragade et al., 2017).

The overall growth and development of various plants is also related to the activity of rhizospheric microorganisms in the soil. A significant positive response in growth parameters has also been observed by inoculating some bacteria in the soil in the presence of vermicompost (Varma et al., 2017). For these reasons, the aim of this study was to determine and put into practice how vermicompost affects some germination values in paddy and at which doses these effects give better results.

2. Material and Method

This research was carried out in Ordu University Faculty of Agriculture Laboratory in 2020. In this study, 5 different vermicompost doses (0.5% ml; 1% ml; 2% ml; 3% ml) and 3 different paddy (*Oryza sativa* L.) varieties (Osmancık-97; Aslı; Baldo) were used. In the study, vermicompost in the soil-applied liquid content had 2-4% organic matter, 2-4% total (Humic + Fulvic) acid, 0.4-1.8 organic nitrogen, 6.5-7.7 pH and 4-7 EC values. The research was conducted in glass petri dishes. The experiment was planned according to the factorial trial design in randomized plots with 3 replications.



Figures 1. Differences in seed (a: Osmancık-97; b: Aslı; c: Baldo) (URL-3, 2023)

2.1. Germination Method

The seeds subjected to the treatments were placed in sterilized glass petri dishes on filter paper moistened with 13 ml of liquid solution with the help of pliers (50 seeds/petri dishes). The seed sowing was completed and the closed petri dishes were placed in an oven with a temperature of 20 ± 5 °C and seed germination trials were started under dark conditions. (The use of 13 ml of water for 50 paddy seeds was predetermined according to the preliminary germination study). For germination, radicle which has emerged out of testa for 2 mm was taken as a basis. The seeds were counted every day at the same time. Parameters such as germination rate (Power) (%), average germination time (days), germination index (%), shoot length (mm), root length (mm), stem wet weight (mg.), root wet weight (mg.), stem dry weight (mg.) and root dry weight (mg.) were evaluated.

2.2. Germination rate (Power) (%): At the end of the 10th day, germinated seeds were counted and germination rate was calculated as % with the formula (number of germinated seeds/total number of seeds) x 100 (Akıncı and Çalışkan, 2010).

$$G. R. (\%) = \frac{\text{Number of Total Germinated Seeds}}{\text{Total Number of Seeds Tested}} \times 100$$

2.3. Mean germination time (days): Average germination time was calculated as the sum of the product of the number of germinated seeds (f) and the number of germination days (x) divided by the total number of germinated seeds (Ellis and Roberts, 1980).

$$M. G. T. (day) = \frac{\sum(fx)}{\sum f}$$

2.4. Germination index: The ability of the seed to germinate quickly is called "germination rate" (Widajati 2013).

Gr: germination rate

Nt: normally germinated seed (%)

Dc: Days count

n: Indicates the last counting day.

$$G. I. = \sum_{t=1}^n \frac{Nt}{Dt} = \frac{N1}{D1} + \frac{N2}{D2} + \dots + \frac{Nn}{Dn}$$

2.5. Shoot and root length (mm): Shoot and root length were determined by measuring with a millimetric ruler. At the end of the experiment, the stem length of 10 randomly selected plants was measured with a millimetric ruler (Yılmaz and Kısakürek 2021).

2.6. Shoot and root fresh weight (mg.): The green parts of randomly selected plants (5 plants) from each group were separated and their fresh weights were weighed in mg with a precision balance (Yıldız and Özgen, 2004).

2.7. Shoot and root dry weight (mg.): The roots were dried in a circulating oven at 70°C until they reached constant weight and then weighed on a precision balance to determine their dry weight (mg plant⁻¹) (Yılmaz and Kısakürek 2021).

2.8. Statistical Analysis

Statistical analyses were performed in JMP13 program, analysis of variance was performed with ANOVA test and multiple comparisons were performed with Tukey test.

