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The Effect of Water Retaining Polymer Applications on Agricultural Characteristics of Hemp (*Cannabis sativa* L.)

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HIGHLIGHTS

- Hemp is a plant that can make significant contributions to the development of our country. Today, various parts of hemp such as leaves, flowers, seeds, stems, fibers and roots are used in different fields of industry.
- Water-retaining polymers contribute to the growth and development of plants in water-scarce regions due to their high water retention capacity.
- The study found that water-retaining polymer doses did not have a statistically significant effect on the examined characteristics of hemp.

Abstract

Hemp (*Cannabis sativa* L.) is a plant that usage areas and importance have increased rapidly in recent years in the world and in Turkey. This study investigated the effects of water-retaining polymers on yield and quality characteristics of hemp cultivation in Yozgat ecological conditions. Narlısaray population and Vezir variety, which are local dioecious genotypes of Turkey, were used. The experiment was established with Split Plots Experimental Design in Coincidence Blocks with three replications. Varieties were applied in the main plots, and water-retaining polymer doses (0, 2.5, 5, 7.5, 10, 12.5 kg da^{-1}) were used in the sub-plots. According to the results obtained, the measurements were as follows: plant height 194.11-224.11 cm, stem diameter 9.70- 10.66 mm, dry stem yield 1720.55 - 2181.11 kg da^{-1}, fiber yield 338.88 - 480.00 kg da^{-1}, seed yield 200.55 - 272.77 kg da^{-1} and oil content 29.20 - 31.44% in Narlısaray population. In the Vezir variety, plant height ranged between 200.16- 214.03 cm, stem diameter between 8.76 - 9.89 mm, dry stem yield between 1688.88 - 1949.88 kg da^{-1}, fiber yield between 333.33 - 412.77 kg da^{-1}, seed yield between 228.88 - 271.66 kg da^{-1} and oil content between 29.59 - 32.07%. As a result, there was no statistically significant effect of water retaining polymer doses on the examined traits of hemp plants. Still, significant differences were observed among the varieties regarding these traits.

Keywords: Fiber, hemp, seed, yield, water-retaining polymer, quality

1. Introduction

Hemp (*Cannabis sativa* L.) is an annual plant belonging to the *Cannabinaceae* family, originating from Central Asia, with different species. Among these species, *C. sativa* L. is mostly used for its fiber and seeds with thin leaves and low medicinal use. *C. indica* L. is a species with broader leaves mostly used for medicinal purposes.

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On the other hand, *C. ruderalis* L. is a wild species with thinner leaves and shorter stature compared to other species (Yılmaz and Yazıcı 2022).

The hemp plant has been cultivated throughout history for its fiber, medicinal applications, and seeds. Archaeological studies have revealed that fiber remains of hemp dating back to 10,000 BC. The wild species were used first, and cultivation has been practiced for at least 5,000-6,000 years (Schultes and Hofmann 1980; Fleming and Clarke 1998; Yazıcı and Yılmaz 2021).

Today, various parts of hemp, such as leaves, flowers, seeds, stems, fibers, and roots, are used in different fields of industry. Hemp leaves and flowers are used in cosmetic products such as medicine, skin, and hair care; fibers are used in textile products, paper production, home textiles, construction, plastics, and packaging materials. The seeds are used especially in food products such as pasta, cakes, biscuits and bread, and the remaining meal after the oil is extracted from the seed can be used in animal feeding and some rations (Gül 2008; Townshend and Boleyn 2010; Baldini et al. 2018; Yazıcı and Yılmaz 2021).

Hemp seeds contain essential fatty acids, linoleic acid (omega 6) and alpha-linolenic acid (omega 3). The importance of 3-6% alpha-linolenic acid in hemp oil is increasing in nutrition, cosmetics, and biomedical fields. Since the human body cannot synthesize these essential fatty acids, they must be taken through food. It is reported to provide health benefits such as cardiovascular diseases, diabetes, resistance to inflammation, night vision, and embryo brain and eye development during pregnancy (Smith 2000; Ozgul et al. 2005).

