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Effects of Rice Husks on Yield and Tuber Quality of Potatoes (*Solanum tuberosum* L.)

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The present study was designed to investigate the effects of rice husks on yield and quality of potato (Sante cv.). In the study, 4 treatments including control (no fertilizer), farmyard manure (10 t/ha), rice husks (1 t/ha) and farmyard manure + rice husks (10 + 1 t/ha) were used. Total tuber yield, first class and third class tuber yield were significantly affected by treatments. First class tuber yield and total tuber yield were higher in farmyard manure, rice husks and farmyard manure + rice husks treatments when compared to control. In these treatments first class tuber yield and total tuber yield were *ca.* 29.8 and 28.2 % higher than control, respectively. In rice husks treatment, tuber yield, tuber number per plant and mean tuber weight were as high as in farmyard manure and farmyard manure + rice husks. There were no significant differences among treatments in dry matter content and bulk density of tuber. Whereas protein and ash content of tuber were significantly affected by treatments. This study showed that total and first class yield of potato increased with application of rice husks.

Key Words: *Solanum tuberosum* L., Rice husks, Yield, Quality, Soil chemical content.

INTRODUCTION

More than 100,000,000 metric tons of rice husks are generated each year throughout the world. They were stored or burned which pose risks for environment. Rice husks have a pH around 5.7. Compared to peat it has a relatively low water-holding capacity, holding a weight of water that is about 50 % of their dry weight. They have a high proportion of air-filled pore space[1]. Low water-holding or nutrient-storing capacities are not necessarily negative features as long as rice husks are combined with components that provide nutrient and water holding capacity[2]. Due to properties mentioned above they have been used as a substitute for perlite in preparation of growing media in horticulture and floriculture[3]. Rice husks also have been used in compost. Pinamonti *et al.*[4] used a growing media composing of peat + rice husks + compost at a rate of 8:7:5 (v/v), respectively, in which raised cucumber, tomatoes, strawberry and gerbera. Güler and Büyük[5] showed that growing media composing of rice husks, poultry manure and sunflower cake (1:2.5:5 w/w) can be used

for cucumber and tomato seedling without adding any nutrients during growth. There have been studies showing beneficial effects of rice husks in growing media. These beneficial effects are increasing cation exchange capacity, water and aeration[6-8].

Taja *et al.*[9] used rice straw and sugarcane bagasse residues (incorporated and mulched) in potato growing and found that potato yield increased with application of rice straw by 6 t/ha or 1 t/ha when compared to without rice straw (only 50 kg/ha N) and without N application, respectively. Kwon *et al.*[10] reported that application of 1 ton rice straw/ha increased plant height and number of stolons compared with chemical fertilizers, resulting in about 18 % increase in total yield. Meena and Gupta[11] obtained the same amount of potato yield from castor cake applied at 3 t/ha and nitrogen at 12 kg/ha.

This study was designed to investigate the effect of rice husks on the yield, quality and nutritional status of potato.

EXPERIMENTAL

This study was carried out at Ladik-Samsun, Turkey with Sante potato cultivar during 2005 and 2006. Four treatments including control (no fertilizer), farmyard manure (10 t/ha), rice husks (1 t/ha) and farmyard manure + rice husks (10 t/ha + 1 t/ha) were used.

Experimental site is above 950 m sea level. Mean, the highest and the lowest temperature of the site are 9.5 ºC, 36 ºC (August) and -17 ºC (January), respectively. Physical and chemical properties of experimental soil were as follows: Texture: loam, pH: 7.6, salinity: 0.07 %, organic matter: 2.4 %, $CaCO_3$: 3.86 %, exchangable potassium: 362 kg/ha, available phosphorus: 242 kg/ha. Farmyard manure had 1.64 % N, 0.69 % P and 0.38 % K.

Experimental design was completely randomized block with three replications. Each plot was 18 m^2. Inter row and inter plant spacing were 0.70 and 0.40 m, respectively. Each plot had four rows having 16 plants each. Potato seeds were sown in 2 May in both years. Data was collected from inner rows, leaving two outer rows as guard plants. Farmyard manure and rice husks were incorporated into the soil before sowing.

Leaf samples were taken at the beginning of flowering stage for N and P determination and chlorophyll measurement. Nitrogen was analyzed by Kjeldahl method. Phosphorus was determined colorimetrically. Leaf chlorophyll was measured on 20 leaf samples by using SPAD chlorophyll meter (Minolta). Soil samples were taken after harvest for determination of NO_3, NH_4 and P analyzes.

