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Determination of the Effect of Poultry Ash Application on Agro Morphological and Quality Properties of Potato (*Solanum tuberosum* L.)

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Highlights:

- Potato yield increased
- Increased marketable tuber rate
- Small tuber rate decreased

Keywords:

- Average tuber weight
- Big tuber rate
- Tuber yield
- Marketable tuber ratio

ABSTRACT:

This study was carried out in Bolu conditions in 2021 to see the effect of poultry ash, which has the potential to be a nutrient in terms of being rich in minerals and is also a soil conditioner, on the yield and quality characteristics of potato (*Solanum tuberosum* L.). In the study, the conventional production method of 8 kg/da P + 20 kg/da N application was tried with six different ash amounts (0, 500, 1000, 1500, 2000 kg/da poultry ash + 20 kg/da N). According to the values obtained from the study, the highest plant height (cm), the number of main stems (pieces), the specific gravity (g) 1500 kg/da ash application, the number of tubers per plant (pieces) from farmer conditions; average tuber weight (g), french fries oil rate (%), protein rate (%), big tuber rate (%) 2000 kg/da; chips oil rate (%), small tuber rate (%), dry matter rate (%) in the control plot where there was no application; Tuber yield per decare (kg/da), medium tuber ratio (%), marketable tuber ratio (%), were obtained from 1000 kg/da poultry ash application.

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This study was produced from Emre ÖZCAN's Master's thesis.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is an annual plant from *Solanaceae* family, native to South America. Potato is seen as a very important product in the nutrition of the developing countries of the world due to its high nutritional value. For this reason, increasing the productivity and profitability of strategic products such as potatoes in our country seems necessary for the establishment of nutritional health. (Felenji & Ahmadizadeh, 2011; Yaşar & Kendal, 2022; Yaşar, 2023).

The livestock sector, which has grown in parallel with the increasing demands of human beings, brings along the waste problem. Especially in the industrial sense, the waste and residues arising from the animal production sector have started to have an important place in environmental problems (Koç, 2002; Eleroğlu & Yıldırım, 2011; Özdemir et al., 2013; Çolakoğlu, 2018).

According to the figures of 2020, the world poultry stock is 35 billion units. 94.4% of this amount is chicken, 3.3% is duck, 1.3% is turkey and 1% is goose and guinea fowl. Of the total poultry meat production of 133 million tons in 2020, 89.6% chicken meat, 4.5% turkey meat, 3.7% duck meat and 2.1% goose and guinea fowl. In 2021, the number of poultry in Türkiye was 398 million and the number of meat chickens was 270 million. It is reported that 12.7% of the number of poultry belongs to Bolu (Anonymous, 2022). Only broiler chickens and turkeys are produced in Bolu. The rearing period of broiler chickens is 42 days, and during the rearing period, they produce approximately 4.5 kilograms of manure and 0.5 kg of litter, producing a total of 5 kg of waste.

Wastes from Turkey's poultry production are mostly used as farm manure in agricultural lands. However, these wastes cause environmental problems (Karaca & Başçetin, 2009; Yetilmezsoy, 2010). According to 2021 figures, the annual amount of poultry manure and litter should be approximately 2 000 000 tons. In Bolu, this amount is approximately 235 thousand tons. After these wastes are purified from environmental threats such as various bacteria, viruses and drug residues, they should be evaluated as a source of organic matter for agricultural lands (Kütük, 2013). However, it is a very difficult and costly method to dispose of drug residues. For this reason, producers set up thermal power plants to burn wastes and generate electrical energy from the heat energy (Eleoğlu & Yıldırım, 2002; Eleroğlu et al., 2013). Although the incineration of waste seems to eliminate an agriculturally valuable product, it is reported that the marek virus (*Vaccinum morbi*) tays alive for 7 days, the Gumbaro viruse (Infectious Bursal Disease Virus-IBDV) mains alive for 122 days, and contains different types of bacteria that threaten the environment and human health (Cabaleiro et al., 2008).

