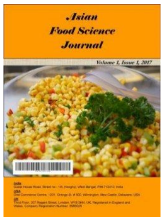

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The Effect of Different Organic Nutrients on Some Quality Properties of Popcorn (*Zea mays* L. *everta*)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: Organic nutrients such as animal manures, plant-derive compost, biosolids and bioliquids contain varying amounts of plant nutrients and can improve the biological, chemical, and physical properties of soils. They are used primarily for promoting growth of a plant or improving the quality of a crop. Study was aimed to find out the effect of conventional and fifteen different organic nutrients (peat, compost, cattle manure, chicken manure, horse manure, sheep manure, pigeon manure, vermicompost, seaweed + cattle manure, compost + humic acid, cattle manure + humic acid, chicken manure + humic acid, horse manure + humic acid, sheep manure + humic acid and peat + humic acid) on some quality properties of popcorn.
Study Design: Trial was designed in complete randomized block design with three replications. Ant-Cin-98 popcorn cultivar was used in the study. Each parcel comprised 4 lines. The planting was made into a depth of 5-6 cm along the lines 5 meters long with a row spacing of 70 cm and intra row of 20 cm.
Place and Duration of Study: This study was conducted in Diyarbakır - Cermik conditions of Turkey between 2010 and 2011.
Methodology: The effect of conventional and fifteen different organic materials to some quality parameters of popcorn such as cob ratio, 1000-kernel weights, test weight, popping volume and number of unpopped kernel were evaluated in the study. Physical and chemical properties of the

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trial area were determined by taking soil sample from a depth of 0-30 cm on the trial area before planting.

Results: According to the investigated results, the highest and the lowest values were ranked between 19.98% (peat + humic acid) and 17.26% (vermicompost) for cob ratio, 138.65 g (seaweed + cattle manure) and 122.48 g (chicken manure) for 1000-kernel weight, 81.29 kg hl^{-1} (horse manure + humic acid) and 75.62 kg hl^{-1} (vermicompost) for test weight, 19.71 cm^3 g^{-1} (peat) and 17.17 cm^3 g^{-1} (sheep manure + humic acid), for popping volume 5.92% (peat) and 3.65% (horse manure + humic acid) for number of unpopped kernel.

Conclusion: Higher values were obtained from organic nutrient sources than conversional application in all tested quality parameters. The implementation of organic fertilizers together with humic acid in popcorn produced better results in comparison to alone implementation of organic fertilizers. Also it was determined that use of natural enemies of *Trichogramma* spp against corn borer can be possible without any chemicals.

Keywords: Organic nutrients; popcorn; popping volume; test weight; thousand weight.

1. INTRODUCTION

The corn is used in human nutrition directly and indirectly in addition to the use as industrial raw material and animal feed in the world. Although dent corn *(Zea mays* L. *indentata)* varieties comprise the vast majority of corns grown both in world and in Turkey, no statistics so far related to the cultivation area, manufacture and consumption amount of popcorn *(Zea mays* L. *everta)* is available in Turkey. It is reported that planting is made around the provinces of Adana, Canakkale, Adapazari, Antalya, Isparta and Burdur, in Aegean and Mediterranean Regions of Turkey [1]. Consumption of popcorn is increasing every passing day in Turkey.

Popcorn is also directly used in human nutrition. The sub type of corn having grains popped when heated is popcorn. It generates pressure inside the grain through expansion when the humidity in the endosperm is heated because its grain is hard, its hull is thick and impermeable. At the same time the starch in the endosperm transforms with the effect of heat. The hull can't resist this pressure and bursts by splitting suddenly. The volume of the grains burst expands and they are eaten by salting or adding oil. Its consumption rises also in Turkey because of low cost and easy to prepare with popping machines, in pans or pots. Popcorn is commonly consumed while watching cinema and soccer matches and television during winter months. Additionally, it is preferred much by children [2].

Nowadays environmental pollution has reached a significant level as a result of the use of synthetic and chemical inputs in excessive amounts due to the production increase within conventional agriculture system. Organic fertilizers/matters, which are essential inputs of organic agriculture systems that have become widespread in parallel with the interest of people in organic products, are made available for producers under a great variety of names and contents in the market. It is necessary to utilize these matters in various ways to prevent environmental pollution caused by wastes, and to enhance organic matter level of our soil.