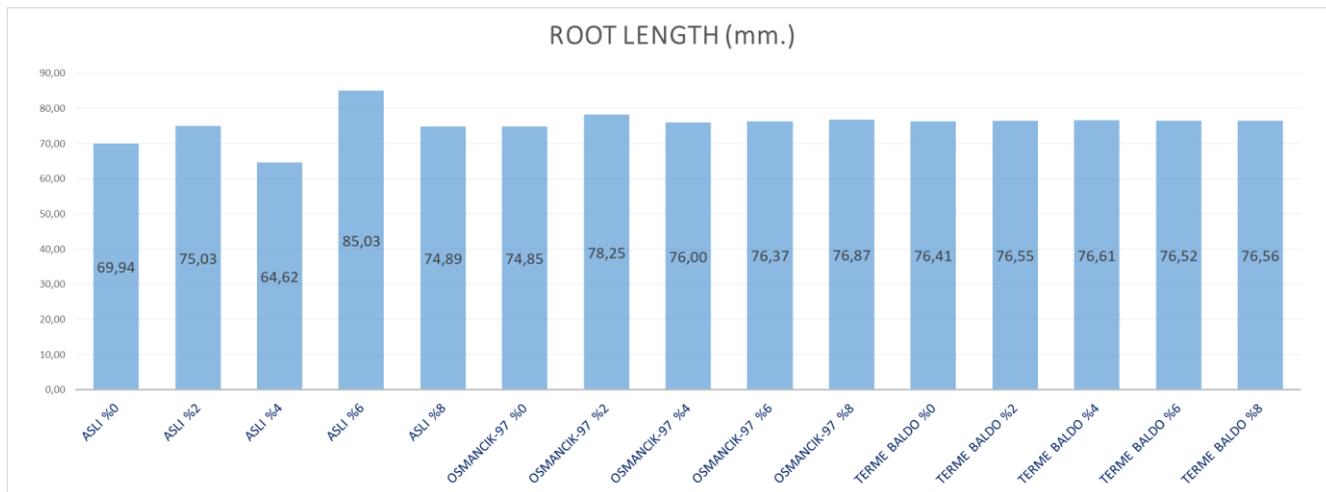
3. Results and Discussion

The results of the effects of 5 different vermicompost doses (0.5% ml; 1% ml; 2% ml; 3% ml) on some germination parameters of 3 different rice (*Oryza sativa* L.) varieties (Osmancık-97; Aslı; Baldo) are given in Table 1-2 and the graphs of the comparison of the effects are given in Figures 2 to 4.

Table 1. Effect of varieties, doses on germination parameters

Varieties	G.R.	M.G.T.	G.I.	S.L.	R.L.	S.D.W.	R.D.W.	S.W.W.	R.W.W.
	**	**	**	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
<i>Aslı</i>	99.07 ^a	3.43 ^b	4.49 ^a	51.52	74.32	0.03	0.03	4.83	4.73
<i>Osmancık 97</i>	97.67 ^a	3.22 ^c	4.44 ^a	52.83	74.55	0.03	0.03	4.80	4.77
<i>Baldo</i>	90.53 ^b	3.89 ^a	4.11 ^b	51.73	74.70	0.03	0.03	4.76	4.66
Doz	n.s.	*	n.s.	*	n.s.	n.s.	n.s.	n.s.	n.s.
0	97.11	3.48 ^{ab}	4.29	57.83 ^a	72.80	0.03	0.03	4.99	5.14
2%	96.33	3.46 ^{ab}	4.41	53.62 ^{ab}	74.57	0.03	0.03	4.96	5.09
4%	95.56	3.42 ^b	4.33	48.69 ^b	71.23	0.03	0.03	4.62	4.63
6%	95.33	3.58 ^{ab}	4.32	50.91 ^{ab}	78.15	0.03	0.03	4.86	4.39
8%	94.44	3.61 ^a	4.38	49.08 ^b	75.89	0.03	0.03	4.56	4.34
CV (%)	0.03	0.04	1.00	0.12	0.09	0.17	0.32	0.08	0.15

(**p<0.01, *p<0.05, n.s.: not significant). **G.R.:** Germination rate (Power) (%); **M.G.T.:** Mean germination time (days); **G.I.:** Germination index; **S.L.:** Shoot length (mm); **R.L.:** Root length (mm); **S.F.W.:** Shoot fresh weight (mg.); **R.F.W.:** Root fresh weight (mg.); **S.D.W.:** Shoot dry weight (mg), **R.D.W.:** Root dry weight (mg). **CV (%):** Coefficient of mass variation



Figures 2. Effect of interactions on root length (mm)

