

Growth and yield of red and purple colored potatoes: a significant antioxidant source in human nutrition

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Abstract: Present experiment was conducted at the USDA Alliums Field laboratory of BAU, Mymensingh during November 2015 to March 2016. Twenty three potato varieties were tried under 4 treatments which were applications of Paclobutrazol @ 0, 100, 200ppm and Maleic Hydrazide @ 500ppm. Growth and yield of all treatments varied significantly. Potatoes regarding their consumption are a significant antioxidant source in human nutrition. The main potato an-tioxidants are polyphenols, ascorbic acid, carotenoids, tocopherols, α -lipoic acid, and selenium. The most contained polyphenolic antioxidants in potatoes are L-tyrosine, caffeic acid, scopolin, chlorogenic and cryptochlorogenic acid and ferulic acid. In red and purple potatoes are in addition contained acylated anthocyanins and pigmented potatoes are shown two to three times higher antioxidant potential in comparison with white-flesh potato. Red potato tubers contain glycosides of pelargonidin and peonidin, purple potatoes glycosides of malvidin and petunidin. New red and purple flesh potato varieties are breded for their use in food and in the non-food industry. Anthocyanins of potatoes are also useful against potato blight. Different potato accessions showed significant differences in all growth and yield parameters.

Keywords: Red and purple potatoes; antioxidants; polyphenols; anthocyanins; breeding; nutrition, paclobutrazol, maleic hydrazide.

Introduction

Potato one the of major vegetables in Bangladesh. Although potato grown in winter seasons but it is used round the year. One of the richest sources of antioxidants in the human diet is potato tubers (*Solanum tuberosum* L.) (Lachman *et al.* 2000) specially colored fleshed potato. Their antioxidant content decreases at a great deal from atherosclerotic processes, and is inhibited from cholesterol by the accumulation in blood serum and enhances the resistance of the vascular walls. Many antioxidants decrease risk of coronary heart disease and have free radical scavenging effect. The main potato antioxidants are polyphenols, ascorbic acid, carotenoids, tocopherols, α -lipoic acid, and selenium. Polyphenolic compounds, esp. flavonoids are effective antioxidants (Bors and Saran 1987) due their capability to scavenge free radicals of fatty acids and oxygen (Good, 1994). Vegetables and crops are significant sources of antioxidants in human nutrition either in direct consumption or in the form of vegetable juices. Justesen *et al.* (1997) estimated the daily flavonoid intake at 26 mg/day. Potato tubers present a very significant source of antioxidants (Al-Saikhan *et al.* 1995) in human nutrition, e.g. among fruits and vegetables they insure an average daily intake of about 64 mg polyphenols per capita in the U.S.A. and occupy the second place after

tomatoes. From antioxidants they are richest in polyphenols (1.226–4.405 mg/kg) and ascorbic acid (170–990 mg/kg). Different colored varieties may show different contents of antioxidant, growth and yield of tubers. The present study was conducted to know the performances of different colored and non-colored varieties of potato treated with different chemicals.

Materials and Methods

The present experiment was conducted at the USDA Alliums Field laboratory of BAU, Mymensingh using twenty three potato varieties (listed below) during November 2015 to March 2016. These colored flesh potatoes were collected from University of Wisconsin, Madison in 2008 by Prof. Rahim. The soil of the experimental area was sandy loam and belongs to the Old Brahmaputra Floodplain under Agro ecological Zone nine having non-calcareous dark grey soils. The experimental area is situated under the subtropical humid climate. The two factorial experiment was conducted in randomized complete block design with three replications. The land was medium high land with pH about 7.8. The land was ploughed and cross ploughed in the month of October to get the good tilth. The size of each unit plot was 2.0m \times 1.0m.

Table 1. Twenty three colored potato accessions and their source of collection.