There are numerous sources of organic nutrients available for plant production. Organic nutrients such as animal manures, plant-derive compost, biosolids and bioliquids contain varying amounts of plant nutrients and can improve the biological, chemical, and physical properties of soils. Organic nutrients are an excellent source of plant nutrients while contributing to the aeration, drainage and water holding characteristics of the soil. They are used primarily for promoting growth of a plant or improving the quality of a crop.

Organic plant nutrients are frequently made from a range of materials including: grass clippings, leaves, yard wastes, ground organic matter, manures, etc. Organic nutrient materials can be solid or nonsolid substance or compound that contains essential plant nutrient elements in a form available to plants.

Different results have been obtained in studies regarding the subject of the study. Anac and Okur [3] reported that application of Biofarm (certified organic fertilizer) and farm fertilizer as organic fertilizer (uncertified) to soil has led to significant increase in dry weight, mineral content and growth of corn compared to control. Yazici and Kaynak [4] reported that seaweed organic nutrient increases yield and quality in organic farming, regulate the growth of plants, increase resistance to pests and diseases, improves the structure of the soil. Seker and Ersoy [5] investigated the effects of different doses of compost, cattle manure, chicken manure and leonardit on the soil properties and the development of corn (*Zea mays* L.). They found as a result of the research that type and dose of used organic fertilizer affects positively soil properties and the corn's growth.

Shafiq et al. [6] stated that chicken manure affected positively some parameters such as plant height, seed number, 1000-kernel weight and grain yield values. Selcuk and Tufenkci [7] reported that increasing humic acid application provided significant increase in number of kernel per ear, ear length, plant height and 1000-kernel weight. Cengiz et al. [8] emphasized that effect of organic fertilizers on yield and quality of the corn plant were similar with chemical fertilizers.

In this study, it was aimed determining the effect of some organic nutritional sources on some quality properties of popcorn.

2. MATERIALS AND METHODS

2.1 Material

Ant-Cin-98 popcorn variety was used in the experiment. Organic nutrient sources were used in the study (Table 1). Amount of total pure nitrogen both conventional and organic farming were 17 kg da^{-1} based on the regulation for principles and applications of organic agriculture in Turkey [9]. According to nitrogen content of organic material, maximum pure nitrogen amount (17 kg da^{-1}) was calculated for each organic applications (Table 1). For conventional applications total of 17 kg da^{-1} nitrogen, 8 kg da^{-1} phosphor and potassium (15-15-15 NPK as bottom fertilizer and urea as top fertilizer) were given as pure per decare. Nitrogen content of nutritional sources used in the study and the amount of fertilizer thrown per decare were given in Table 1.

2.1.1 Climatic characteristics of the research area

Experiment was conducted in Diyarbakır province Cermik district under second crop conditions. Climate values of 2010 and 2011 in which the research was conducted and long years climatic values were given in Table 2. In 2010, average highest temperature value (32.7°C) was observed in July whereas the lowest temperature was seen (12.0°C) in November. In 2011, the average highest temperature was recorded (31.5°C) in July. The lowest temperature (6.6°C) was seen in November in accordance with the data received from Diyarbakır Regional Directorate of Meteorology. The highest value (61.8%) in terms of relative humidity occurred in October 2010, and the lowest value (22.3%) in August 2011. The water need of plants was met through irrigation during the growing period.

2.1.2 Soil characteristics of the research area

Total salt content was found to be 0.03%, nitrogen content 1.19%, lime rate 9.8%, phosphorus amount 2.75 kg da^{-1}, potassium amount 82.05 kg da^{-1} and soil pH 7.4 in the soil sample taken from 30 cm soil depth in the place where trial was established in Diyarbakır province Cermik district.

Table 1. The nitrogen content of organic nutrient sources and applied amount

	Nutritional sources	N content (%)	The amount of applied (kg da^{-1})
1	Conventional manure (urea)	46	36.96 kg da^{-1}
2	Peat	1.2	1416 kg da^{-1}
3	Compost	2.5	680 kg da^{-1}
4	Cattle manure	3.5	486 kg da^{-1}
5	Chicken manure	3.0	567 kg da^{-1}
6	Horse manure	2.0	850 kg da^{-1}
7	Sheep manure	2.0	850 kg da^{-1}
8	Pigeon manure	6.0	283 kg da^{-1}
9	Seaweed + Cattle manure	2.0 + 3.5	51.5 kg da^{-1} + 457 kg da^{-1}
10	Vermicompost	1.5	1133 kg da^{-1} + 140 g da^{-1}
11	Compost + Humic acid	2.5	680 kg da^{-1} + 140 g da^{-1}
12	Cattle manure + Humic acid	3.5	486 kg da^{-1} + 140 g da^{-1}
13	Chicken manure + Humic acid	3.0	567 kg da^{-1} + 140 g da^{-1}
14	Sheep manure + Humic acid	2.0	850 kg da^{-1} + 140 g da^{-1}
15	Peat + Humic acid	1.2	1416 kg da^{-1} + 140 g da^{-1}
16	Horse manure + Humic acid	2.0	850 kg da^{-1} +140 g da^{-1}

