PRELIMINARY STUDIES ON YIELD AND SOME YIELD ATTRIBUTES OF POTATO GROWN UNDER HIGH AND LOW AMBIENT TEMPERATURES

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ABSTRACT

Forty-eight potato genotypes from various sources were evaluated at two warm locations and a cool mid-altitude location as part of a study on the adaptation of potato genotypes to heat stress. The experiment aimed at clarifying the inter-relationship between yield and some agronomic characters through path coefficient analysis with a view to identifying suitable plant characters as selection index for potato breeding. Significant positive correlation coefficients were established between tuber yield and each of the following attributes namely: plant emergence, stem number, number of leaves, tuber number and average tuber weight; significant negative correlation coefficients was established between tuber yield and the number of wilted stands, days to tuber initiation, and maturity. Through partial correlation method it becomes clear that tuber number (partial r = 0.86) and average tuber weight (partial r = 0.70) were the major individual contributors to yield. This was corroborated by the path-coefficient analysis which showed tuber number and average tuber weights as the major factors exerting both direct and indirect influences on yield. It was concluded that both tuber number per plant and average tuber weight per plant could be used as selection indices for high yields in potato grown in climates with optimal and supra-optimal temperatures.

Key words: High temperatures, Path-coefficient analysis, Potato genotypes, Selection

INTRODUCTION

Potato cultivars are generally best adapted to cool temperate zones (Hawkes, 1978) and grow best at temperature range of about 15-20°C (Borah and Milthorpe, 1962). Potato production has rapidly expanded to tropical and subtropical areas of the world, becoming one of the most valuable staple foods due to its high nutritional value (Van der Zaag and Horton, 1983). In tropical lowlands potatoes are exposed to day and night temperatures far above the optimum leading to a significant loss of tuber yield and quality in most cultivars (Levy, 1983). The adverse effect of high temperature on tuber yield and quality of potato is a major obstacle for potato production in hot regions. Hence local breeding of heat tolerant cultivar has been suggested to improve potato crops in hot environment (Levy, 1984).
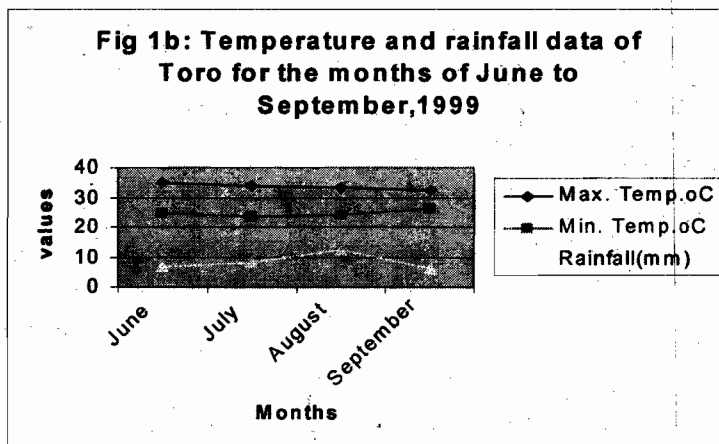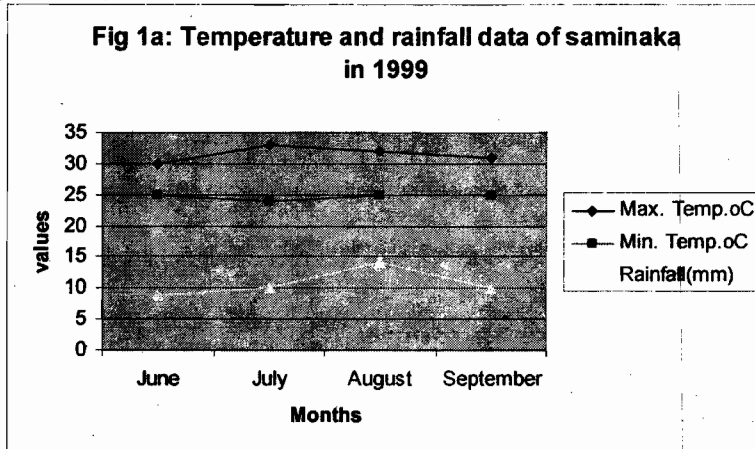
Analysis of genetic variability and inter-relationship among important agronomic characters in the available germplasm is vital to the breeding of heat tolerant cultivars. Evaluating genotypes simultaneously at locations with optimal and supra-optimal temperatures not only enables the detection of genotype x environment interactions but also better understanding of the nature of association between tuber yield and other trait of agronomic importance. This present paper is part of a study on the adaptation of potato genotypes to heat stress and it aims at clarifying the inter-relationship between yield and some agronomic traits in the potato germplasm exposed to optimal and supra-optimal temperatures using the combined data from different locations.
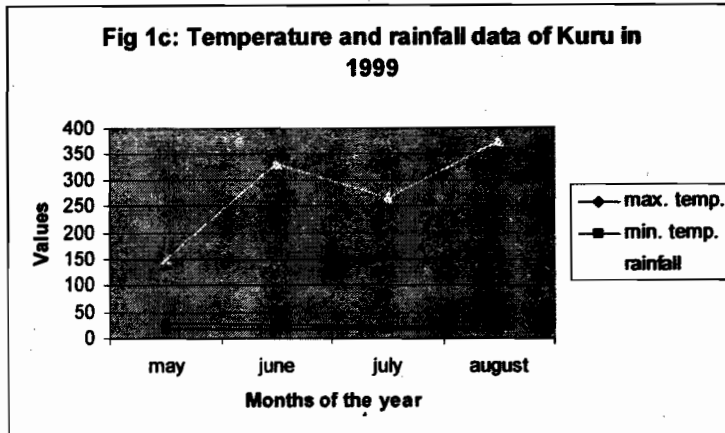
MATERIALS AND METHODS