Variety	Accession No.	Source	Variety	Accession No.	Source
V ₁	10110	University of Wisconsin, USA	V ₁₃	10063	University of Wisconsin, USA
V ₂	10076	University of Wisconsin, USA	V ₁₄	10069	University of Wisconsin, USA
V ₃	10081	University of Wisconsin, USA	V ₁₅	10123	University of Wisconsin, USA
V ₄	10190	University of Wisconsin, USA	V ₁₆	Cardinal	TCRC, BARI
V ₅	10064	University of Wisconsin, USA	V ₁₇	Diamont	TCRC, BARI
V ₆	10062	University of Wisconsin, USA	V ₁₈	Sarpomira	Local NGO
V ₇	10068	University of Wisconsin, USA	V ₁₉	Courage	Local NGO
V ₈	10125	University of Wisconsin, USA	V ₂₀	Lady Roseta	Local NGO
V ₉	10078	University of Wisconsin, USA	V ₂₁	10016	University of Wisconsin, USA
V ₁₀	10074	University of Wisconsin, USA	V ₂₂	10072	University of Wisconsin, USA
V ₁₁	10120	University of Wisconsin, USA	V ₂₃	Pakistani	Kashmir, Pakistan
V ₁₂	10097	University of Wisconsin, USA			

Potato tubers of each variety were planted at 12 November, 2015 maintaining a spacing of 70cm x 30cm. Cowdung @ 10t/ha was applied during land preparation. TSP @ 200kg/ha applied during final land preparation. Urea and MoP @ 250 and 350Kg/ha respectively applied twice during earthing up. Fungicides were applied time to time to control late blight of potato. Granular insecticides

(Furadan) also applied in the soil to control cutworm (*Agrotis ypsilon*). Harvesting was done on 13 February, 2016. The experiment consisted of three factors where twenty three colored potato varieties (Table 1) were Factor A and the four treatments were Factor B which were applications of Paclobutrazol @ 0, 100, 200 ppm and Maleic Hydrazide @ 500ppm at 48, 60 and 72 days after

planting (DAP) as foliar spray. In each concentration solutions had sprayed adding 20 drops of Tween 80 as adhesive materials. In total there 92 treatments combination. Five plants were selected randomly from each unit plot for the collection of periodical data. Periodical data were taken at 15 days interval on plant height and number of leaves during the growing stage of plants. After harvesting, plant height, no. of branches, no. of tubers/hill, weight of tubers and yield of tubers per hill of the five selected plants were taken and their mean were calculated separately. After taking fresh weight, 100 g of fresh potato tuber were cut into small pieces, dried in the sun for 3-4 days and kept in an oven at 80°C for 72 hours, till a constant weight was achieved. Average dry

weight of 100 g of fresh potato tuber was then calculated in gram (g). The yield of potato tuber per hectare was calculated from the per plot yield and expressed in tons (t). The data were analyzed using GESTAT statistical program. The differences between treatments means were compared using LSD both at 1 % level of significance.

Results and Discussion

The present study was conducted to observe the effect of Paclobutrazol and Maleic Hydrazide on growth and yield of twenty three different varieties of potato. The results on plant height, no. of branches, no. of tubers, weight of tubers, dry weight of 100 gram fresh tuber and yield of tubers were significantly affected by varieties, Paclobutrazol and Maleic Hydrazide (Tables 2-4).

Table 2. Main effect of variety on yield and yield contributing characters of potato