Table 2. Rainfall, temperature and relative humidity values for 2010, 2011 and long years in Diyarbakır province

Months		Min. Temp. (ºC)	Max. Temp. (ºC)	Average Temp. (ºC)	Rainfall (mm)	Relative humidity (%)
June	2010	14.9	40.8	27.2	8.0	47.6
	2011	13.2	37.9	26.3	14.6	33.9
	Long years	16.9	33.7	26.3	7.2	36.0
July	2010	18.0	44.0	32.7	0.0	34.3
	2011	18.4	45.0	31.5	0.2	22.6
	Long years	21.7	38.5	31.2	0.7	27.0
August	2010	18.0	43.6	32.4	0.0	32.2
	2011	16.0	43.5	31.2	0.0	22.3
	Long years	21.0	38.1	30.3	0.3	27.0
September	2010	13.6	41.2	26.8	3.0	44.7
	2011	12.8	38.1	25.6	1.9	28.5
	Long years	16.0	33.1	24.8	2.6	31.0
October	2010	7.3	30.0	17.6	49.2	61.8
	2011	3.0	32.8	17.4	57.4	52.5
	Long years	10.1	25.3	17.2	30.8	48.0
November	2010	1.0	26.1	12.0	0.0	57.4
	2011	-4.7	19.9	6.6	104.0	61.1
	Long years	3.6	15.9	9.3	54.6	68.0

Resource: Anonymous [10]

2.2 Method

Before the starting of experiment, the trial area was planted with wheat in 2008 and 2009 for making suitable area for organic farming in which the trial would be established, and wheat was cultivated and harvested without application of any chemical fertilizer and agricultural pesticide. Physical and chemical properties of the trial area were determined by taking soil sample from a depth of 0-30 cm on the trial area before planting.

The soil was made ready for planting by processing with goble-disc and then with disc-harrow prior to planting. The trial was established with three replicates according to randomized complete block experimental design. Each parcel comprised 4 lines. The planting was made by hand into a depth of 5-6 cm along the lines 5 meters long with a row spacing of 70 cm and intra row of 20 cm in 15-30 June. Most of the nutritional organic sources were applied with planting. Also some part of seaweed manure was applied before planting and the rest as foliar fertilizer in three times. An equal amount of water was given to the parcels with sprinkler irrigation system after planting for germination due to lack of moisture in sufficient levels for output. Furrow irrigation applied throughout the growing period. A space of 2 meters was left between parcels to hinder water passage and the parcels were surrounded with berm.

Cultural measures (tractor and hand hoeing) were implemented to combat the weed. Chemical pesticides were not used in the search, *Trichogramma sp*. predator that was obtained from Adana Agricultural Research Institute Biological Control Unit was used within scope of biological control against Corn Cob Worm which leads to great productivity losses for corn plants. Values were taken from two rows in the middle of parcel after discarding 0.5 m from both sides of the parcel as edge effect. Harvest was made between 20-25 September.

An analysis of variance (ANOVA) was performed by using Totemstat-C software package for the tested characteristics to evaluate statistical differences between used organic nutrients. Means were compared by the Duncan's multiple range test ($P \leq 0.05$) [11].

3. RESULTS AND DISCUSSION

3.1 Cob Ratio (%)

Considering 2010-2011 year averages according to Table 3, cob ratio varied between percent 17.26-19.98 in different nutrient applications. The highest cob ratio value was determined to be

19.98% in peat + humic acid. The lowest cob ratio was obtained as 17.26% from vermicompost application along combined averages in the trial.