Worldwide hemp cultivation increased to 1 million hectares in the 1950s and then steadily declined. Between 2015 and 2020, the average hemp cultivation area for fiber purposes was reported to be 40-45 thousand hectares and 30-35 thousand hectares for seed purposes (Anonymous 2021). In Turkey, according to TUIK data, 15.66 tons of industrial hemp fiber production was made on an average area of 175 decares between 2017 and 2022, and the yield was calculated as 111.5 kg/decare. In the same period, 79.33 tons of industrial hemp seed production was realized on an average area of 1191 decares, and the yield was 56.5 kg/decare. In 2022, the highest fiber hemp production in Turkey was performed in Samsun (188 decares), Sakarya (100 decares), Sivas (47 decares), Sinop (15 decares), Burdur (9 decares), Tokat (4 decares) and Uşak (2 decares) respectively. The highest cultivation area and the production for seed purposes were in Amasya (1001 decares, 82 tons) and Kastamonu (817 decares, 66 tons) (Anonymous 2023).

In Turkey, the laws and regulations regulate permits for hemp cultivation, the determination of the provinces, permitted districts, and the procedures to be applied in hemp cultivation. Legislation on hemp includes Law No. 2313 on the Control of Narcotic Substances, the Regulations on the Cultivation and Control of Hemp issued in 1990 and 2016, and Law No. 32154 dated April 5, 2023, on the Forest Law and Certain Laws Amendment. Hemp cultivation for producing fiber, seeds, stalks, and medicines is subject to permission from the Ministry of Agriculture and Forestry.

Hemp production for stalk, fiber, and seed purposes has never been banned in Turkey; this issue has no law or regulation. However, its production can be carried out in a controlled and permitted manner. Currently, authorized hemp cultivation can be carried out in 21 provinces in our country. The permitted provinces are Amasya, Antalya, Bartın, Burdur, Çorum, İzmir, Karabük, Kastamonu, Kayseri, Kütahya, Konya, Malatya, Ordu, Rize, Samsun, Sinop, Sivas, Tokat, Uşak, Yozgat and Zonguldak (Yilmaz and Yazici 2022).

Hemp is a plant that can make significant contributions to the development of our country, and its importance and use have been increasing rapidly both in the world and Turkey in recent years. Hemp-based products have the potential to increase industry and employment, especially in agriculture, by being used in many sectors such as food, feed, cosmetics, health support, construction, energy, and textiles (Yazıcı and Yılmaz, 2021). In the field of agriculture, hemp has an important place, especially in removing weeds from the fields, and it is used as an effective pre-plant in rotation systems, leaving a cleared field for the following crop (Atakisi 1999).

Global warming and climate change negatively impact the environment and agriculture, and water shortage is one of the most critical problems. Lack of sufficient water negatively affects the yield and quality characteristics of the plant. The sustainability of water resources and the increasing demand for limited water resources are among the most critical problems. Considering that 74% of the total water in Turkey is used in the agricultural sector, water saving comes to the forefront in agrarian production (Mirze and Yazici 2023).

Various applications are made to increase the water retention capacity of the soil. Water-retaining polymers are one of these applications, and they contribute to the growth and development of plants in water-scarce regions due to their high water retention capacity (Johnson and Piper 1997; Lobo et al. 2006).

This study aims to determine the effects of different water-retaining polymer doses (0 kg da^{-1}, 2.5 kg da^{-1}, 5 kg da^{-1}, 7.5 kg da^{-1}, 10 kg da^{-1}, 12.5 kg da^{-1}) on fiber and seed yield, some yield components and quality of local hemp genotypes (Narlısaray population and Vezir variety) under Yozgat ecological conditions. Detailed studies on hemp and water-retaining polymers in the agricultural field are limited. This study aims to obtain information about water-retaining polymers, facilitate their use in plant production, popularize them in the hemp sector, test the effectiveness of water-retaining polymers applied at different doses, and transfer the information to farmers.