Variety	No. of branches plant ⁻¹	Plant height (cm)	No. of tubers plant ⁻¹	Wt. of tuber plant ⁻¹ (g)	Dry wt. of 100 g fresh tuber	No. of tubers/plot (m ²)	Total yield of potato (t/ha)
V ₁	2.95	93.00	9.80	340.25	27.04	113.25	23.05
V ₂	2.85	59.50	11.05	387.83	22.06	161.50	31.78
V ₃	1.30	36.50	6.35	197.25	18.35	72.25	10.90
V ₄	2.95	82.50	7.55	272.75	18.92	109.00	23.18
V ₅	2.75	53.25	9.45	297.50	20.50	136.75	22.53
V ₆	2.63	57.75	8.05	290.25	19.15	142.75	24.90
V ₇	1.85	48.25	10.20	177.92	20.06	130.75	14.70
V ₈	1.17	43.25	5.35	155.75	23.80	75.00	11.23
V ₉	1.15	42.50	10.00	161.50	23.85	135.83	11.58
V ₁₀	2.25	47.25	14.55	321.25	22.05	197.75	27.00
V ₁₁	1.90	48.50	11.80	338.75	21.18	167.50	25.95
V ₁₂	3.14	52.25	10.25	295.50	20.50	159.50	25.15
V ₁₃	2.85	51.75	11.65	351.50	22.81	174.75	24.90
V ₁₄	2.90	82.50	14.45	516.00	22.18	181.75	33.15
V ₁₅	4.00	57.00	10.00	329.25	20.73	154.75	28.58
V ₁₆	1.85	68.50	8.33	313.00	22.80	133.50	26.28
V ₁₇	2.15	60.75	6.00	306.25	22.65	88.00	21.88
V ₁₈	3.40	51.50	8.10	418.00	22.81	111.00	31.83
V ₁₉	2.05	65.50	6.65	318.00	27.46	91.00	25.60
V ₁₈	1.70	63.50	6.35	360.33	29.88	94.00	28.40
V ₂₀	1.75	56.75	6.50	217.00	19.48	99.00	17.10
V ₂₁	1.70	49.75	6.40	258.42	20.53	102.50	22.10
V ₂₂	1.05	66.25	3.45	177.00	19.66	38.00	12.75
V ₂₃	2.95	93.00	9.80	340.25	27.04	113.25	23.05
LSD _{0.05}	0.116	1.030	0.165	18.740	0.134	2.140	0.445
Level of sign.	**	**	**	**	**	**	**

** Significant at 1% level of probability, V₁=10110, V₂=10076, V₃=10081, V₄=10190, V₅=10064, V₆=10062, V₇=10068, V₈=10125, V₉=10078, V₁₀=10074, V₁₁=10120, V₁₂=1009, V₁₃=10063, V₁₄=10069, V₁₅=10123, V₁₆=Cardinal, V₁₇=Diamont, V₁₈=Sarpomira, V₁₉=Courage, V₂₀=Lady Roseta, V₂₁=10016, V₂₂=10072, V₂₃=Pakistani

Table 3. Main effect of treatment on yield and yield contributing characters of potato

Treatment	No. of branches plant ⁻¹	Plant height (cm)	No. of tubers plant ⁻¹	Wt. of tuber plant ⁻¹ (g)	Dry wt. of 100 g fresh tuber	No. of tubers/plot (m ²)	Total yield of potato (t/ha)
T ₁	2.35	57.57	9.84	313.73	21.92	123.91	22.05
T ₂	2.44	57.22	8.69	276.73	21.66	121.61	21.12
T ₃	2.08	56.83	8.30	294.09	22.21	124.19	23.86
T ₄	2.23	61.13	8.36	298.29	22.63	129.44	24.19
LSD _{0.05}	0.049	0.431	0.069	7.810	0.056	0.893	0.185
Level of sign.	**	**	**	**	**	**	**

** Significant at 1% level of probability, T₁=Water spray, T₂=100ppm Paclobutrazol, T₃=200ppm Paclobutrazol, and T₄=500ppm Maleic Hydrazide

Table 4. Combined effects of variety and treatment on yield and yield contributing characters of potato