Table 3. Cob ratio (%) values found in popcorn grown using different nutritional sources and the groups formed according to Duncan test

Nutritional sources	2010^{ns}	2011^{ns}	Average‡
Conventional fertilizer	15.74	20.24	17.99 AB
Peat	14.44	22.40	18.42 AB
Compost	14.29	20.63	17.46 AB
Cattle manure	15.25	22.06	18.65 AB
Chicken manure	15.41	22.41	18.91 AB
Horse manure	15.37	20.01	17.69 AB
Sheep manure	15.46	19.39	17.43 AB
Pigeon manure	15.93	21.99	18.96 AB
Seaweed + cattle manure	15.73	24.16	19.95 A*
Vermicompost	15.30	19.21	17.26 B
Compost + humic acid	14.67	20.87	17.77 AB
Cattle manure + humic acid	15.50	22.92	19.21 A
Chicken manure+ humic acid	15.36	23.43	19.40 A
Sheep manure. + humic acid	15.71	22.14	18.92 AB
Peat + humic acid	15.51	24.45	19.98 A
Horse manure + humic acid	15.64	21.40	18.52 AB
Average	15.33 B	21.73 A	
LSD	Year: 2.014		
	2010-2011 Average nutritional sources: 2.539		

**There is no significant difference at 0.05 level according to Duncan Test among the averages falling within same letter group; †: P≤ 0.01, ‡: P≤ 0.05 ns: No significant*

Table 4. 1000-kernel weight (g) values found in popcorn grown using different nutritional sources and the groups formed according to Duncan test

Nutritional sources	2010†	2011†	Average†
Conventional fertilizer	123.38 a*	141.43 de	132.41 A-E
Peat	113.97 a-d	131.68 e	122.82 DE
Compost	105.78 cd	141.89 cde	123.84 CDE
Cattle manure	115.6 abc	144.02 bcd	129.81 A-E
Chicken manure	105.22 cd	139.73 de	122.48 E
Horse manure	117.10 ab	148.31 a-d	132.71 A-E
Sheep manure	118.27 ab	150.04 a-d	134.16 ABC
Pigeon manure	120.25 a	148.00 a-d	134.13 A-D
Seaweed + cattle manure	121.47 a	155.84 a	138.65 A
Vermicompost	104.40 d	148.73 a-d	126.56 B-E
Compost + humic acid	107.73 bcd	146.87 a-d	127.30 B-E
Cattle manure + humic acid	117.72 ab	148.64 a-d	133.18 A-E
Chicken manure+ humic acid	108.85 bcd	144.84 a-d	126.85 B-E
Sheep manure. + humic acid	120.30 a	153.92 ab	137.11 AB
Peat + humic acid	116.38 abc	143.64 cde	130.01 A-E
Horse manure + humic acid	121.00 a	153.82 abc	137.41 AB
Average	114.84 B	146.34 A	
LSD	Year: 4.826		
	2010 Nutritional sources: 10.021		
	2011 Nutritional sources: 10.175		
	2010-2011 Average nutritional sources: 9.841		

**There is no significant difference at 0.05 level according to Duncan Test among the averages falling within same letter group; †: P ≤ .01, ‡: P ≤ .05 ns: No significant*

3.2 1000-Kernel Weight (g)

Considering 2010-2011 year averages according to Table 4, 1000-kernel weights varied between 122.48 and 138.65 g in different nutrient applications. While the highest 1000-kernel weight value was determined to be 138.65 g in seaweed manure + cattle manure, and afterwards this was followed by horse manure + humic acid (137.41) with sheep manure + humic acid (137.11), respectively. In the meantime, conventional fertilizer application ranked sixth among the applications with a 1000-kernel weight value of 132.41 g. The lowest 1000-kernel weight was obtained as 122.48 g from chicken manure application along combined averages in the trial. In terms of 1000-kernel weight, it can be said that the abundance of all applications in second year compared to the first year resulted from both climate and environmental conditions and positive effect of nutritional sources.

The effect of plant nutritional sources on 1000-kernel weight in respect of corn plant was given by obtaining different results in different studies. Prasanna et al. [12] reported that they received the highest 1000-kernel weight from vermicompost in respect of corn plant, Shafiq et al. [6] stated that chemical fertilizer yielded 1000-kernel weight higher than organic fertilizers (chicken manure, farmyard manure, bio-manure).

Various results were obtained in different studies carried out related to 1000-kernel weight in popcorn. Ertas et al. [13] 54.8-64.6 g; Ozkan [14] 127.0-133.0 g; Tekkanat and Soylu [15] 114.68-175.93 g; Ozkaynak and Samancı [16] reported 1000-kernel weight varying between 86.0-140.0 g in lines, 83.0-115.0 g in hybrids. Using humic acid with organic fertilizers increased 1000-kernel weight. Some researchers reported that humic acid applications raised 1000-kernel weight [17,18,19].