The experiment was carried out in 1999 at three locations in Nigeria namely Saminaka - a warm location (Lat. 10° 27'N and Long 4°E in Kaduna State); Toro - a warm location (Lat. 10°3'N, and Long 9°E in

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Bauchi State) and Kuru - a cool mid attitude location ((Lat. $09^{0}44'N$, Long. $08^{0}47'E$ and Alt.1350m on the Jos Plateau). Rainfall and temperature data of Saminaka, Toro and Kuru during the period of the experiment are shown if Figs 1a 1b and 1c respectively. Forty-eight genotypes from various sources were evaluated. These genotypes were laid out in a randomized complete block design with 3 replications in each of the localities. Net plot size was $(3x1)m^{2}$ and gross plot size was $(3x3)m^{2}$. The seed tubers were planted at the rate of one tuber per stand and an intra-row and inter-row spacing of 30cm and 1m respectively giving a plant density of 33,333 plants per hectare. Weeding was carried out manually at 4 and 8 weeks after planting (WAP). Fertilizer was applied at the rate of 100kg N, 100kg P_2O5 and 40kg K_2O per hectare by side banding two weeks after planting. No fungicide was applied. The plants were harvested when the leaves began to senesce. Data collected includes plant emergence at 4 weeks after planting (WAP), number of stems per plant, plant height (cm), number of leaves per plant, days to tuber initiation, days to maturity, severity of early blight, number of wilted stands, number of tubers per plant , average tuber weight/plant, and tuber yield per plant.

Statistical analyses were performed on plot means for all attributes. Location specific and combined analysis of variance (ANOVA) was carried out using Michigan state University statistical software version C. (MSTAT C). Pearson's simple correlation, partial correlation, multiple correlation and regression analyses were carried out using the STATVIEW for windows software. Path-coefficient analysis was carried out according to the method outlined by Dewey and Lu, (1959).

Fig 1a: Temperature and rainfall data of saminaka in 1999

Fig 1b: Temperature and rainfall data of Toro for the months of June to September,1999

Fig 1c: Temperature and rainfall data of Kuru in 1999

RESULTS AND DISCUSSION

The potato genotypes differed significantly in all the attributes assessed at all locations and also on the basis of the combined data (Tables1-4). The simple correlation coefficients obtained for the relationship between different attributes based on the combined data are shown in Table 5. All the attributes except early blight had significant associations with tuber yield per plant. There were significant positive correlation between tuber yield and each of the following attributes namely plant emergence, stem number, number of leaves, tuber number and average tuber weight. Conversely, significant negative correlation coefficients were established between tuber yield and the number of wilted stands, days to tuber initiation, and maturity respectively. Lopez et al (1987) reported a significant positive correlation between plant height and tuber yield; and between tuber number and tuber yield. However data from Birhman and Kang, (1993) showed no significant correlation between number of tubers and tuber yield under both long and short day conditions. The association between tuber number and average tuber weight was not significant (r =0.023). Various authors have reported either a negative or absence of relationship between tuber number and average tuber weight (Birhman and Verma, 1986; Amadi, 2005).