2. Materials and Methods

2.1. Material

In the experiment, the local hemp genotype Narlısaray population and Vezir variety were supplied by Yozgat Bozok University Hemp Research Institute and used as materials. Narlısaray population is a local hemp genotype from the Vezirköprü district of Samsun province. It is a genotype with a dioecious flower structure, is tall, is suitable for fiber and seed use, and its thousand seed weights range between 17.5 and 18 g. Vezir variety is a variety bred by the Black Sea Agricultural Research Institute; leaf green color intensity; medium, cotyledon shape; narrow, central leaflet length; medium, anthocyanin intensity in male flowers; weak and THC content was observed as very low or absent. The thousand seed weight of the variety is 17.4 grams.

In the study, a water-retaining polymer consisting of organic materials to which a certain amount of straw was added and used. The general purpose of combining the water-retaining polymer with straw is to increase the water retention capacity as much as possible. The water-retaining polymer contains different ratios of Oxygen (O), Hydrogen (H), Carbon (C), Potassium (K) and minerals such as 65-75% cellulose, 15-20% pentazones and hemicellulose, 5-10% lignin, 1-3% protein and wax, 2-10% silica in the straw composition (Yakupoğlu et al., 2019).

2.2. Climate characteristics of the experimental site

Climatic data for 2022 and many years (1929-2022) are presented in Table 1. When Table 1 is examined, the long-term average precipitation for the vegetation period in Yozgat province was 571 mm. In the year when the study started, the average rainfall was calculated as 507.8 mm. In the vegetation period 2022, 63.2 mm less precipitation was realized compared to the long-term average.

The long-term (1929-2021) average temperature in Yozgat province was 9.3 °C. In the growing period of 2022, when the experiment was conducted, the average temperature was 9.5 °C. This data was 0.2 °C higher than the long-term average. The long-term average relative humidity in Yozgat province was 66.2% and 64.2% in the 2022 vegetation period.

2.3. Soil characteristics of the experimental site

The soil properties of the field where the experiment was conducted are shown in Table 2. Amasya Central Research and Application Laboratory analyzed soil samples taken from three different locations and 30 cm depth of the soil. When the soil properties of the experimental area were analyzed, it was observed that it had clay loamy-loamy soil, neutral pH level, low organic matter content, medium salty, slightly calcareous, and very low nitrogen and phosphorus content.

Table 1. Total Precipitation (mm), Average Temperature (°C), and Average Relative Humidity (%) of Yozgat province for many years (1929-2021) and the year of the experiment (2022)

Months	Total Precipitation (mm)		Average Temperature (°C)		Average Relative Moisture (%)	
	2022	Long Years (1929-2021)	2022	Long Years (1929-2021)	2022	Long Years (1929-2021)
January	121.1	68.6	-2.4	-1.7	76.6	77.6
February	48.8	59.7	0.2	0,6	77.1	75.3
Mart	83.3	68.4	-1.5	3.0	73.9	70.9
April	16.4	57.8	11.6	8.5	47.4	64.9
May	50.2	66.1	12.4	13.1	60.2	63.5
June	98.9	45.7	17.5	16.7	64.3	60.7
July	1.2	12.6	18.3	19.6	57.9	56.0
August	7.3	11.4	22.9	19.8	50.9	54.7
September	9.2	18.3	17.4	15.9	48.8	57.1
October	13.9	33.3	10.6	10.8	69.0	64.2
November	23.8	53.4	7.0	5.1	69.5	71.9
December	33.7	75.7	0.8	0.6	75.1	77.7
Tot./Middle.	507.8	571.0	9.5	9.3	64.2	66.2

Table 2. Some chemical and physical properties of the soil in the year the experiment was conducted.