3.3 Test Weight (kg hectoliter^{-1})

Average values of the proportion of test weight determined in different nutritional sources in popcorn grown organically between 2010 and 2011 and the groups formed according to Duncan multi comparison test were given in Table 5.

In the trial, the difference among fertilizer applications was found to be statistically significant. Considering 2010-2011 year averages, test weight ranged from 75.62 kg hectoliter^{-1} (hl^{-1}) to 81.29 kg hl^{-1} in different nutrient applications. When examined the Table 5, the highest test weight value was 81.29 kg hl^{-1} in horse manure + humic acid application, and afterwards respectively, peat + humic acid (80.58 kg hl^{-1}) and sheep manure + humic acid (80.56 kg hl^{-1}) applications. Meanwhile, the lowest test weight was obtained as 75.62 kg hl^{-1} from vermicompost. Effects of organic nutrients on test weight were different.

The highest test weight values were obtained from using organic fertilizers with humic acid which is a growth regulator. The studies have shown that humic acid effects dry weight in plant. Some researchers reported that fresh and dry weights increased significantly ($P \leq 0.05$) with treated humic acid at different levels compared to control [6,20]. On contrary, Asli and Neuman [21] reported that the humic acids reduce the dry weight of corn.

3.4 Popping Volume (cm³ g^{-1})

Considering 2010-2011 year averages according to Table 6, popping volume varied between 17.17 cm³ g^{-1} and 19.71 cm³ g^{-1} in different nutrient applications. When examined the Table 6, the highest popping volume value was seen in peat application as 19.71 cm³ g^{-1}, and afterwards followed respectively, vermicompost (19.41 cm³ g^{-1}) and pigeon manure (18.98 cm³ g^{-1}) applications. Meanwhile, the lowest popping volume was obtained as 17.17 cm³ g^{-1} from sheep manure + humic acid. The difference of nutrient elements in the structure of organic and conventional nutritional sources was seen clearly in popping volume values.

Besides, even though no study has been seen about popping volume in organic popcorn, different study results obtained related to popping volume as 19.79-22.92 cm³ g^{-1} [13]; 19.67-25.33 cm³ g^{-1} [16]; 18.50-35.25 cm³ g^{-1} [15]; 21.0-27.5 cm³ g^{-1} [22]; 28.1-28.7 cm³ g^{-1} [14] values have a nature supporting given research results.

3.5 Number of Unpopped Kernel (%)

In the experiment, the difference among fertilizer applications was found to be statistically significant. Average values of number of unpopped kernel determined in different nutritional sources in popcorn grown organically between 2010 and 2011 and the groups formed according to Duncan multi comparison test were given in Table 7. Considering 2010-2011 year averages, number of unpopped kernel ranged from 3.65% to 5.92% in different nutrient applications. When examined the Table 7, the highest number of unpopped kernel value was found in peat application as 5.92%, and afterwards pursued respectively, chicken manure (5.63%) and compost (5.16%) applications. In addition, the lowest number of unpopped kernel was obtained as 3.65 % from horse manure + humic acid.

Table 5. Test weight (kg hl^{-1}) values found in popcorn grown using different nutritional sources and the groups formed according to Duncan test

Nutritional Sources	2010‡	2011†	Average†
Conventional fertilizer	80.57 ab	76.55 e	78.56 AB
Peat	78.70 ab	80.62 abc	79.66 A
Compost	75.68 bc	79.47 bcd	77.58 AB
Cattle manure	76.43 abc	80.60 abc	78.52 AB
Chicken manure	75.98 abc	79.62 bcd	77.80 AB
Horse manure	78.13 abc	81.32 abc	79.73 A
Sheep manure	76.10 abc	79.82 bcd	77.96 AB
Pigeon manure	79.28 ab	80.63 bc	79.96 A
Seaweed + cattle manure	79.38 ab	79.25 cd	79.32 A
Vermicompost	73.47 c	77.77 de	75.62 B
Compost + humic acid	75.95 bc	82.78 a	79.37 A
Cattle manure + humic acid	76.87 abc	81.42 ab	79.14 AB
Chicken manure+ humic acid	80.95 a	79.80 bcd	80.38 A
Sheep manure. + humic acid	80.23 ab	80.88 abc	80.56 A
Peat + humic acid	79.75 ab	81.40 abc	80.58 A
Horse manure + humic acid	80.88 ab	81.70 ab	81.29 A
Average	78.02 B	80.23 A	
LSD	Year: 0.463		
	2010 Nutritional sources: 4.445		
	2011 Nutritional sources: 1.955		
	2010-2011 Average nutritional sources: 3.346		