It has been reported that as a result of the incineration of poultry waste, ash up to 10-30% of the dry matter amount is formed (C.A.M.M.G., 1979). With the burning of approximately 2 000 000 tons of litter throughout our country, assuming the average ash rate of at least 10%, it is seen that approximately 200 thousand tons of ash will be generated annually. It is reported that poultry ash contains 25 kg/ton phosphorus, 16 kg/ton potassium and many mineral substances (Dede & Akbulut, 2017; Özer, 2017). Both elements are the most important macro nutrient elements that affect yield and quality in potato plant. Since our country is not self-sufficient in terms of phosphorus resources, it imported $83 236 051 of phosphate in 2019 for the production of phosphorus fertilizer (MTA, 2015).

No research has been found on the evaluation of poultry waste ash containing phosphorus and potassium in significant proportions as fertilizer. Studies in this field are mostly studies on wood ash. This study shows the feature of being an original study in this respect.

MATERIAL AND METHOD

The trial was established in Bolu Province, Merkez District, Yenicepınar Village (Beylik Locality). Agria potato variety used as a research material. The experiment was set up in a randomized block split plot design with three replications. Sowing as done by machine on April 1-15, 2021. The plots were 6 m long and consisted of 4 rows (70 cm between rows). The row spacing was left as 30 cm. A gap of 1 m was left between the plot and 2 m between the blocks. Ash application was applied one week before planting (0, 500, 1000, 1500 and 2000 kg/da), nitrogen application (20 kg/da N) was applied half before planting and the other half was applied before throat filling (ammonium sulfate). As a conventional farmer application, 15.15.15 fertilizer was applied to the basic fertilization plots before planting, at a rate of 2 kg /da P_2O_5 against a ton of potato production. Irrigation was done by sprinkler irrigation method. Chemical control was made for *Alternaria solani* and mildew diseases. During the harvest, the side rows and the ends of the rows were excluded from the evaluation as an edge effect.

In the experiment, 15:15:15 pure 8 kg/da P + 20 kg/da N fertilizer was used as fertilizer. Poultry ash was used as a soil conditioner and a source of macro and micro nutrients. The ash was passed through a 2 mm wire sieve before it was used, and the part that passed to the bottom was used in the study. The poultry ash compositions (%) used in the study are given in Table 1.

Table 1. Content of Poultry Ash

Element	Oxide	%
Mg	MgO	1.47
P	P_2O_5	1.53
K	K_2O	2.90
Ca	CaO	66.30
Mn	MnO	0.04
Fe	Fe_2O_3	0.279
Cu	CuO	0.01
Zn	ZnO	0.105
Na	Na_2O	3.77

Climatic Characteristics of the Trial Area

The climatic characteristics of the experimental site are given in Table 2.

Table 2. Climatic Values of the Experimental Site

Months	Max. Temp. (ºC)		Min. Temp. (ºC)		Average Temp.(ºC)		Average humidity (%)		Rain (mm)	
	2021	Long Years average	2021	Long Years average	2021	Long Years average	2021	Long Years average	2021	Long Years average
April	25.7	13.5	-3.4	2.3	9.1	8.0	74.2	80	80	108
May	30.7	17.8	-0.2	6.9	14.8	12.6	65.5	80	61	114
June	30	20.9	4.3	10.8	15.8	16.1	77.7	80	112	99
July	36	23.8	9.9	12.9	20.6	18.5	67.7	70	31	56
August	36.9	24.6	9.5	13.7	20.6	19.0	66.7	70	22	57
September	28	21.3	4.2	10.3	14.6	15.5	78	70	54	72

When the climatic data of the region where the research is conducted are examined, it is seen that the amount of precipitation falling in the vegetation period was 359 mm in the trial year, the long-term average was 506 mm in the same period, and the average relative humidity was lower than the long-term average (Table 2).

Soil properties of the trial area

The results of the analysis of the soil samples taken from 0-20 cm depth from different parts of the field where the experiment was established are given in Table 3.