Characteristics	Results	Meaning
Saturation (%)	71.5	Clay loam
pH	7.24	Neutral
Nitrogen kg da^{-1}	2,20	Very Little
Salt (μ^s/cm)	758	No Salt
Lime (%)	0,39	Less Calcareous
Useful Potassium (kg da^{-1})	59.43	Less
Useful Phosphorus (kg da^{-1})	4.14	Very little
Organic Matter (%)	1.24	Less

2.4. Method

The experiment was carried out in the experimental field of Yozgat Bozok University Campus Agricultural Research and Application Center in the vegetation period of 2022. The study was established according to the split-plot experimental design in randomized blocks with three replications as varieties in main plots and water-retaining polymer doses (Control, 2.5 kg da^{-1}, 5 kg da^{-1}, 7.5 kg da^{-1}, 10 kg da^{-1}, 12.5 kg da^{-1}) in sub-plots, totaling 36 sub-plots. Water-retaining polymers were applied to the seedbed during sowing by hand, right next to the seed. Each plot consisted of 6 rows with a row spacing of 20 cm and a length of 5 m. The sowing norm was set at 150 seeds/m². Harvesting was carried out on 20.10.2022, the whole maturity period of the seeds, by cutting the plant from the root collar area with pruning shears. After the harvested plants were left to dry naturally for a certain period (25-30 days), the green parts of the plants were manually removed from the stems. Then, the plant stems were stripped of fiber on 20.12.2022 using the fiber stripping machine (decortication) at Yozgat Hemp Research Institute. The seed blend was made on 17.01.2023 by sieving the seeds from the green parts removed from the stems with the help of sieves.

Statistical analysis of the data obtained from the studies was analyzed using variance analysis according to the Split Plots Experimental Design in Coincidence Blocks. The multiple comparison test LSD (Least Significant Difference) was used to statistically calculate the differences between the means (Efe et al., 2000).

3. Results and Discussion

The results of analysis of variance for plant height, stem diameter, dry stem yield, fiber yield, seed yield, and oil content in different water-retaining polymer doses are given in Table 3 and Table 4.

Table 3. Variance analysis table for plant height, stem diameter, and dry stem yield of male + female plants in hemp in different water-retaining polymer dose applications.

Sources of Variation	Plant Height (cm)			Stem Diameter (mm)			Dry Stem Yield (kg da^{-1})		
	M.S	F Value	P Value	M.S	F Value	P Value	M.S	F Value	P Value
Repetition (A)	1060.69	14.27	0.06	0.79	2.26	0.30	732160	88.39	0.01*
Variety (B)	471.25	6.34	0.12	7.37	21.14	0.04*	81637.5	9.85	0.08
Error 1 (AxB)	74.27	0.34	0.71	0.34	0.71	0.50	8282.98	0.10	0.89
Dose (C)	226.76	1.06	0.41	0.46	0.96	0.46	89437.9	1.16	0.36
B x C	295.10	1.38	0.27	0.57	1.18	0.35	63760.8	0.82	0.54
Error 2	213.54	-	-	0.48	-	-	76944.31	-	-
General	274.89	0.14	-	0.70	0.06	-	110497.21	0.07	-
CV (%)	6.97			7.08			14.94		

* Significant at the 0.05 level, **Significant at the 0.01 level.

When Table 3 is examined, plant height and dry stalk yield values were not statistically significant in the variety, dose, and variety x dose interactions in the water-retaining polymer doses applied in hemp varieties. The effect of the cultivar on average values of stem diameter was found to be significant.

Table 4. Variance analysis table for fiber yield, seed yield and oil ratio of male + female plant height in hemp in different water retaining polymer dose applications.

Sources of Variation	Fiber Yield (kg da^{-1})			Seed Yield (kg da^{-1})			Oil Ratio(%)		
	M.S	F Value	P Value	M.S	F Value	P Value	M.S	F Value	P Value
Repetition (A)	29497.80	30.43	0.03*	23789.2	456.07	0.00**	2.55	0.20	0.83
Variety (B)	5216.05	5.38	0.14	3533.64	67.74	0.01*	0.88	0.06	0.81
Error 1 (AxB)	969.05	0.22	0.79	52.16	0.03	0.96	12.71	4.70	0.02*
Dose (C)	6548.09	1.54	0.22	1783.64	1.20	0.34	3.51	1.30	0.30
B x C	3344.01	0.78	0.57	1212.72	0.82	0.54	1.68	0.62	0.68
Error 2	4248.23	-	-	1475.40	-	-	2.70	-	-
General	5730.70	0.10	-	2734.46	0.01*	-	3.18	0.23	-
CV (%)	17.34			15.80			5.39		

* Significant at the 0.05 level, **Significant at the 0.01 level.