Variety x treatment	No. of branches plant ⁻¹	Plant height (cm)	No. of tubers plant ⁻¹	Wt. of tuber plant ⁻¹ (g)	Dry wt. of 100 g fresh tuber	No. of tubers/plot (m ²)	Total yield of potato (t/ha)
V ₁ T ₁	3.00	87.00	12.40	366.00	41.91	103.00	18.30
V ₁ T ₂	3.40	92.00	11.20	384.00	21.31	100.00	19.40
V ₁ T ₃	2.60	95.00	10.20	344.00	24.27	117.00	24.50
V ₁ T ₄	2.80	98.00	5.40	267.00	20.66	133.00	30.00
V ₂ T ₁	3.80	57.00	12.60	396.00	22.64	163.00	29.50
V ₂ T ₂	2.00	63.00	7.40	307.00	21.39	172.00	30.80
V ₂ T ₃	2.00	60.00	12.60	355.00	20.99	173.00	34.50
V ₂ T ₄	3.60	58.00	11.60	493.33	23.22	138.00	32.30
V ₃ T ₁	1.80	42.00	9.80	310.00	19.17	81.00	12.70
V ₃ T ₂	1.60	49.00	3.00	122.00	17.80	61.00	9.30
V ₃ T ₃	1.40	25.00	5.00	178.00	17.23	52.00	9.90
V ₃ T ₄	0.40	30.00	7.60	179.00	19.19	95.00	11.70
V ₄ T ₁	3.40	76.00	10.20	371.00	20.38	106.00	19.90
V ₄ T ₂	2.60	62.00	8.40	204.00	18.18	97.00	13.20
V ₄ T ₃	3.20	100.00	5.60	237.00	19.56	108.00	21.70
V ₄ T ₄	2.60	92.00	6.00	279.00	17.55	125.00	37.90

Table contd.