**There is no significant difference at 0.05 level according to Duncan Test among the averages falling within same letter group; †: P ≤ .01, ‡: P ≤ .05 ns: No significant*

Table 6. Popping volume (cm^3/g) values found in popcorn grown using different nutritional sources and the groups formed according to Duncan test

Nutritional Sources	2010ns	2011ns	Average‡
Conventional fertilizer	18.95	17.42	18.18 AB
Peat	20.41	19.00	19.71 A*
Compost	19.93	17.75	18.84 AB
Cattle manure	19.66	19.04	19.35 AB
Chicken manure	18.99	17.68	18.33 AB
Horse manure	19.02	18.43	18.72 AB
Sheep manure	19.00	17.64	18.32 AB
Pigeon manure	19.20	18.76	18.98 AB
Seaweed + cattle manure	18.54	16.65	17.60 AB
Vermicompost	20.56	18.26	19.41 A
Compost + humic acid	18.62	17.15	17.89 AB
Cattle manure + humic acid	18.27	18.09	18.18 AB
Chicken manure+ humic acid	18.95	17.65	18.30 AB
Sheep manure. + humic acid	17.40	16.93	17.17 B
Peat + humic acid	19.42	16.12	17.77 AB
Horse manure + humic acid	17.75	17.61	17.68 AB
Average	19.04 A	17.76 B	
LSD	Year: 0.467		
	2010-2011 Average nutritional sources: 2.011		

**There is no significant difference at 0.05 level according to Duncan Test among the averages falling within same letter group; †: P ≤ .01, ‡: P ≤ .05 ns: No significant*

Table 7. Number of unpopped kernel (%) values determined in popcorn grown using different nutritional sources and the groups formed according to Duncan test

Nutritional sources	2010†	2011†	Average†
Conventional fertilizer	6.48 abc	3.51 b-e	5.00 A-D
Peat	7.05 a*	4.79 a	5.92 A
Compost	6.72 ab	3.59 b-e	5.16 ABC
Cattle manure	4.86 def	3.84 bcd	4.35 CD
Chicken manure	6.97 a	4.28 ab	5.63 AB
Horse manure	5.27 b-f	3.88 abc	4.58 BD
Sheep manure	4.74 ef	3.18 cde	3.96 CD
Pigeon manure	5.47 a-f	3.45 b-e	4.46 BCD
Seaweed + cattle manure	4.88 c-f	2.67 e	3.78 D
Vermicompost	5.91 a-e	3.63 bcd	4.77 A-D
Compost + humic acid	4.41 f	3.46 b-e	3.93 CD
Cattle manure + humic acid	6.33 a-d	3.23 cde	4.78 A-D
Chicken manure+ humic acid	4.63 ef	3.51 b-e	4.07 CD
Sheep manure. + humic acid	4.67 ef	2.81 de	3.74 D
Peat + humic acid	4.65 ef	3.10 cde	3.88 CD
Horse manure + humic acid	4.50 ef	2.79 de	3.65 D
Average	5.47 A	3.48 B	
LSD	Year: 0.467		
	2010 Nutritional sources: 1.393		
	2011 Nutritional sources: 0.889		
	2010-2011 Av. Nutritional sources: 2.011		

**There is no significant difference at 0.05 level according to Duncan Test among the averages falling within same letter group;†: P ≤ .01, ‡: P ≤ .05 ns: No significant*

On the other hand, even though no study has been seen about number of unpopped kernel in organic popcorn, different study results obtained related to non-popped kernel rates as 12.43-16.91% [13], 3.49-12.19% in lines and 6.33-9.94% in hybrids [16]; 2.42-9.90% [15]; 2.77-3.48% [14] values, have a nature supporting present research results. Many researchers [13, 22,23] have found significant differences in non-popped kernel rate which is among major quality parameters of popcorn, and they reported that the impact of varieties and growing conditions had a largest share in this situation.

4. CONCLUSION

It has been determined with this study that organic popcorn production can be made also by using different organic nutritional sources under Diyarbakır ecological conditions. Higher values obtained from organic nutrient sources than conversional application in all tested quality parameters. Furthermore, it was observed that the implementation of organic fertilizers together with humic acid in popcorn produced better results in comparison to alone implementation of organic fertilizers. It has been proved that corn production can be made without the use of chemical pesticides in the trial. *Trichogramma sp*. beneficial insects can be introduced to local farmers and its use may be encouraged on corn planted areas.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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