The real effects on yield as judged from the simple regression coefficients were significant for all attributes in some locations except for early blight (Table 6). The coefficients of determination (Table 7) show that the highest contributors to yield at most of the locations were tuber number and average tuber weight. At Kuru and Toro, the contribution of number of stems/plant and plant height were relatively high. However, after fixing the effects of the other attributes by the method of partial correlation coefficients using the combined data (Table 8) it become clear that tuber number (partial r = 0.86) and average tuber weight (partial r = 0.70) were the major individual contributors to yield. This is corroborated by the path-coefficient analysis (Table 9) which shows that tuber number and average tuber weights not only exerted the highest direct influence on yield but were also the major indirect means through which the other attributes influenced yield. Potato tuber yield is a function of the tuber number and average tuber weight (Birhman and Kang, 1993). Sidhu and Pandita (1979) considered tuber number to be more important than average tuber weight in determining tuber yield, where as Birhman and Verma (1986) considered the contrary to be true. Lynch and Kozub (1991) observed that while tuber number was more important for determining tuber yield in some progenies and environments, it was average tuber weight that was more important for tuber yield determination in other genotypes and environments. Results obtained from this experiment indicate that tuber number was more important in determining tuber yield. Multiple regresssion coefficient and coefficient of determination based on the combined data were significant (Table 10). The high coefficient of determination ($R^2 = 0.938$, P<0.05) indicates

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Table1: Means for various attributes of some the potato genotypes studied at Kuru in 1999

Genotype	% plant emergence (4WAP)	No. stem/ plant	Plant height (cm)	No. of leaves/ plant	Days to tuber Initiation	Days to maturity	*Early blight severity	No. wilted stands	No. of tubers/pt.	Average Tuber weight/ pt.	Tuber yield /plant (g)
Desiree	93.3	2.23	40.60	97.93	33.00	86.33	3.00	1.00	6.90	88.25	613.33
RC7716-3	100	2.87	48.10	62.20	28.33	75.33	3.67	0.33	9.53	62.75	593.33
392280.1	80.0	2.70	39.03	62.53	31.00	81.33	3.00	0.33	8.33	70.80	586.67
377865.35	86.7	2.83	42.33	66.47	32.00	83.00	2.67	0.67	6.77	76.16	513.33
392281.040	76.7	2.43	44.67	62.93	34.00	84.00	3.00	1.33	9.17	57.38	506.67
ML98.14	90.0	2.20	50.10	66.60	29.00	79.00	3.00	0.00	5.00	96.57	480.00
Famosa	80.0	2.60	44.63	62.03	30.00	84.33	3.00	0.67	7.10	64.99	473.33
RC7716-3	83.3	1.93	38.87	59.33	33.00	81.00	3.00	1.00	7.33	65.83	466.67
392228.045	80.0	2.17	27.57	53.40	27.67	71.67	3.33	3.00	9.03	52.26	460.00
WC732-1	70.0	2.07	37.97	81.07	34.00	82.00	4.67	3.33	4.63	104.95	456.67
VC785-2	96.7	1.73	46.73	66.83	29.00	74.00	2.67	0.00	5.20	88.68	453.33
Baraka	83.3	2.67	42.00	35.60	32.00	84.33	4.00	1.00	8.23	53.60	433.33
392282.010	83.3	2.00	40.83	54.33	34.00	83.00	3.00	1.67	9.63	44.99	430.00
RC7716-17	90.0	1.90	36.93	35.47	30.00	73.67	4.67	1.00	6.80	62.08	423.33
BR63-18	93.3	1.97	29.93	29.97	30.00	78.00	4.00	1.33	6.50	65.75	423.33
391538.3	80.0	1.90	38.73	53.03	32.67	80.00	3.67	0.67	9.10	45.39	416.67
Bertita	96.7	1.77	35.70	31.03	28.00	73.00	4.33	1.33	4.27	100.25	410.00
392278.4	86.7	2.57	35.43	48.87	33.00	83.67	4.33	1.00	7.83	52.70	406.67
CV%	14.87	26.48	10.70	29.34	4.59	2.92	13.96	78.66	24.06	27.38	24.71
SED	1.02	0.40	3.14	2.77	0.22	0.55	0.40	1.72	1.17	15.15	76.13

