


HERBAL CHARACTERISTICS AND YIELD PARAMETERS OF ORGANICALLY GROWN *Phacelia tanacetifolia* Bentham

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ABSTRACT. The main sources of human nutrition are plant and animal foods. The world population is increasing day by day and the demand for basic foodstuffs is increasing depending on this increase. In order to fulfil this increasing demand, the producers are in search of new products that can be substituted for the existing products and to obtain more products from the unit area. For this purpose, synthetic fertilizers, hormones, and pesticides are used unconsciously. These unconscious practices have increased the importance of sustainability and organic production in agricultural production. In this study, the phacelia plant, which has the potential to be an alternative to forage plants, has a wide growing area and offers different usage possibilities. Phacelia, Latin *Phacelia tanacetifolia* Bentham, is an annual plant belonging to the Hydrophyllaceae family and is the most common type of cultivation. The study was carried out with the Sağlamutimur variety planted under organic conditions in the Çubuk district of Ankara. In the results of studying, average first flowering time was 56.88 days, staying in flower 28.22 days, plant height 42.66 cm, fresh yield 1608.77 kg/ha, hay yield was 366.55 kg/ha, seed yield 56.55 kg/ha, thousand-grain weight 2.31 kg/da, crude nitrogen rate was 2.31%, crude protein rate 14.47% and crude ash rate was 10.23%.

Keywords: *Phacelia*, fresh grass, seed yield, crude nitrogen content, crude ash content

INTRODUCTION

Organic agriculture aims to protect the health of people and animals, makes soil fertility sustainable with practices such as plant rotation and green manure, and rejects or limits the use of synthetic fertilizers, pesticides, hormones, animal feed additives, veterinary drugs, nuclear rays, and genetically modified organisms, from production to consumption. The features of organic agriculture such as its renewable resources, recycling, and supporting the conversion of nutrients in waste into the soil are important factors that distinguish it from other agricultural systems. The principles of animal welfare and the use of natural feeds are adopted in animal production. The fight against diseases and pests, it is aimed to protect the natural system of the environment by using techniques that help to reduce pollution [1].

In the first years of organic agriculture in Turkey, there was a rapid increase in the number of farmers, the area of cultivation, the number of products, natural collection areas, total production area, and production amount. While the number of organic farmers was 12,428, the total production area was 89,827 ha and the production amount was 310,125 tons in 2002, the number of farmers increased to 74,545, and the total production area increased to 545,870 ha and the production amount increased to 2,030,465 tons as of 2019. However, there has been a decline in organic farming data in recent years (Table 1). Among the reasons for this are the increase in production costs, low productivity and sufficient government support, so the producers turn to alternative production methods.

Table 1. Production data for organic agriculture between 2002-2019 in Turkey [2]

Years	Number of products	Number of farmers	Cultivated area (ha)	Natural collection area (ha)	Total production area (ha)	Production amount (tons)
2002	150	12.428	57.365	32.462	89.827	310.125
2003	179	14.798	73.368	40.253	113.621	323.981
2004	174	12.751	108.598	100.975	209.573	377.616
2005	205	14.401	93.134	110.677	203.811	421.934
2006	203	14.256	100.275	92.514	192.789	458.095
2007	201	16.276	124.263	50.020	174.283	568.128
2008	247	14.926	109.387	57.496	166.883	530.224
2009	212	35.565	325.831	175.810	501.641	983.715
2010	216	42.097	383.782	126.251	510.033	1.343.737
2011	225	42.460	442.581	172.037	614.618	1.659.543
2012	204	54.635	523.627	179.282	702.909	1.750.127
2013	213	60.797	461.395	307.619	769.014	1.620.387
2014	208	71.472	491.977	350.239	842.216	1.642.235
2015	197	69.967	486.069	29.199	515.268	1.829.291
2016	225	67.878	489.671	34.106	523.778	2.473.600
2017	214	75.067	520.885	22.148	543.033	2.406.606
2018	213	79.563	540.000	86.885	626.885	2.371.612
2019	213	74.545	505.140	33.283	545.870	2.030.465

Turkey is behind many developed countries in terms of animal production [3]. The main reason for this is the problems in roughage production. The source of roughage in Turkey is largely meadow pastures and forage crops produced by field agriculture. [4]. However, the intense grazing pressure on the local pastures and the inability to implement the improvement projects widely are the reasons for not reaching the expected yield levels. In order to benefit more effectively from meadows and pastures, first of all, it is necessary to scientifically protect flora, fauna, and gene resources, effectively manage agricultural activities and animal husbandry, and implement sustainable agricultural systems [5].