Table 3. Some Physical and Chemical Properties of Experimental Area Soils

Analysis name	Result	Degree	Analysis Method/Reference
Saturation	72.60	Clayey	TS 8333 (+%10) (Air Dry)
pH	7.58	Slightly Alkaline	Yurdakul 2018
Total Salt	0.03	Without salt	TS 8334 (In mud)
Lime	12.65	Medium Lime	TS EN ISO 10693 (Modifiye)
Organic Matter	2.47	Medium	Olsen (Concentration)
Phosphorus	0.08	Very Little (kg/da) According to Olsen – Less According to Bray and Kurtz	OLSEN (Concentration)
Potassium	69.51	High (kg/da)	TS8341 (Konsantrasyon)

The structure of the soil where the experiment is established is clayey, has a slightly alkaline pH, very low salt content, medium lime content, medium organic matter ratio, low useful phosphorus ratio and high potassium (Table 3).

Examined trials

In the study, the applications were determined according to the plant height (cm), the number of main stems (number), the number of tubers per plant (number), the tuber yield per plant (g / plant), the average tuber weight (g), the tuber yield per decare (kg/da), Large tuber ratio, medium tuber ratio (%), small tuber ratio (%), marketable tuber ratio (%), tuber specific gravity (g/cm^3) (İncekara, 1973), dry matter ratio (%), chips and French fries oil The effects on shrinkage rates (Lulai & Orr, 1979), French fries yield (kg/da), tuber protein ratio (%) (Bremner, 1965) were investigated.

Statistical analyses: Analysis of variance (ANOVA) was performed with JMP Pro11 (SAS Institute Inc., Cary, NC). The mean values of the properties were compared using the Duncan multiple range test ($P<0.05$).

RESULTS AND DISCUSSION

The variance analysis results and the mean values and the resulting groups of the effects of the treatments on the agro-morphological traits of potato are given in Table 4-5.

Tablo 4. The Variance Analysis Results of the Effects of the Treatments on the Agro-Morphological Traits of Potato

Sources of variation	S.D.	Plant Height (cm)		Number of main stems (pcs)		Number of tubers per plant (pcs)	
		Mean of squares	Probe>F	Mean of squares	Probe>F	Mean of squares	Probe>F
Replication	2	2.567	0.329	0.121	0.39	0.374	0.568
Doses	5	14.744	0.004**	0.435	0.040*	3.682	0.009**
Error	10	2.063	0	0.12	0	0.623	0
General	17						
VK (%)		2.542		10.052		7.88	
Sources of variation	**S.D.**	**Average tuber weight (g)**		**French fries fat content (%)**		**Fat content of chips (%)**	
		Mean of squares	Probe>F	Mean of squares	Probe>F	Mean of squares	Probe>F
Replication	2	17.146	0.369	47.245	0.652	0.004	0.027
Doses	5	783.83	0.001**	36462.752	0.001**	0.0002	0.09
Error	10	15.519	0	0.00009	0	0.0008	0
General	17						
VK (%)		4.1191		2.05		1.80	
Sources of variation	**S.D.**	**Yield per decare (kg/da)**		**Specific gravity (gr/cm3)**		**Big tuber ratio (%)**	
		Mean of squares	Probe>F	Mean of squares	Probe>F	Mean of squares	Probe>F
Replication	2	616.76	0.485	0.001	0.591	1.8445	0.474
Doses	5	69354.736	0.001**	0.0008	0.775	49.2038	0.001**
Error	10	732.23	0	0.0002	0	2.2913	0
General	17						
VK (%)		2		3.53		6.3	

Continued from Tablo 4. The Variance Analysis Results of the Effects of the Treatments on the Agro-Morphological Traits of Potato

Sources of variation	S.D.	Medium tuber rate (%)		Small tuber rate (%)		Marketable tuber rate (%)	
		Mean of squares	Probe>F	Mean of squares	Probe>F	Mean of squares	Probe>F
Replication	2	9.376	0.242	10.585	0.112	7.085	0.279
Doses	5	15.702	0.082	26.317	0.005**	24.902	0.014*
Error	10	5.716	0	3.854	0	4.8743	0
General	17						
VK (%)		3.5		27.9		2.4	