When Table 4 is examined, fiber yield and oil ratio values were not statistically significant in the variety, dose, and variety x dose interaction in the water-retaining polymer doses applied in hemp varieties. Variety effect on seed yield mean values was found to be significant.

As seen in Table 5, the mean values of plant height of hemp varieties varied between 202.65-218.35 cm. The mean values of the Narlısaray population ranged between 194.11 - 224.11 cm, with an average of 213.01 cm, while the mean values of the Vezir variety ranged between 200.16 - 214.03 cm, with an average of 205.78 cm. In water-retaining polymer dose treatments, the longest plant height of the Narlısaray population was 224.11 cm at 5 kg da^{-1} dose, and the shortest was 194.11 cm at 7.5 kg da^{-1} dose. In the Vezir variety, the longest was 214.03 cm at 12.5 kg da^{-1} dose, and the shortest was 200.16 cm at 5 kg da^{-1} dose. According to both varieties' average plant height values, the longest plant height was found at 12.5 kg da^{-1} dose (218.35 cm) and the shortest at 2.5 kg da^{-1} dose (202.65 cm). Yazici et al. (2020) reported that plant height was between 58.8 - 345.0 cm in a study conducted under Tokat conditions. In another study Koçer (2022) conducted with monoic hemp varieties under Tokat conditions, plant height averages were found to be the lowest at 135.42 and the highest at 207.23 cm.

Table 5. Average male + female plant height values and stem diameter of different water-retaining polymer doses in hemp plants.

Doses	Plant Height (cm)			Stem Diameter (mm)		
	Narlısaray	Vezir	Avg.	Narlısaray	Vezir	Avg.
Control	218.71	206.81	212.76	10.66	9.23	9.65
2.5	204.35	200.95	202.65	9.87	8.76	9.31
5	224.11	200.16	212.14	10.39	8.87	9.63
7.5	194.11	211.95	203.03	9.70	9.89	9.80
10	214.13	200.78	207.45	10.05	9.25	9.65
12.5	222.68	214.03	218.35	10.50	9.74	10.12
Avg.	213.01	205.78	209.39	10.19a	9.29b	
LSD (%)	Variety (a): 12.34 Dose (b): 17.53 a x b: 27.81			Variety (a): 0.81 Dose (b): 0.83 a x b: 1.18		

The mean values of stem diameter varied between 9.31 and 10.12 mm. The Narlısaray population ranged between 9.70 - 10.66 mm with an average of 10.19 mm, and in the Vezir variety, 8.76 - 9.89 mm with an average of 9.29 mm. When the stalk diameter data between doses were analyzed, the maximum was 10.66 mm at the control dose, and the minimum was 9.70 mm at the dose of 7.5 kg da^{-1} in the Narlisaray population. In the Vezir variety, the highest stem diameter was determined at the dose of 7.5 kg da^{-1} with 9.89 mm and the lowest stem diameter at the control dose at 9.23 mm. In water-retaining polymer dose applications, stem diameter values were higher (10.12 mm) at 12.5 kg da^{-1} than other doses and the lowest (9.63 mm) at 2.5 kg da^{-1} dose. Şakar (2022) found that the lowest stem diameter was 7.1 mm and the highest was 9.3 mm in a study conducted in Tokat province conditions. Koçer (2022) reported that the stem diameter was 12.39 - 18.05 mm in dioecious male plants and 13.35 - 18.71 mm in female plants.

Table 6. Average dry stem yield and fiber yield values of different water retaining polymer doses in hemp plants.