Table 2. Effect of varieties, interactions on germination parameters

Variety * Dose Interaction	G.R.	M.G.T.	G.I.	S.L.	R.L.	S.D.W.	R.D.W.	S.W.W.	R.W.W.
	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Asli,0%	99,33	3,28	4,52	62,42	69,94	0,04	0,03	5,27	5,49
Asli,2%	98,67	3,41	4,48	56,62	75,03	0,03	0,03	5,26	5,79
Asli,4%	98,00	3,36	4,45	43,24	64,62	0,03	0,02	4,33	4,53
Asli,6%	99,33	3,46	4,45	50,97	85,03	0,04	0,04	5,12	4,00
Asli,8%	100,00	3,64	4,55	44,36	76,98	0,04	0,04	4,16	3,82
Osmancik-97,0%	96,00	3,20	4,36	58,95	73,74	0,03	0,03	4,95	5,25
Osmancik-97,2%	99,33	3,17	4,52	52,50	74,19	0,03	0,03	4,85	4,82
Osmancik-97,4%	98,00	3,15	4,45	51,00	74,41	0,03	0,03	4,76	4,67
Osmancik-97,6%	98,00	3,33	4,45	50,35	74,63	0,03	0,03	4,71	4,55
Osmancik-97,8%	97,00	3,23	4,41	51,36	75,81	0,03	0,03	4,76	4,56
Baldo,0	88,00	3,96	4,00	52,13	74,71	0,03	0,03	4,76	4,68
Baldo,2%	93,33	3,79	4,24	51,75	74,48	0,03	0,03	4,76	4,67
Baldo,4%	90,00	3,76	4,09	51,84	74,67	0,03	0,03	4,77	4,68
Baldo,6%	89,33	3,96	4,06	51,40	74,79	0,03	0,03	4,75	4,63
Baldo,8%	92,00	3,95	4,18	51,53	74,87	0,03	0,03	4,75	4,63
CV (%)	0,03	0,04	1,00	0,12	0,09	0,17	0,32	0,08	0,15

(**p<0.01, *p<0.05, n.s.: not significant). **G.R.:** Germination rate (Power) (%); **M.G.T.:** Mean germination time (days); **G.I.:** Germination index; **S.L.:** Shoot length (mm); **R.L.:** Root length (mm); **S.F.W.:** Shoot fresh weight (mg.); **R.F.W.:** Root fresh weight (mg.); **S.D.W.:** Shoot dry weight (mg), **R.D.W.:** Root dry weight (mg). **CV (%)**: Coefficient of mass variation



Figures 3. Effect of interactions on shoot length (mm)

As can be seen from the table-1 and figures, germination rates were determined between 88.00%-100.00%. The effect of paddy varieties on germination rate was found to be statistically very significant. Germination rate of the varieties varied between 90.53%-99.07%. The highest germination rate was determined from Aslı variety, followed by Osmancık-97 and Baldo. Aslı and Osmancık-97 varieties were in the same statistical group.

The effect of vermicompost doses and variety*vermicompost dose interaction on germination rate was not statistically significant. Germination rates of different paddy cultivars were generally determined as; Ruttanaruangboworn et al., (2017), 93.25-97.38%; Chatchavanthatri et al., (2020); 96-98%; Billah et al., (2021); 89.75%. The difference in varietal trait between seeds can only be recognized if the germination environment provides optimum physical conditions and is equal in all seeds. In this study, the variety trait had different values in terms of germination rate (Table-2).

In terms of germination time; statistically very significant differences between paddy varieties and significant differences between vermicompost doses were found. The average germination time of the varieties differentiated between 3.22-3.89 days. The shortest germination time was obtained from Osmancık-97 variety and the longest germination time was obtained from Baldo variety. The effect of vermicompost doses on germination times varied between 3.42-3.61 days and the shortest germination time was obtained from 4% vermicompost dose application and the longest germination time was obtained from 8% vermicompost dose (Table: 1, Figure: 1). The vermicompost dose application which decreased the germination time the most was 4% dose, and the doses more than 4% increased the germination time. It is not desirable to prolong the germination time in plants. Likewise, if the germination time is prolonged, the seed can be negatively affected by many