Sources of variation	S.D.	Dry matter ratio (%)		Protein ratio (%)	
		Mean of squares	Probe>F	Mean of squares	Probe>F
Replication	2	0.0001	0.2873	0.0245	0.319
Doses	5	0.00014	0.2781	0.559	0.001**
Error	10	0.0001	0	0.0192	0
General	17				
VK (%)		5.3		7.9	

*, **, ns : significant at 5%, 1% level and not significant, respectively

Table 5. The Mean Values and the Resulting Groups of the Effects of the Treatments on the Agro-Morphological Traits of Potato

Applications	Plant height (cm)	Number of main stems (pcs)	Number of tubers per plant (piece)	Average tuber weight (g)
0	52.3B	2.8 B	8.3C	73.4C
15.15.15	57.3A	3.4AB	11.4A	96.9B
500	56.1A	3.3AB	10.7A	83.1C
1000	57.5A	3.5A	9.2BC	97.9B
1500	58.6 A	3.9A	10.4AB	102.2B
2000	57.2A	3.8A	10.1AB	120.2A

Applications	Specific density (gr/cm3)	Coarse tuber ratio (%)	Medium tuber ratio (%)	Smaller tuber ratio (%)
0	1.1	17.6D	69.7	12.7A
15.15.15	1.1	22.7C	69.4	7.6B
500	1.1	22.9C	69.9	6.2B
1000	1.1	24.7BC	70.9	4.4B
1500	1.1	26.5B	67.2	6.0B
2000	1.1	29.6A	64.7	5.4B

Applications	French fries fat ratio (%)	Chips fat ratio (%)	Yield per decare (kg/da)	Marketable tuber rate (%)
0	17D	44	1158.5E	87.3B
15.15.15	17CD	44	1370.2D	92.1A
500	18BCD	45	1336.2D	92.8A
1000	21A	43	1586.1A	95.6A
1500	19BC	42	1531.1B	93.7A
2000	19AB	44	1423.8C	94.3A

Applications	Dry matter ratio (%)	Protein ratio (%)
0	20	1.6B
15.15.15	19	1.5B
500	20	1.5B
1000	19	1.6B
1500	19	1.6B
2000	20	2.6A

When the results in Table 4 were examined, the effect of the applications on plant height, number of tubers per plant, average tuber weight, yield per decare, big tuber ratio, small tuber ratio and protein ratio was statistically significant at the level of 1%; the effect of the applications on the number of main stalks and tuber ratio was statistically significant at the level of 5%; It is seen that the effect of the applications on finger potato fat ratio, chips fat ratio, specific gravity, medium tuber ratio and dry matter ratio was not statistically significant.

Plant height

The average values and the resulting groups are examined, it is seen that two different groups emerged in plant height values with the effect of applications, the highest value was obtained from the applications and the lowest value was obtained from the zero application (Table 4).

In the study, the highest plant height was obtained from poultry ash at applications of 15:15:15, 500 kg/da, 1500 kg/da and 2000 kg/da which is similar to the results obtained from the studies of other researchers. Akal (2016) found the highest plant height with the combined use of organic + inorganic fertilizers (56.35 cm), Asghari et al. (2015a) that the highest plant height (59.55cm) was obtained with organic + inorganic fertilizer application, Tamer et al. (2016) on sunflower plant with organic soil conditioners, all organic material applications have a significant effect on plant height, Tunçtürk et al. (2004) determined that increasing nitrogen doses increased vegetative growth and therefore increased plant height in potatoes, Aytekin et al. (2014) reported that the application of animal manure on the Agria potato variety had a positive effect on plant height. In general, it is seen that soil conditioners can be effective on plant height in potatoes.

Number of main stems

Where the average values and the resulting groups are examined, it is seen that three different groups were formed in the number of main stems with the effect of the applications, the highest value was obtained from 1000, 1500 and 2000 kg/da ash applications, and the lowest value was obtained from the zero application (Table 4).