Doses	Dry Stem Yield (kg da^{-1})			Fiber Yield (kg da^{-1})		
	Narlısaray	Vezir	Avg.	Narlısaray	Vezir	Avg.
Control	1937.22	1949.88	1943.55	400.55	412.77	406.66
2.5	1720.55	1688.88	1704.72	364.44	340.00	352.22
5	2181.11	1816.99	1999.05	480.00	371.11	425.55
7.5	1631.11	1852.44	1741.77	338.88	366.11	352.50
10	1900.00	1707.77	1803.88	385.00	358.88	371.94
12.5	2052.77	1835.33	1944.05	357.77	333.33	345.55
Avg.	1903.79	1808.55		387.77	363.70	
LSD (%)	Variety (a): 130.41 Dose (b): 333.11 a x b: 471.07			Variety (a): 44.59 Dose (b): 78.27 a x b: 110.67		

It was observed that the average dry stem yield of the varieties examined was between 1704.72 - 1999.05 kg da^{-1}. In the Narlısaray population, the average was 1903.79 kg da-1 between 1720.55 - 2181.11 kg da^{-1}, and in the Vezir variety, the average was 1808.55 kg da^{-1} between 1688.88 - 1949.88 kg da^{-1}. Among the doses of water-retaining polymer, the highest dry stalk yield in the Narlisaray population was 2181.11 kg da^{-1} at 5 kg da^{-1} dose, and the lowest was 1631.11 kg da^{-1} at 7.5 kg da^{-1} dose. When the averages of the Vezir variety were examined, the highest dry stalk yield was found in the control dose with 1949.88 kg da^{-1}, and the lowest was found in the 2.5 kg da^{-1} dose with 1688.88 kg da^{-1}. According to the mean values of both varieties, the highest dry stalk yield values were determined at 5 kg da^{-1} dose (1999.05 kg da-^{1}) and the lowest at 2.5 kg da^{-1} dose

(1704.72 kg da^{-1}) (Table 6). In their study, Flajsman et al. (2016) reported that dry stalk yield varied between 8000 – 10000 kg ha^{-1}. Kime (1996), in another study conducted in Canada, found that dry stalk yield was between 2.5 - 3 tons/ha. Meijer et al. (1995) reported that dry stalk yield was between 9.4 - 13.6 tons ha^{-1} in their study conducted between 1987 and 1989.

The average values of fiber yield were found between 345.55-425.55 kg da^{-1}. Fiber yield values of Narlısaray population varied between 338.88 - 480.00 kg da^{-1}, with an average of 387.77 kg da^{-1}, and Vezir variety varied between 333.33 - 412.77 kg da^{-1}, with an average of 363.70 kg da^{-1}. In water-retaining polymer dose applications, the highest fiber yield in the Narlisaray population was 480.0 kg da^{-1} at 5 kg da^{-1} dose, and the lowest was 338.88 kg da^{-1} at 7.5 kg da^{-1} dose. When the Vezir variety was examined, the highest fiber yield was 412.77 kg da^{-1} at the control dose, and the lowest was 333.33 kg da^{-1} at the 12.5 kg da^{-1} dose. When the average of both varieties was examined, the highest fiber yield was found at 5 kg da^{-1} dose (425.55 kg da^{-1}) and the lowest at 2.5 kg da^{-1} dose (352.22 kg da^{-1}). Deleuran and Flengmark (2006) found fiber yield between 170-310 kg da^{-1} in their study on fiber yield. Aksoy (2021) reported that fiber yield was between 11.65 - 242.2 kg da^{-1} in his research conducted under Samsun conditions.

Table 7. Average values of seed yield and oil content of different water-retaining polymer doses in hemp plants.