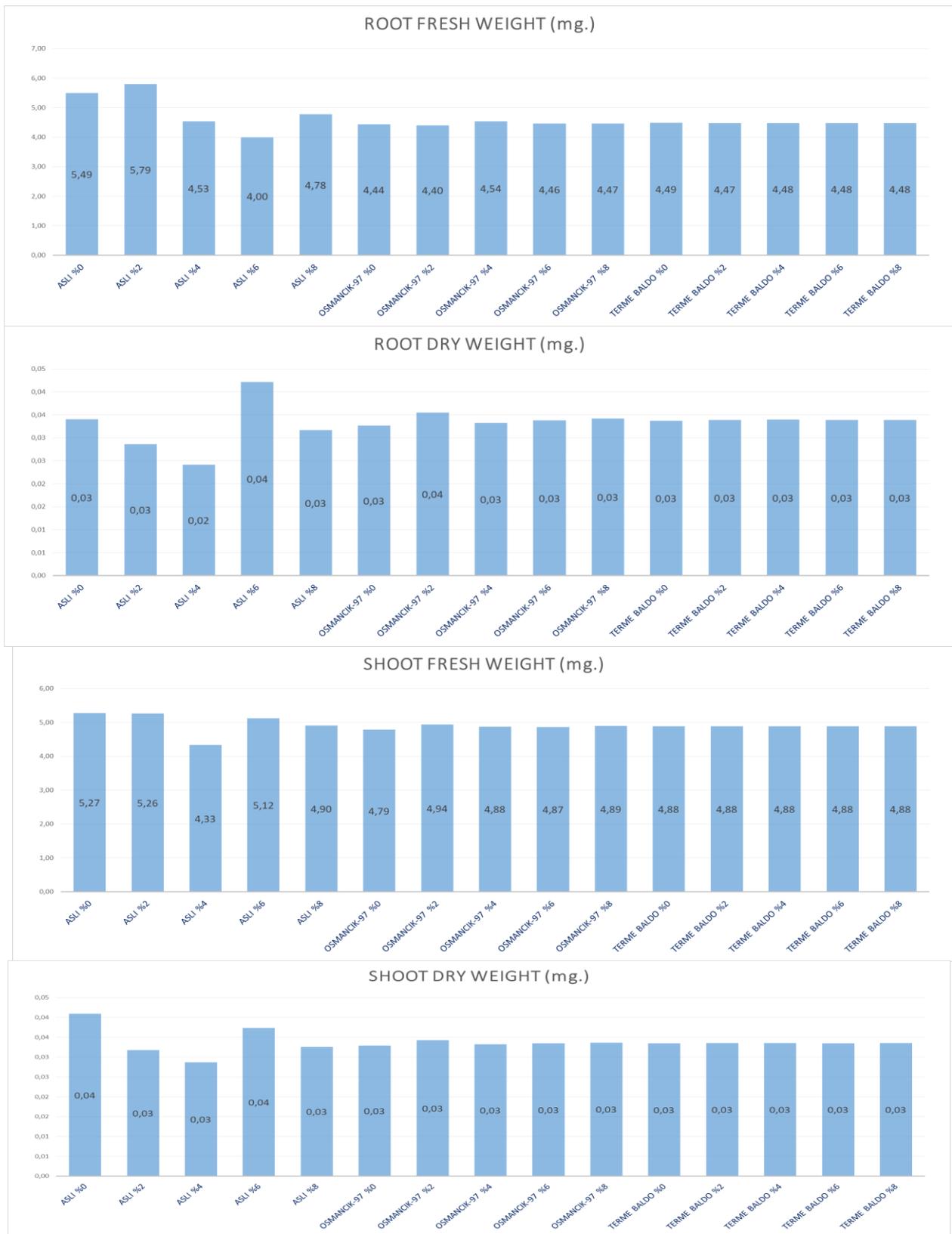
environmental conditions. This decreases the germination rate. For this reason, Osmancık-97 variety and 4% vermicompost dose application seems to be more advantageous in terms of germination time. In some studies, the effect of vermicompost applications on germination time was found to be significant similar to our findings and it was determined that vermicompost application decreased the germination time (Dhanalakshmi et al. 2014; Başay et al., 2019).

As can be seen in Table: 1 and Figure: 1, germination index values were determined between 4.00%-4.55%. The effect of paddy varieties on germination index was found to be statistically very significant. Germination index of the varieties differentiated between 4.11%-4.49%. The highest germination index was determined from Aslı variety, followed by Osmancık-97 and Baldo. Aslı and Osmancık-97 varieties were in the same statistical group. The effect of vermicompost doses and cultivar*vermicompost dose interaction on germination index was not statistically significant. Related to the subject, Kaya et al. (2020) reported that vermicompost increased the germination index on plants belonging to different species in their studies, which is different from our findings. It is believed that this is due to the cultural differences applied in the trials.