According to the values obtained from the study, applications of 1000 kg/da, 1500 kg/da and 2000 kg/da poultry ash dose had the highest effect on the number of main stems. The result obtained was lower than the 5.49 number obtained by Akal (2016), while Yılmaz et al. (1996) obtained 2.1-5.2 main stem number/plant value remained within the limits. This situation can be explained by variety and environmental differences. Arıoğlu (2002) reported that the number of main stems is a characteristic of the variety, and the physiological age of the seed tubers and the number of buds per tuber due to their size affect the number of main stems. Tuncturk et al. (2004) as a result of the 2-year study on nitrogen fertilization in potato plant, increasing nitrogen doses caused an increase in the number of main stems, Aytekin et al. (2014) reported that the use of animal manure and chemical fertilizers together had a significant effect on the number of stalks per hearth. Çalışkan (1997) and Knowles et al. (2003) reported that this feature is a characteristic of the variety, and that the physiological age of the seed tubers, the size of the tubers and the number of buds of the tubers affect the number of main stems. The values obtained from the study showed similar stalk counts and similar responses according to the fertilizers used when compared to studies by other researchers.

Tubers per plant

When the average values and groups are examined, it is seen that four different groups were formed in the number of tubers per plant with the effect of the applications, the highest value was obtained from 15.15.15 and 500 kg/da fertilizer applications, the lowest value was obtained from zero application (Table 4).

Akal (2016) found the highest number of tubers (8.26 pieces) in inorganic fertilizer application, Demir (2017) stated in his study that increasing iron doses and the number of tubers per hearth were inversely proportional, and the number of tubers per hearth he obtained was 5.5- There are 7.7 units, Ferdoushi et al. (2010) found that the highest number of tubers per plant was obtained from the application of mineral fertilizers (7.11 units), followed by the use of organic and inorganic fertilizers

together (6.66 units) and then organic fertilizers (6.29). Tuncturk et al. (2004) found that increasing nitrogen doses did not have a significant effect on the number of tubers per hearth in a 2-year study on nitrogen fertilization in potato plant, Aytekin et al. (2014) reported that the application of animal manure and chemical fertilizers in the Agria potato variety significantly affected the number of tubers per plant, but the interaction of fertilizers was insignificant. Although the values obtained from the study are higher than the values obtained from other researchers' studies on similar subjects, it is seen that mineral fertilization is effective in the number of tubers per plant, and similar results can be obtained with organic and inorganic fertilization.

Average tuber weight

When the average values and the resulting groups are examined, it is seen that three different groups were formed in the average tuber weight with the effect of the applications, the highest value was obtained from the application of ash at 2000 kg/da and the lowest value was obtained from the application of zero and 500 kg/da of ash (Table 4).

Akal (2016), in his study on a similar subject, stated that he obtained the highest tuber weight (69.88g) from organic + inorganic fertilizer application, Asghari et al. (2015a) found that the highest average tuber weight was obtained from organic + inorganic fertilizer application (97.94g), but nitrogen fertilizer and doses did not have a statistical effect on average tuber weight, Yılmaz et al. (1996) found an inverse relationship between the average tuber weight and the number of tuber per plant, Tunçtürk et al. (2004) in the nitrogen fertilization study applied to the potato plant, they determined that there was an increase in tuber values until the application of nitrogen dose of 15 kg/da, and a decrease in tuber value in the application of 15 kg/da nitrogen. Aytekin et al. (2014) reported that the tuber weight increased due to the increased doses of animal manure in the parcels where chemical fertilizer was applied in the Agria potato variety, and that they obtained the highest tuber weight from the use of chemical fertilizer with 30 t/ha of animal manure, and Çalışkan (1997) found that They reported that the excess amount of tuber increased the competition among the tubers and caused a decrease in the average tuber weight. Jamaati et al. (2010) and Asghari et al. (2015b) reported that nitrogen fertilization had a significant effect on the average tuber weight, but high-dose nitrogen fertilizer application caused a weight reduction in the weight and size of the tubers. The findings obtained from the study are similar to the findings of other researchers working on a similar subject. It is seen that tuber weight is significantly affected by fertilizer applications.