V ₅ T ₁	2.40	50.00	7.40	217.00	20.40	122.00	16.90
V ₅ T ₂	4.40	49.00	13.00	382.00	19.10	158.00	24.70
V ₅ T ₃	2.00	56.00	8.20	291.00	20.40	136.00	24.90
V ₅ T ₄	2.20	58.00	9.20	300.00	22.10	131.00	23.60
V ₆ T ₁	2.90	62.00	8.20	310.00	19.90	106.00	21.40
V ₆ T ₂	3.00	58.00	8.20	313.00	17.90	107.00	19.20
V ₆ T ₃	2.60	54.00	7.80	219.00	17.60	163.00	27.10
V ₆ T ₄	2.00	57.00	8.00	319.00	21.20	195.00	31.90
V ₇ T ₁	1.60	46.00	8.80	211.00	19.46	130.00	19.30
V ₇ T ₂	2.00	43.00	9.00	125.67	20.47	127.00	13.60
V ₇ T ₃	1.60	59.00	14.80	250.00	19.21	152.00	15.50
V ₇ T ₄	2.20	45.00	8.20	125.00	21.09	114.00	10.40
V ₈ T ₁	1.43	46.00	8.00	216.00	19.20	108.00	14.20
V ₈ T ₂	0.83	46.00	4.60	136.00	21.60	71.00	12.60
V ₈ T ₃	0.97	33.00	2.60	124.00	28.90	54.00	9.70
V ₈ T ₄	1.43	48.00	6.20	147.00	25.50	67.00	8.40
V ₉ T ₁	0.80	47.00	10.20	159.00	19.20	101.00	8.70
V ₉ T ₂	1.00	35.00	10.00	132.00	28.20	126.00	9.10
V ₉ T ₃	1.00	28.00	9.80	131.00	19.30	132.33	10.30
V ₉ T ₄	1.80	60.00	10.00	224.00	28.70	184.00	18.20
V ₁₀ T ₁	2.60	45.00	21.00	411.00	19.20	235.00	29.80
V ₁₀ T ₂	2.20	40.00	12.40	256.00	25.30	152.00	22.50
V ₁₀ T ₃	1.40	47.00	10.80	306.00	22.90	194.00	28.90
V ₁₀ T ₄	2.80	57.00	14.00	312.00	20.80	210.00	26.80
V ₁₁ T ₁	2.20	47.00	9.80	293.00	22.64	142.00	22.80
V ₁₁ T ₂	1.60	50.00	10.60	352.00	20.54	154.00	26.80
V ₁₁ T ₃	1.60	46.00	10.20	392.00	20.04	176.00	28.90
V ₁₁ T ₄	2.20	51.00	16.60	318.00	21.50	198.00	25.30
V ₁₂ T ₁	2.20	55.00	11.60	304.00	20.70	183.00	27.80
V ₁₂ T ₂	4.20	39.00	9.00	208.00	20.10	175.00	25.70
V ₁₂ T ₃	3.17	61.00	9.80	378.00	21.40	147.00	25.80
V ₁₂ T ₄	3.00	54.00	10.60	292.00	19.80	133.00	21.30
V ₁₃ T ₁	3.40	53.00	13.80	430.00	20.70	205.00	31.40
V ₁₃ T ₂	3.20	64.00	12.00	335.00	21.80	200.00	24.90
V ₁₃ T ₃	2.60	47.00	11.40	308.00	20.70	167.00	21.80
V ₁₃ T ₄	2.20	43.00	9.40	333.00	28.04	127.00	21.50
V ₁₄ T ₁	3.00	73.00	17.40	544.00	20.38	201.00	35.20
V ₁₄ T ₂	2.60	97.00	14.00	562.00	20.93	145.00	27.60
V ₁₄ T ₃	2.20	82.00	13.80	476.00	25.76	154.00	26.60
V ₁₄ T ₄	3.80	78.00	12.60	482.00	21.65	227.00	43.20
V ₁₅ T ₁	3.20	63.00	10.60	339.00	18.60	133.00	23.60
V ₁₅ T ₂	3.60	46.00	10.20	277.00	20.70	129.00	20.90
V ₁₅ T ₃	5.80	51.00	11.00	389.00	20.30	166.00	31.90
V ₁₅ T ₄	3.40	68.00	8.20	312.00	23.30	191.00	37.90
V ₁₆ T ₁	1.80	71.00	10.00	325.00	20.88	127.00	23.80
V ₁₆ T ₂	2.20	67.00	9.80	268.00	23.32	129.00	23.40
V ₁₆ T ₃	1.80	59.00	7.73	199.00	25.59	133.00	22.50
V ₁₆ T ₄	1.60	77.00	5.80	460.00	21.39	145.00	35.40
V ₁₇ T ₁	2.60	54.00	5.60	254.00	21.90	70.00	18.30
V ₁₇ T ₂	1.60	72.00	6.80	329.00	22.70	108.00	24.50
V ₁₇ T ₃	1.80	61.00	5.80	354.00	24.20	90.00	24.30
V ₁₇ T ₄	2.60	56.00	5.80	288.00	21.80	84.00	20.40
V ₁₈ T ₁	3.60	51.00	8.20	449.00	20.74	103.00	33.20
V ₁₈ T ₂	5.00	42.00	10.40	347.00	21.45	144.00	31.60
V ₁₈ T ₃	2.60	59.00	6.60	425.00	24.95	111.00	34.60
V ₁₈ T ₄	2.40	54.00	7.20	451.00	24.10	86.00	27.90
V ₁₉ T ₁	2.40	68.00	9.20	408.00	26.80	103.00	25.90
V ₁₉ T ₂	1.80	62.00	5.60	221.00	26.80	84.00	23.90
V ₁₉ T ₃	2.00	64.00	6.60	377.00	28.90	89.00	28.30
V ₁₉ T ₄	2.00	68.00	5.20	266.00	27.33	88.00	24.30
V ₂₀ T ₁	1.60	60.00	5.20	295.00	31.30	77.00	21.10
V ₂₀ T ₂	1.80	61.00	5.60	326.00	30.80	104.00	32.20
V ₂₀ T ₃	1.60	55.00	6.00	400.00	27.01	103.00	32.90
V ₂₀ T ₄	1.80	78.00	8.60	420.33	30.40	92.00	27.40
V ₂₁ T ₁	1.80	63.00	6.60	226.00	16.92	125.00	20.90
V ₂₁ T ₂	2.80	55.00	8.40	270.00	18.04	97.00	17.80
V ₂₁ T ₃	1.40	60.00	6.60	214.00	22.85	94.00	16.80
V ₂₁ T ₄	1.00	49.00	4.40	158.00	20.10	80.00	12.90
V ₂₂ T ₁	1.40	48.00	6.20	219.67	20.30	101.00	25.30
V ₂₂ T ₂	1.60	55.00	5.40	233.00	20.40	107.00	19.20
V ₂₂ T ₃	1.20	45.00	6.40	308.00	19.20	108.00	25.50
V ₂₂ T ₄	2.60	51.00	7.60	273.00	22.20	94.00	18.40
V ₂₃ T ₁	1.00	60.00	3.40	162.00	20.90	25.00	7.10
V ₂₃ T ₂	1.00	69.00	4.80	275.00	19.40	50.00	12.90
V ₂₃ T ₃	1.40	60.00	1.60	109.00	19.53	37.00	21.80
V ₂₃ T ₄	0.80	76.00	4.00	162.00	18.80	40.00	9.20
LSD _{0.01}	0.234	2.079	0.331	37.670	0.270	4.309	0.894
Level of sign.	**	**	**	**	**	**	**