The effect of experimental factors on shoot length was found to be significant in vermicompost treatments and insignificant in cultivars and cultivar*vermicompost doses. The effect of vermicompost doses on shoot length varied between 48.69-57.83 mm. The longest shoot length was obtained from plots without vermicomposting and the shortest shoot length was obtained from plots with 4% vermicomposting. Vermicompost application of doses up to 4% shortened shoot elongation while the doses after 4% increased it compared to controlled plots (Table: 1 and Figure: 1). Najar and Khan (2013) reported that vermicompost applied at different doses (2t/ha, 4t/ha and 6t/ha) had significant effects on vegetative growth parameters (shoot length, root length, leaf area, shoot dry weight, root dry weight and leaf dry weight) in tomato cultivation. In a study on strawberry, plant growth and yield characteristics of different fertilizer and vermicompost applications in the upper 10 cm depth of the soil in strawberry were examined, and it was reported that a significant increase in growth and yield was observed, 37% increase in plant shoot biomass and 36% increase in stolon ratio was observed (Yaviç, 2019). In a study conducted by Arancon et al. (2003); vermicompost application was made on tomato, pepper and strawberry. According to the results of the study, vermicompost increased shoot length and leaf area in tomato and pepper (Abacıoğlu et al., 2020). These results similarly support the results obtained in our study.



Figures 4. Effect of interactions on germination rate, germination index and average germination time



Figures 5. Effect of interactions on shoot-root dry weight (mg.) and shoot-root fresh weight (mg)

The effects of paddy varieties, vermicompost treatments and variety*vermicompost dose interaction on root length, shoot wet weight, root wet weight, shoot dry weight, and root dry weight were not statistically significant (Table-2). According to the results obtained from our study, shoot wet weight was 4.16-5.27 mg, shoot dry weight was 0.03-0.04 mg, root wet weight was 4.00-5.79 mg, root dry weight was 0.03-0.04 mg and root length was 64.62-85.03 mm. Erşahin et al. (2017) investigated the effect of vermicompost and cattle manure obtained from kitchen waste on seedling growth of tomato plants. Vermicompost rates were determined as 0%, 10%, 20%, 30%. They stated that high pH and EC values of vermicompost negatively affected the growth parameters of the plant such as root length, number of leaves and shoot diameter. Therefore, the researchers stated that the feeding stock of the worm should be determined well in vermicompost production and the best dose for plant growth was 20%. These results are compatible with our study. Yılmaz et al. (2017) investigated the effect of tomato seedlings grown in different growing mediums on yield and quality. In the study, they prepared different media with vermicompost, zeolite, peat and their different ratios. In the study, parameters such as seed germination percentage, seedling height, seedling stem diameter, shoot fresh weight, root length, root weight and plant nutrient content (N, P, K, Ca, Mg, Fe, Zn, Mn and Cu) were determined. In the experiment, it was determined that M5 medium (peat 65% + zeolite 15% + vermicompost 20%) gave the best results in the parameters of germination percentage, root length, seedling height, seedling fresh weight and root weight of tomato seedlings (Benek 2022). Considering the fresh and dry weight results we found, it was not found to be compatible with our study.

4. Conclusion and Recommendations

This study was carried out to determine the effects of different concentrations of vermicompost applied through soil on some germination characteristics of three different paddy varieties. According to the results obtained from the study; statistically very significant differences were obtained between the paddy varieties used in the experiment in terms of germination rate, germination time and germination index. There were no significant differences between the varieties in terms of the other parameters examined.

Vermicompost doses had statistically significant effects on germination time and shoot length. Vermicompost application of doses up to 4% decreased the germination time, while the doses higher than 4% increased the germination time. On the other hand, vermicompost application of does up to

4% shortened shoot elongation while doses more than that increased it compared to controlled plots. The effect of vermicompost treatments on other parameters examined was not significant.

In conclusion, soil applied vermicompost partially affects germination parameters in paddy varieties. The effects of soil applied vermicompost on different paddy varieties are quite different from each other. In addition, it is recommended that new studies should be established with varying doses and fertilizer content with different ratios in accordance with the variety characteristics. Considering the damages caused by many chemicals used today to both nature and living tissues, this and similar studies are considered to be promising.

Contribution of the Authors

Both authors contributed equally to the study.

Conflict of Interest Statement

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

In the study, research and publication ethics were complied with.

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