*Early blight severity was recorded at 10 weeks after planting based on a scale developed by Martin and Thurston, (1987). The scale ranges from 1 to 9 with a mid point of 4 were 1 = no blight spots seen on the foliage; 4 = 25 50% of the foliage infected by blight; 9 = foliage completely covered/killed by blight

that 93.8% of the variation in tuber yield can be attributed to the 10 plant characters assessed. Results obtained from this experiment suggests that tuber number and average tuber weight are the important determinants of tuber yield and could be relied upon as indices for the selection of high yielding potato genotypes for growth in both cool and warm environments.

Studies on yield attributes of potato

Table 2: Means for various attributes of some of the potato genotypes studied in Toro in 1999

Genotype	Plant emergence /m^2 (4WAP)	Stem number plant	Plant height (cm)	Number of leaves /plant	Days to tuber initiation	Days to maturity	*Early blight	Number wilted plants /m^2	Tuber number /plant	Average tuber weight(g)	Tuber weight /plant (g)
VC785-2	2.4	2.00	57.07	66.50	47.00	81.33	4.00	0.6	5.40	52.14	281.56
Desiree	3.0	1.90	63.47	111.80	50.00	92.33	3.00	1.4	6.13	45.49	278.87
377865.35	2.7	2.17	50.40	76.10	44.67	87.33	4.00	0.9	5.93	46.99	278.67
392281.040	3.1	2.23	48.53	59.63	42.00	90.00	4.00	1.1	6.13	45.35	278.00
WC732-1	2.9	1.63	45.03	89.13	47.67	88.67	4.00	1.3	5.07	53.21	269.77
RC7716-3	2.6	2.17	59.97	69.53	47.00	82.00	3.00	0.7	5.37	49.55	266.10
Bertita	3.0	1.83	58.73	36.33	42.00	80.00	4.00	1.4	4.80	54.61	262.23
Famosa	2.6	2.20	50.03	68.60	49.33	89.33	3.00	1.3	3.57	71.71	256.00
B9449-17	2.9	1.83	35.40	40.20	50.00	85.67	4.00	1.0	5.20	48.79	253.77
Accent	2.3	1.50	42.90	43.00	43.33	91.00	3.67	0.8	5.73	43.61	249.87
Redone	2.9	2.33	58.93	41.80	49.33	87.00	5.00	0.4	6.80	34.62	232.67
387300.8	3.1	1.70	48.93	154.27	46.33	86.67	3.00	0.9	4.83	47.25	228.20
Kondor	2.2	2.23	47.20	36.93	52.00	92.33	3.00	0.9	5.03	44.86	223.77
392011.041	2.3	2.13	46.83	35.90	54.00	89.00	4.00	0.8	5.00	44.41	221.67
RC7716-3	2.3	2.20	57.10	68.13	48.00	81.00	4.00	0.8	5.57	39.58	220.83
392278.4	2.7	2.10	47.17	56.90	45.33	88.67	5.00	0.9	6.00	36.76	220.53
Alpha	2.8	1.57	47.87	51.20	56.00	94.33	3.00	1.1	4.30	51.17	218.33
392010.12	3.1	1.67	44.33	60.40	48.00	89.33	4.00	1.2	5.93	36.53	216.67
CV%	5.6	19.41	12.07	27.88	5.00	2.45	2.20	8.2	21.04	16.64	23.25
SED	1.08	0.16	2.63	2.84	0.35	0.28	0.07	0.18	0.47	5.88	25.56

*Early blight severity was recorded at 10 weeks after planting based on a scale developed by Martin and Thurston, (1987). The scale ranges from 1 to 9 with a mid point of 4 were 1 = no blight spots seen on the foliage; 4 = 25 50% of the foliage infected by blight; 9 = foliage completely covered/killed by blight

Table 3: Mean for various attributes of some potato genotypes studied at Saminaka the year 1999