Fries and chips fat rate

When the average values and the resulting groups are examined, it is seen that three different groups were formed in the finger potato oil ratio with the effect of the applications, the highest value (20.92%) was obtained from the application of 1000 kg/da ash, and the lowest value (16.46%) was obtained from the application of zero. is seen (Table 4).

When the average values and groups are examined, although there is no statistical difference with the effect of the applications, the highest value (45%) in the chips oil ratio is determined by the application of ash at 500 kg/da and the lowest value (42%) by the application of ash at 1500 kg/da appears to have been achieved (Table 4).

There were not enough studies on the oil extraction rate in French fries, and Karadoğan (1994) reported that in his study with different potato varieties, he found the oil extraction rate between 9.97-16% and the highest (16%) in Agria variety. In the study conducted by Kara & Kara (2016) with 17 different potato cultivars grown in Erzurum ecological conditions, the oil extraction rates varied

between 24.4% and 30.8%, Karadoğan (1994) found the highest oil extraction rate in Granula cultivar (36.99) and in the study conducted with different potato cultivars. were detected in Isola (36.10) and Agria (33.73) cultivars, respectively, Karadogan et al. (2013) in their study on animal and chemical fertilizers reported that the effect of animal fertilizers and phosphorus fertilizer on the oil absorption rate of chips was not statistically significant, and the oil extraction ratio increased from 34.4% to 38.5% with the increase of nitrogen fertilizer. In addition, Burton (1966) found that the oil absorption rate of the chips affects the chips yield and dry matter content of the potato, the oil absorption rate decreases with the increase in the chips yield, Smith (1968) in his study, the oil absorption rate of the potato, the type of oil used, the dry matter rate of the potato, They reported that factors such as frying temperature, time and thickness of the chips slice can also affect it.

Tuber yield per decare

When the average values and groups are examined, five different groups were formed in yield per decare with the effect of the applications (Table 4).

In the studies conducted by other researchers on a similar subject, Akal (2016) obtained the highest yield value from organic + inorganic fertilizer application with 2149.7 kg/da in his study, Demir (2017) obtained the highest yield value from iron application with 3229 kg/da, Amara et al. (2013), they obtained 6850.8 kg/da from sheep manure application, Güler et al. (2011) stated that in 6 different fertilizer studies (farm manure, paddy husk, farm manure + paddy husk, biofarm, inorganic fertilizer, NPK) NPK application provides higher yield (2252.52 kg/da) compared to other organic fertilizers, Yeng et al. (2012) obtained from the application of NPK + chicken manure at 2200 kg/da, Tunçtürk et al. (2004) reported that in nitrogen fertilizer application in potatoes, the yield increased significantly with increasing the nitrogen dose, but the increase after a certain dose was insignificant, Aytekin et al. (2014), in their study on Agria potato variety, found that animal manure had a positive effect on tuber yield and at the same time increased the effectiveness of chemical fertilizer application and the highest tuber yield (4464.8 kg/da) was higher than the application of animal manure with chemical fertilizer (30 t/ha). that they detected, Çalışkan et al. (2004) reported that the application of animal manure had a positive effect on tuber yield, and in addition, tuber yield increased with the use of animal manure together with chemical fertilizers. When the data obtained from the studies are compared, as in the results found by other researchers, the yields per decare showed a certain increase compared to the fertilizer doses in this study.

Specific density

When the average values and the groups are examined, although there was no statistical difference in the specific density with the effect of the applications, the highest value was between 1.1386 g/cm^3 and 1500 kg/da poultry ash application, and the lowest value was between 1.0910 and 15:15:15 appears to be obtained from the application (Table 4).

If we look at the studies of other researchers on the subject, Güler et al. (2011) reported in their study that organic and inorganic fertilizers had no effect on specific density. Kara & Kara (2016) reported that they determined the specific density of potatoes in the range of 1.070-1.216 in their study to compare the characteristics of 17 different potato varieties. When the results obtained from the study are compared with the studies conducted by other researchers, it is seen that the values obtained are similar to the values obtained by other researchers and that the applications do not have a significant effect on the specific density (g/cm^3).