** =Significant at 1% level of probability

Performance of varieties: Growth and yield of different varieties varied significantly (Table 2 and Fig. 1). Different varieties shown different foliage and colored tubers (Plates 1). Accession number V₁₅ produces the

highest number of branches whereas the Accession No. V₂₂ produces the lowest number. Plant height was maximum in V₁ and minimum in V₁₈. The highest yield was obtained from the accessions V₁₈ and the lowest in V₈ (Fig. 1).



Plate 1. Foliage and tubers growth different varieties of potato (V₁ to V₂₃)

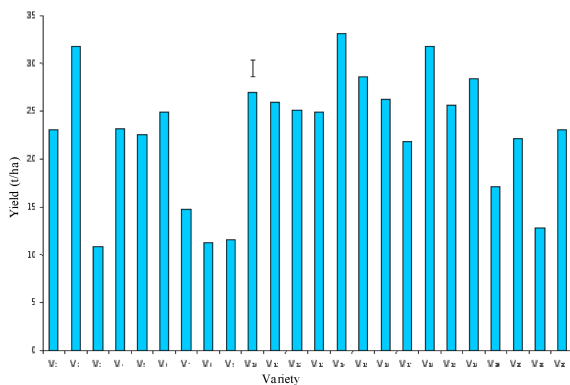


Fig. 1. Performance of different potato varieties in respect of tuber yield.

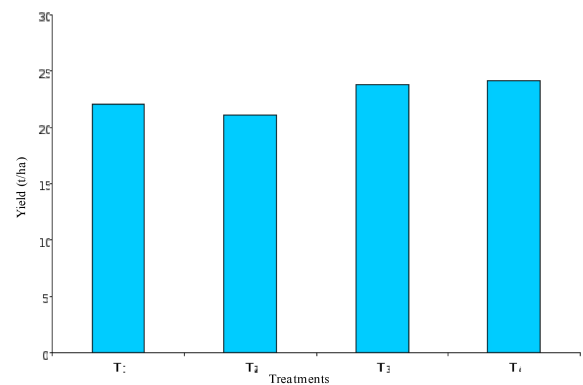


Fig. 2. Effects of different treatments on the yield of potato tuber.

Effect of Paclobutrazol and Maleic Hydrazide on the growth and yield of potato: Different doses of Maleic Hydrazide also are shown significant differences both in respect of growth and yield of potato (Table 3 and Fig. 2). Paclobutrazol at 100 ppm produced the maximum number of branches whereas yield of tubers was the highest in T₄ (500ppm maleic hydrazide) Fig. 2.

Combined Effect of varieties and treatments on the growth and yield: Combined Effect of varieties and treatments on the growth and yield potato also showed significant variations (Table 3 and Fig. 3). Wide range of variations was found among the treatments.

Colored varieties not only given higher yield also antioxidant. Accession numbers AC10063, AC10076 and AC10081 found better in respect of growth, yield and appearance among the twenty three accessions of potato.

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