Doses	Seed Yield (kg da^{-1})			Oil Ratio (%)		
	Narlısaray	Vezir	Avg.	Narlısaray	Vezir	Avg.
Control	233.33	271.66	252.50	29.28	30.43	29.86
2.5	216.66	234.44	225.55	29.84	29.59	29.71
5	272.77	252.77	262.77	31.44	32.07	31.75
7.5	200.55	263.88	232.22	29.20	30.52	29.86
10	221.66	228.88	225.27	30.28	30.85	30.56
12.5	253.33	265.55	259.44	31.29	29.75	30.52
Avg.	233.05b	252.87a		30.22	30.53	
LSD (%)	Variety (a): 10.32 Dose (b): 46.11 a x b: 65.22			Variety (a): 5.07 Dose (b): 1.95 a x b: 2.78		

The average values of seed yield of the varieties varied between 225.27 - 262.77 kg da^{-1}. Seed yield in the Narlısaray population ranged between 200.55 - 272.77 kg da^{-1} with an average of 233.05 kg da^{-1} and in the Vezir variety between 228.88 - 271.66 kg da^{-1} with an average of 252.87 kg da^{-1}. When the doses applied were examined, the highest dose of 272.77 kg da^{-1} was determined at 5 kg da^{-1} dose with the highest rate of 272.77 kg da^{-1} in the Narlisaray population and the lowest dose of 200.55 kg da^{-1} was determined at 7.5 kg da^{-1} dose. In the Vezir variety, the highest seed yield was 265.55 kg da^{-1} at 12.5 kg da^{-1} dose, and the lowest was 228.88 kg da^{-1} at 10 kg da^{-1} dose. When the mean values of the varieties were examined, the highest seed yield was found at 5 kg da^{-1} dose (262.77 kg da^{-1}) and the lowest at 10 kg da^{-1} dose (225.27 kg da^{-1}) in water-retaining polymer dose applications. In his study, Özdemir (1992) reported that seed yield was between 31.0 - 60.6 kg da^{-1}. Yazici et al. (2022) found that seed yield was 130.90 - 217.86 kg da^{-1} in another study.

The mean values of oil content in different water-retaining polymer treatments in hemp varieties varied between 29.71% and 31.75%. In the Narlısaray population, the oil ratio was found between 29.20 - 31.44%, and in the Vezir variety, between 29.59 - 32.07%. When the applied doses were analyzed, the highest rate of 31.44% was found at 5 kg da^{-1} dose with 31.44% in the Narlisaray population, and the lowest rate was seen at 7.5 kg da^{-1} dose with 29.20%. In the Vezir variety, the highest oil content was 32.07% at 5 kg da^{-1} dose, and the lowest was 29.59% at 2.5 kg da^{-1} dose. When the mean values of both varieties were analyzed, the highest oil content was found at 5 kg da^{-1} dose (31.75%) and the lowest at 2.5 kg da^{-1} dose (29.71%) in water retaining polymer doses applications (Table 7). Höppner and Hartmann (2007) found an average oil content of 23.2% in their study. According to Aksoy (2021), the oil content was between 16.25 - 35.79%.

4. Conclusions

In the study conducted to determine the effect of water-retaining polymer applications on yield and quality traits in hemp (*Cannabis sativa* L.) cultivation under Yozgat conditions, five different water-retaining polymer doses (0, 2.5, 5, 7.5, 10, 12.5 kg da^{-1}) were applied on two different hemp genotypes (Narlısaray and Vezir). The effect of water-retaining polymer doses on the examined traits in hemp plants was statistically insignificant. Still, significant differences were determined in some traits among the varieties. The differences observed between the Narlısaray and Vezir genotypes reveal the varying potential of genetic structures to adapt to environmental conditions. This finding underscores the critical role of genotype selection in hemp cultivation. Moreover, it highlights that while the effects of water-retaining polymers may not always be pronounced, the response of genotypes to environmental conditions can significantly impact yield and quality traits. In the future, examining the effects of water-retaining polymers under longer-term and varied irrigation regimes and focusing on studies comparing the outcomes of genotype selection in different regions will deepen our understanding of this field. In conclusion, in drought-sensitive areas like Yozgat, adopting strategic approaches in the efficient use of water resources and genotype selection can substantially contribute to the sustainability of hemp cultivation.

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