Genotype	% Plant emergence (4WAP)	Number of stems/ plant	Plant height (cm)	Number of leaves /plant	Days to tuber initiation	Days to maturity	*Early blight severity	Number of wilted stands/m^2	Number Tuber /plant	Average tuber weight/ plant	Tuber Yield /plant (g)
RC7716-3	70	2.10	60.8	68.3	51.0	84.7	3.0	1.22	3.5	72.7	225.6023
Desiree	90	3.00	62.4	110.5	54.0	94.0	3.0	1.56	5.3	43.3	219.0022
392277.41	90	2.07	50.2	51.5	45.0	85.0	4.0	0.89	7.1	33.1	210.0021
Accent	73	2.60	40.8	44.8	45.0	90.0	4.0	1.33	6.0	34.3	198.302
377865.35	73	1.73	47.8	71.1	52.0	89.0	3.0	1.00	5.1	42.5	195.002
392281.040	77	2.07	44.9	57.1	46.0	92	4.0	1.00	5.2	42.2	191.1019
Kondor	73	1.60	46.3	38.1	54.0	94.0	3.0	1.22	4.8	43.0	189.3019
RC7716-17	90	2.03	46.0	41.3	48.0	81.0	5.0	0.89	3.5	38.4	188.4019
Baraka	83	1.80	41.6	43.7	46.0	92.0	3.0	0.89	6.0	32.4	188.4019
392246.017	67	1.43	36.1	44.6	44.0	89.0	4.0	1.22	4.0	52.0	187.8019
392280.1	80	2.00	42.3	56.8	47.0	86.3	3.0	0.89	3.0	66.7	185.7019
Bertita	77	1.87	56.6	39.3	46.0	80.0	4.0	1.33	4.3	46.5	177.3018
WC732-1	73	2.63	42.3	87.6	50.0	90.0	4.0	1.67	4.0	39.8	169.5017
392228.045	57	1.93	34.1	49.6	44.0	82.7	5.0	1.44	4.6	40.5	164.4016
392286.14	80	1.43	46.1	62.1	49.0	97.0	4.0	1.00	4.8	34.0	163.2016
B9449-17	83	1.70	36.5	46.0	54.0	87.7	3.3	0.89	5.2	32.8	157.8016
392282.010	60	1.37	54.5	62.9	50.0	93.0	3.0	1.11	3.7	44.7	157.2016
BR63-18	80	2.40	45.9	33.1	45.0	86.0	4.0	1.78	3.2	47.5	154.5015
387300.8	90	1.30	51.3	148.7	50.0	91.7	3.0	1.00	3.9	41.2	151.5015
CV%	12.6	17.8	5.98	8.49	0.28	0.55	6.40	20.52	25.56	18.54	24.88
SED	7.881	0.268	2.272	3.753	0.117	0.405	0.187	0.187	0.794	6.197	29.46029

*Early blight severity was recorded at 10 weeks after planting based on a scale developed by Martin and

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Thurston, (1987). The scale ranges from 1 to 9 with a mid point of 4 were 1 = no blight spots seen on the foliage; 4 = 25 50% of the foliage infected by blight; 9 = foliage completely covered/killed by blight

Table 4: Mean of various attributes of some the potato genotypes evaluated across 3 locations based on combined data