Tubers were harvested at the second week of September in both years. Inner rows (32 plants) were used for harvest. Tuber diameter was used for classification of tuber in size. Tubers > 5.5 cm were classified as first class, between 5.5 to 3.5 cm as second class and < 3.5 cm as third class. Tubers were counted for each plot. Tuber number per plant was calculated dividing the total number of tuber to the total number of plant in each plot. Mean tuber weight was calculated dividing the

tuber yield to the number of tuber. Twenty tubers were selected for analysis of tuber dry matter, ash, protein and specific gravity. Dry matter was determined gravimetrically after drying at 105 ºC. The density of tubers was determined with an underwater balance. Ash content was determined gravimetrically after burning in a furnace at 550 ºC. Nitrogen was analyzed by Kjeldahl digestion and protein was calculated by multiplying N with 6.25[12].

Analysis of variance was performed by using MSTAT program. LSD test was used for comparison of the mean values[13].

RESULTS AND DISCUSSION

Total and marketable yield: Total tuber yield and marketable yield classified as tuber size are given in Table-1. Total tuber yield, first and third class yield were significantly affected by treatments. There were no significant differences among farmyard manure, rice husks and farmyard manure + rice husks in total and first class tuber yield. First class tuber yield and total tuber yield of farmyard manure, rice husks and farmyard manure + rice husks (mean of 3 treatments) were 29.8 and 28.2 % higher when compared to control. When evaluated mean value, yield increase in rice husks was 34.2 % when compared to control. In rice husks first class tuber yield and total tuber yield were as high as in farmyard manure and farmyard manure + rice husks. When considered that rice husks did not add nutrients due to their slow decomposition in the soil this result was interesting. Because, rice husks plot was not received any nutrient as in the control. Yield increase in rice husks plot was attributed to increasing nitrogen mineralization due to positive effect of rice husks on soil water and aeration[6-8]. Soil NO_3-N content of rice husks plot (27.22 mg/L) was as high as twice when compared to control (14.83 mg/L) plot (Table-3). Also soil NH_4-N (9.75 mg/L and P (28.30 t/ha) contents were the highest in rice husks plot. Another reason for yield increase in rice husks plot might be increasing cation exchange capacity of the soil. In farmyard manure + rice husks treatment leaf N and P content and soil NO_3-N, NH_4-N and soil P contents were higher when compared to farmyard manure treatment, indicating that there were positive effects of rice husks on plant and soil nutrient contents. Rice husks have been used widely for soilless media due to these effects mentioned above[3,14].

Tuber number and mean tuber weight: There were no significant differences among treatments in tuber number per plant and mean tuber weight (Table-1). Tuber number per plant and mean tuber weight were lowest in control when compared to the other treatments. Tuber number of plant in rice husks plot was comparable with the other treatments. Mean tuber weight values were close in farmyard manure, rice husks and farmyard manure + rice husks. The positive effects of rice husks on these properties of potatoes are clear. The same reasons which explained above are valid for rice husks in terms of these characters of potatoes.

Tuber quality: Tuber dry matter, ash, protein and specific gravity are given in Table-2. There were no significant differences among treatment in tuber dry matter

TABLE-1
TUBER YIELD, TUBER NUMBER AND MEAN TUBER WEIGHT OF POTATOES

Year	Treatment	Tuber yield (ton/ha)				Tuber number (no./plant)	Mean tuber weight (g)
		Class I	Class II	Class III	Total		
Year	2005	3.59	4.19	4.11	11.90	5.27	63.43
	2006	4.06	5.04	7.91	17.02	6.94	70.77
2005	Control	2.96	3.87	2.69	9.53	4.61	57.97
	FYM	3.71	4.42	4.97	13.10	5.75	64.33
	RH	3.78	3.95	4.46	12.20	5.33	64.53
	FYM + RH	3.93	4.51	4.33	12.77	5.39	66.90
2006	Control	2.85	4.73	5.22	12.80	5.93	69.40
	FYM	4.82	5.13	7.79	17.75	6.70	74.27
	RH	5.04	4.75	8.01	17.81	6.96	72.02
	FYM + RH	3.54	5.54	10.62	19.71	8.17	67.38
Mean	Control	2.90 b	4.30	3.95 c	11.17 b	5.27	63.68
	FYM	4.26 a	4.77	6.38 b	15.43 a	6.23	69.30
	RH	4.41 a	4.35	6.24 b	15.00 a	6.14	68.28
	FYM+RH	3.73 a	5.02	7.48 a	16.24 a	6.79	67.14
Year		NS	NS	**	**	NS	*
Treatment		**	NS	**	**	NS	NS
Year × treatment		NS	NS	**	NS	NS	NS
CV (%)		16.56	20.92	12.33	10.77	15.11	8.04

FYM = Farm yard manure; RH = Rice husks.