Although there has been no significant change in agricultural areas in the last 6 years (2015-2020), fallow areas have started to decrease, and it has been observed that forage crops cultivation areas have increased (Table 2) (Changes [4]).

Table 2. Agricultural areas cultivated in Turkey (1000ha)

Years	Field area	Fallow lands	Vegetable Field	Fruit, beverage and spice area	Ornamental crops	Total worked area	Forage crops cultivation area
2015	15723	4114	808	3284	4.5	23934	2117
2016	15575	3998	804	3329	4.8	23711	2118
2017	15497	3697	798	3348	4.9	23346	2236
2018	15421	3513	784	3462	5.1	23179	2243
2019	15398	3387	790	3525	5.2	23094	2287
2020	15615	3 173	779	3563	5.4	23135	2458

Commonly known species such as alfalfa, silage corn and vetch are preferred by producers in forage crop farming in Turkey. However, in order to increase the production areas of forage crops, alternative forage crops suitable for the ecology of the region should be researched and revealed. For this reason, phacelia is one of the plants that is an

alternative to forage plants, has different usage possibilities, and is generally considered a bee pasture due to its wide growing area.

Phacelia: It is an annual herb belonging to the Hydrophyllaceae family, originating from California in North America, with purple-violet flowers [6]. Although 13 species are known in nature, the most cultivated species is *Phacelia tanacetifolia* Bentham [7]. The chromosome number of the phacelia is $2n=22$ [5]. The first known agriculture was made in the European continent in the 18th century. In Turkey, the first study on phacelia was conducted in Adana and a cultivar named Sağlamtimur was developed [8]. In addition, various studies carried out to date have revealed that phacelia can be evaluated as a fodder plant [9].

In addition, contamination of feeds by mycotoxins, like all foods, is an important problem worldwide. According to the Food and Agriculture Organization [10], about one-third of all food produced (1.3 billion annually) is lost as a result of contamination. Therefore, organic feed production and organic animal breeding fed with this feed are important in order to eliminate or neutralize mycotoxins in food and feed [11]. When choosing plants for organic roughage needs, plants that grow in different soil structures, do not need excessive soil cultivation, do not tire the soil, and do not need chemical fertilizers should be preferred. Considering these features, the phacelia plant comes to the fore. If the phacelia is considered as a fodder plant, it is recommended to harvest the plant at 50% flowering period [12]. If it is harvested towards the end of flowering, it can be used as a bee pasture, fodder plant or silage plant [13]. Apart from this, thanks to its flamboyant flowers, it attracts beneficial insects and bees, provides biological control against pests in the environment, and contributes significantly to pollination of foreign pollinated plants [14].

The aim of this study is to determine the yield parameters of the phacelia, which has the potential to be an alternative to the existing forage plants, can be grown in different climate and soil conditions and does not need special care conditions, under organic conditions.

MATERIALS AND METHODS

The study was carried out on 15.04.2020 in an open field on which organic production has been made for many years, at an altitude of 1230 m in Çubuk district of Ankara, according to the random plots trial pattern. In the experiment, Sağlamtimur variety was used as the material. The seeds to be used before planting were prepared according to the calculation of 1.5 kg per da. In order to eliminate the edge effect, 1 row was planted outside the plot areas, but these rows were not included in the samples. After planting, no fertilizer and pesticide applications were made, weeds were collected with hand tools, the plants were fed only with rainwater.

Soil samples taken from the study area were subjected to chemical analysis at Ankara University, Faculty of Agriculture, Department of Soil, and the obtained data are given in Table 3. According to these results the soil texture was sandy-clay, salt-free, lime-free, neutral in terms of pH, medium organic matter level, total nitrogen, available phosphorus and exchangeable potassium were sufficient. In addition, there is no groundwater problem in the trial area and the drainage situation is good.

Table 3. Soil analysis results of the research area

Structure (%)	Sand	56.37
	Silt	21.82
	Clay	21.81
pH		7.19
EC (dS/m)		0.30
salinity (%)		0.89
Organic Matter (%)		2.01
Nitrogen (%)		0.145
Phosphorus (ppm)		15.44
Potassium(ppm)		232.67

As a result of the study, the parameters to be examined for the organically grown phacelia plant are as follows:

First flowering time

It was calculated as the time from the date the phacelia plant was planted to the date it first bloomed.

Time in the flowering period

The time from the beginning of the first flowering to the end of the flowering was calculated.

Plant height

The length of 10 plant samples taken randomly from each plot was measured from the part in contact with the soil to the apex.