Bigger tuber size ratio

When the average values and the resulting groups are examined, it is seen that four different groups were formed with the effect of the applications, the highest value (29.60%) was obtained from the 2000 kg/da ash application, and the lowest value (17.59%) from the zero application (Table 4).

If we look at the studies of other researchers on the same subject, Kavalcı (2019) found in his study on tuber sizes that with the increase of potassium fertilizer doses, the rate of big tuber decreased, while the ratio of large tuber was 28.6% in the control dose, 25.21% in the 15 kg/da dose and 20.88% in the 30 kg/da dose. Karam et al. (2009) reported that increasing potassium dose increased the rate of big tuber. If we look at the data obtained from the study, it is seen that the increased poultry ash increases the lump rate, and the highest lump rate is obtained from the application of poultry ash at 2000 kg/da. In the studies conducted by other researchers, the tuber ratio was positively or negatively affected by increasing fertilizer doses. This can be explained both by the variety and ecology difference, and by the fact that poultry ash is a soil conditioner rather than a fertilizer application.

Medium tuber size ratio

When the average values and the groups are examined, although there was no statistical difference in the middle tuber ratio with the effect of the applications, the highest value (70.94%) was determined by 1000 kg/da ash application, and the lowest (64.69%) was 2000 kg/da. It is seen that it is obtained from the application of ash.

If we look at the studies of other researchers on the same subject, Kavalcı (2019) found that the highest medium tuber ratio was obtained from the Hermes variety at a dose of 30 kg/da potassium fertilizer, 48.91%, Karam et al. (2009) reported that the middle tuber ratio increased with increasing potassium applications. Obtaining different results on the subject can be explained by the differences in variety, environment and applications.

Smaller tuber size ratio

When where the average values and the resulting groups are examined, it is seen that two different groups were formed in the small tuber ratio with the effect of the applications, the highest value (12.69%) was obtained from the zero application, and the lowest value (4.37) was obtained from the 1000 kg/da ash application (Table 4).

If we look at the studies of other researchers on the same subject, Kavalcı (2019) found that the small tuber ratio increased with the increase in the dose of potassium fertilizer and the highest small tuber ratio (41.10%) was found with 30 kg potassium application, and the lowest small tuber ratio (37.75%) in the control application, Karam et al. (2009) reported that increasing potassium applications decreased the small tuber ratio. Obtaining different results from the studies can be explained by the variety, environment and application differences.

Marketable tuber rate

When where the average values and the resulting groups are examined, it is seen that two different groups were formed in the marketable tuber ratio with the effect of the applications, the highest value was obtained from the 500 kg/da,1000 kg/da, 1500 kg/da and 2000 kg/da ash applications, and the lowest from the zero application (Table 4).

If we look at the studies of other researchers on the same subject, Akal (2016) reported that the highest lump rate (72.9%) was obtained from 1 ton farm manure + 7.5 kg N/da application. In addition, Akal (2016), in his study on marketable tuber ratio, found the highest rate from organic + inorganic fertilizer application (1899.30 kg/da), and that it was followed by mineral fertilization

(1749.82 kg/da) and organic fertilization (1592.33 kg/da). Kavalcı (2019), in his study conducted with 3 different potato varieties, showed that the effect of potassium application on marketable tuber yield was statistically insignificant, with the lowest value of 1866.62 kg/da from the control application, L. Clair variety, and the highest value of 4212.53 kg. He reported that he obtained from the Hermes variety in the application of potassium at 30 kg/da with /da. Davenport et al. (1999) and Haile et al. (2013) found that increasing doses of potassium fertilizer application in potato plant increased the rate of marketable tuber, Kumar et al. (2017) reported that increasing doses in potash fertilizer application reduced the rate of marketable tubers. According to the data obtained from the study, the dose application of poultry ash increased the marketable tuber yield to a certain extent, but it decreased after the dose of 1000 kg/da and the lowest rate was obtained from the application without fertilizer. Different results from similar studies can be explained by the differences between cultivar, environment and applications.