TABLE-2
TUBER DRY MATTER, ASH, PROTEIN AND SPECIFIC GRAVITY OF POTATOES

Year	Treatment	Tuber quality analysis			
		Dry matter (%)	Ash (%)	Protein (%)	Specific gravity (g/cm^3)
Year	2005	25.63	4.73	7.99	1.100
	2006	25.33	6.15	7.66	1.085
2005	Control	25.81	5.23	7.62	1.103
	FYM	25.52	4.60	7.19	1.094
	RH	25.98	4.56	8.39	1.110
	FYM + RH	25.19	4.52	8.74	1.093
2006	Control	24.93	6.93	7.95	1.073
	FYM	26.18	5.93	7.31	1.086
	RH	25.74	5.92	7.43	1.087
	FYM + RH	24.48	5.84	7.95	1.094
Mean	Control	25.37	6.08 a	7.79 ab	1.088
	FYM	25.85	5.27 b	7.25 b	1.090
	RH	25.86	5.24 b	7.91 ab	1.099
	FYM + RH	24.84	5.18 b	8.34 a	1.093
Year		NS	**	NS	NS
Treatment		NS	*	*	NS
Year × treatment		NS	NS	NS	NS
CV (%)		5.69	9.92	7.09	1.11

FYM = Farm yard manure; RH = Rice husks.

and specific gravity. Tuber ash and protein content were significantly affected by treatments. Tuber ash was highest in control 6.08 %) when compared to the other treatments. Tuber protein was highest in farmyard manure + rice husks (8.34%) treatment, followed by rice husks treatment (7.91 %). This result is in agreement with the results of Schulz *et al.*[15] and, Gezgin and Uyanoz[16] who reported that tuber protein increased with increasing nitrogen level. In present studies, it is considered that plants on farmyard manure + rice husks and rice husks received higher nitrogen than those of control and farmyard manure due to having high soil NO_3-N, NH_4-N contents. About the leaf nitrogen analyses results and leaf chlorophyll reading values (Tables 3 and 4), it can be questioned that all plants received same amount of nitrogen. But higher leaf nitrogen in control plant does not show that control plant received as much nitrogen as other treatments. Most of plant nutrient studies showed that control plants have higher nutrients and this was attributed to concentration effect due to lower metabolic activity[17,18]. Approximately thirty per cent higher yield in farmyard manure, rice husks and farmyard manure + rice husks when compared to control support this assumption.

TABLE-3
NITROGEN AND PHOSPHORUS CONTENT OF POTATO LEAF AND NO_3, NH_4 AND P CONTENT OF SOIL (2005)

Treatment	Leaf N (%)	Leaf P (%)	Soil NO_3 (mg/L)	Soil NH_4 (mg/L)	Soil P (tha)
Control	5.45	0.44	14.83 b	7.37	26.57
FYM	5.18	0.38	12.84 b	7.96	23.20
RH	5.32	0.43	27.22 a	9.75	28.30
FYM + RH	5.25	0.48	18.28 b	9.05	27.47

FYM = Farm yard manure; RH = Rice husks.

TABLE-4
LEAF CHLOROPHYLL OF POTATOES MEASURED BY SPAD CHLOROPHYLL METER

Treatment	Year		Mean
	2005	2006	
Control	50.4	48.8	49.6
Farm yard manure	49.3	50.1	49.7
Rice husks	50.6	49.9	50.3
Farm yard manure + Rice husks	48.4	51.2	49.8

Year, treatment and year by treatment ($p > 0.05$).

In conclusion, total tuber yield and first class tuber yield in rice husks, farmyard manure and farmyard manure + rice husks were significantly higher than those of control. In rice husks treatment, tuber yield, tuber number per plant and mean tuber weight were as high as in farmyard manure and farmyard manure + rice husks. There were no significant differences among treatments in dry matter content and

bulk density of tuber. Control plant's tuber had the highest ash; tuber from farmyard manure + rice husks plot had the highest protein content. Addition of rice husks to the soil created good soil conditions, resulting 28.2 % tuber yield increase when compared to non rice husks added soil (control). Also, tuber yield and quality of plants grown on rice husks added soil were as high as plants grown on farmyard manure and farmyard manure + rice husks.

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