Green grass yield

The plants in the plot area were harvested at 50% flowering time, by mowing 5 cm from the soil with a 0.25 m² first square hoop. The samples taken were weighed and the results obtained were converted to da and the green grass yield of the plant was calculated [12,13].

Hay yield

Pre-harvested plant samples for green grass yield were placed in cloth sacks and kept under the sun to naturally evaporate their moisture. At the end of the 7th day, the dried plants were weighed, the results obtained were converted to da and the hay yield was calculated.

Seed yield

When the seeds in the lower flowers of the plant kömeç located in the plot area with the previously prepared 0.25 m² square hoop turn brown, they were harvested and dried for the seed yield calculation [15]. Seed yields were calculated by converting the obtained data to da.

1000 grain weight

After harvest, 100 seed samples from each plot were randomly selected and weighed. The obtained results were multiplied by 10 and the 1000 grain weights were calculated.

Crude nitrogen and crude protein ratio

After the samples taken from each plot were dried and ground with a blender, crude nitrogen calculation was made according to the Kjeldahl method [16], the crude protein ratios were determined by multiplying the obtained results with the coefficient of 6.25.

Raw ash ratio

It was determined by the ratio of the ash obtained as a result of burning a certain amount of plant sample whose moisture was evaporated beforehand at 550 °C to the amount of the sample.

RESULTS AND DISCUSSION

In the study, the averages and statistical analysis results of the phacelia planted in summer under organic conditions in Ankara are given in Table 4. When these data are examined, it was observed that the duration of the plant until the first flowering was 56.88 days, and the duration of staying in flower was 28.22 days. Kızılsimşek and Ateş [17] determined that the first flowering period of the phacelia planted in winter under Kahramanmaraş conditions was 146-180 days, and the duration of stay in flower lasted for an average of 45 days. When these results were compared with the data we found the first flowering period and the duration of the flowering period of the phacelia was shortened in late plantings in summer.

Table 4. Standard error, highest and lowest analysis results of yield and quality parameters

Plant yield and quality parameters	Means±S.E	Lower	Upper
First bloom	56.8889±0.96385	54.6662	59.1115
Duration in flower	28.2222±0.46481	27.1504	29.2941
Plant height	42.6667±0.73011	40.9830	44.3503
Green grass yield	1608.78±24.06806	1553.2767	1664.2788
Hay yield	336.5556±12.24417	308.3204	364.7907
Seed yield	56.5556±1.92290	52.1213	60.9898
Thousand grain weight	2.3889±0.06334	2.2428	2.5350
Crude nitrogen rate	2.3144±0.07362	2.1447	2.4842
Crude protein rate	14.4744±0.45839	13.4174	15.5315
Crude ash rate	10.2300±0.06030	10.0909	10.3691

As a result of the study, the average plant height of the phacelia was 42.66 cm, the green grass yield was 1608.77 kg/da, and the dry grass yield was 366.55 kg/da. Okant [18] in the winter season in Şanlıurfa, found the average plant height of 48.5-60.2 cm, the green grass yield in the range of 2191.5-3113.2 kg/da, 403.4-508.7 kg/ha. When the results we found were compared with these data, it was determined that the organically planted phacelia had shorter average height and lower green grass and hay yields.

In our study, the seed yield and thousand-grain weight of phacelia were found to be 56.55 kg/da and 2.38 g, respectively. Akdoğan and Kır [19] conducted a study in the experimental area of Ege University Faculty of Agriculture, Department of Field Crops during the 2016-2017 cultivation period. In this study, they examined the effects of different phosphorus doses on phacelia seed yield and found the seed yield and thousand-grain weight of 43.6-90.4 kg/da and 2.330-2.077g, respectively. When these results were

examined, it was seen that the data we found were in the range of values found by Akdoğan and Kır [19].

In addition, as a result of the study, crude nitrogen, crude protein and crude ash rates were calculated as 2.3%, 14.43% and 10.23%, respectively. Ateş et al. [9] determined the crude protein ratio of phacelia grown in Tekirdağ conditions to be 13.22%, and Okant [18] determined this ratio to be between 11.5%-12.9% in his study. Akbay et al. [20] found the raw ash ratio of the phacelia plant harvested in different vegetation periods in Kahramanmaraş ecological conditions between 14.05-19.17%. When these data were examined the crude protein ratios of we found were higher than the values obtained from other studies, but the crude ash ratios were lower from other studies.

CONCLUSION

As a result of the study, it was concluded that phacelia plant can be grown organically in Ankara conditions. It has been observed that it can be planted as green manure or as a summer second product, especially in fallow areas, to contribute to organic feed production and to be considered as an organic bee pasture with its long flowering period.

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