Dry matter ratio

When the average values and the groups are examined, although there is no statistical difference in the dry matter ratio with the effect of the applications, the highest dry matter ratio (20%) is from the control and 500 kg/ha and 2000 kg/ha applications, the lowest value is from 15:15:15, 1000 kg / da and 1500 kg / da applications (Table 4).

If we look at the studies of other researchers on the same subject, Akal (2016) reported that the highest dry matter ratio (24.74%) was obtained from the application of organic + inorganic fertilizers, Kavurmacı (2008) reported that the application of nitrogen fertilizer at different doses did not have a significant effect on the dry matter ratio. Kara (2003) found the dry matter ratio for Agria variety as 23.97%, Aytekin et al. (2014) reported that only the doses of animal manure had a significant effect on the dry matter ratio in their study with the Agria potato variety, and the combined use of chemical fertilizers and animal manure did not have a significant effect on the dry matter ratio. Çalışkan et al. (2004), Asghari et al. (2015b) and Eleroğlu & Korkmaz (2016) reported in their studies that they found that the dry matter ratio increased with the increase in the application doses of animal manure. In the study of Demir (2017) on iron fertilization in potatoes, they reported that iron fertilization increased the dry matter ratio, but high amount of applications decreased the dry matter ratio. Karadoğan et al. (2013). In the study conducted by Kara & Kara (2016) to determine the characteristics of 17 different potato cultivars, they reported that the dry matter ratios of the cultivars were in the range of 24.9-29.5%.

Protein ratio

When the average values and the resulting groups are given, is examined, it is seen that two different groups are formed in the protein ratio with the effect of the applications, the highest value (2.63%) is from 2000 kg/da ash application, and the lowest value (1.51%) is from 500 kg/da ash application.

If we look at the studies of other researchers on the same protein ratio, Kara (2003) found that the protein ratio varied between 7.48-10.51% in his study, Karadoğan et al. (2013) found that the protein amount increased with the increase in animal manure, but the difference was not statistically significant, phosphorus fertilization had no effect on the protein rate, and the increasing doses of nitrogen fertilizer application increased the protein rate significantly, Kara & Kara (2016) reported the characteristics of 17 different potatoes. When examined, they reported that they found that the protein ratios of the varieties were in the range of 6.7-9%. Similarly, Sharma & Arora (1988 reported that

nitrogen fertilization increased the protein ratio in their studies. The protein ratio values obtained from the study were in the range of 1.50-2.62, and it was considerably lower than the protein ratio values obtained by researchers working on the same subject. The values obtained by other researchers are quite high for potatoes. The resulting differences can be explained by the variety, environment, differences between applications, and the method used to determine protein content.

CONCLUSION

According to the values obtained from the study, the highest plant height (cm) from applications of 15:15:15, 500 kg/da, 1500 kg/da and 2000 kg/da, the highest number of main stems (pieces) from applications of 1000 kg/da, 1500 kg/da and 2000 kg/da, the highest number of tubers per plant (pieces) from applications of 15:15:15 and 500 kg/da, the highest average tuber weight (g) from application of 2000 kg/da, the highest french fries oil rate (%) from application of 1000 kg/da, the highest protein rate (%) from application of 2000 kg/da, the highest big tuber rate (%) from application of 2000 kg/da, the highest small tuber rate (%) were obtained from the control plot. The highest tuber yield per decare (kg/da), medium tuber ratio (%), marketable tuber ratio (%) were obtained from 1000 kg/da poultry ash application.

As a result of the study, it was observed that poultry litter ash had effects on yield and some quality characteristics of potatoes. However, since it is a one-year study, the accuracy of the effect should be supported by further studies. In addition, it is necessary to investigate the effects of ash on the physical, chemical and biological structure of the soil with other experiments to be made.

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Conflict of Interest

We declare that there is no conflict of interest between the authors of the article.

Author’s Contributions

Yusuf Arslan is the thesis supervisor of the thesis.

Emre Özcan is a graduate student conducting the thesis.

Berfin İşler is a graduate student and took part in the writing of the article.

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