Genotype	%Plant Emergence (4WAP)	Number of stems /plant.	Plant height (cm)	Number of Leaves /plant.	Days to Tuber Initiation	Days to maturity	*Early blight score	Number of Wilted stands	Number of Tubers /plant.	Average Tuber Weight /plant (g)	Tuber yield /plant (g)
Desiree	91.1	2.38	55.50	106.73	47.00	92.11	3.00	1.111	6.23	60.62	398.11
RC7716-3	82.2	2.38	56.28	66.69	43.44	80.67	3.22	0.667	6.12	65.10	378.32
377865.35	80.0	2.24	46.83	71.21	45.33	86.89	3.22	0.704	5.92	58.31	345.66
392281.040	82.2	2.24	46.03	59.88	42.00	89.33	3.67	0.852	7.17	47.01	330.81
VC785-2	83.3	1.88	53.14	65.70	43.67	78.78	3.33	0.519	4.72	65.33	313.51
392280.1	80.0	2.00	42.46	59.48	41.67	85.22	3.00	0.630	4.94	61.73	311.67
WC732-1	76.7	2.11	41.76	85.92	45.00	87.33	4.22	1.370	4.58	66.72	302.40
Bertita	87.8	1.82	50.34	35.56	40.00	77.67	4.11	1.074	4.44	71.87	299.81
Famosa	77.8	2.21	48.92	65.33	45.33	88.78	3.00	0.889	4.79	60.81	298.11
392228.045	74.4	2.09	33.31	50.82	38.56	77.67	4.44	1.074	7.07	40.94	282.21
ML98.14	76.7	2.20	46.00	61.90	39.00	83.67	3.67	0.630	4.18	62.99	273.51
Kondor	73.3	1.80	41.50	34.64	48.00	93.00	3.33	1.037	5.17	52.80	267.73
BR63-18	86.7	1.96	40.62	33.38	39.67	83.00	4.00	1.222	4.87	51.79	261.47
RC7716-3	80.0	1.81	50.10	63.86	45.33	82.00	3.33	0.704	5.17	47.39	260.64
Baraka	80.0	2.27	41.46	40.57	41.33	89.44	3.33	0.593	6.59	38.09	259.26
RC7716-17	87.8	2.00	42.47	39.02	41.67	78.44	4.89	0.519	4.90	45.42	256.68
Redone	92.2	2.14	48.14	40.29	43.78	84.67	4.56	0.481	6.02	42.23	254.40
CV%	15.0	19.2	7.8	7.2	0.7	0.6	8.9	33.6	24.6	24.6	25.3
SED	5.61	0.171	1.574	1.810	0.144	0.253	0.151	0.392	0.532	5.869	28.79

*Early blight severity was recorded at 10 weeks after planting based on a scale developed by Martin and Thurston, (1987). The scale ranges from 1 to 9 with a mid point of 4 were 1 = no blight spots seen on the foliage; 4 = 25 50% of the foliage infected by blight; 9 = foliage completely covered/killed by blight

Table 5: Simple correlation matrix for the relationship between potato attributes based on combined data from three locations

Attributes	Number of Stems /plant	Plant height (cm)	Number of leaves /plant	Days of tuber initiation	Day to maturity	Early blight severity	Number of wilted stands/m²	Number of Tuber /plant	Average tuber weight /plant	Tuber yield/plant
%Plant emergence (4WAP)	.012	-.032	.130**	-.238**	-.147**	.032	-177**	138**	.165*	.223**
Number of stems /plant		.121*	.081	.000	-.034	.025	0.33	.246**	-.66	.229**
Plant height (cm)			.343**	.519**	.308**	-.146**	.299*	-.148**	-.199**	-.221**
Number of leaves/plant				.109*	.143**	-.226**	.074	.043	.091	.124**
Days to tuber initiation					.676**	-.020	.547**	-.444**	-.563**	-.700**
Days to maturity						-.121*	.378**	-.356**	-.401**	-.526**
Early blight severity							-.016	.030	-.118*	-.093
Number of wilted stands/m²								-.315**	-.313**	-.457**
Number of tubers /plant									.023	.692**
Average tuber weight /plant										.655**

$N = 432$, * = $P<0.05$, ** = $P<0.01$, *** = $P<0.001$

Table 6: Simple regression coefficients between tuber yield and 10 potato plant attributes at 3 locations and based on combined data.

Attributes	Saminaka	Toro	Kuru	Combined data
Emergence (4 WAP)	-0.21 ns	10.75 **	7.19 ns	21.385***
Number of stems /plant	19.44 **	0.05 ns	108.20***	57.046***
Plant height (cm)	1.33**	3.96 ***	6.50***	-3.191***
Number of leaves/plant	0.56 **	1.10 ***	1.82***	0.784***
Days to tuber initiation	-3.04**	0.44 ns	-7.93*	-9.624***
Days to maturity	-1.77*	-1.60 ns	-6.15**	-11.895***
Early blight severity	-2.64 ns	-4.01 ns	-12.92ns	-16.926 ns
Number of wilted stands/m²	3.34 ns	12.82*	-7.15ns	-44.339***
Number of tubers/plant	20.94**	31.69***	33.44***	48.269***
Average tuber wt./plant	1.60*	3.89***	1.630***	4.358***

Dependent variable = Tuber yield, * = $P<0.05$, ** = $P<0.01$, *** = $P<0.001$,
ns = not significant

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Table 7: Coefficient of determination (R^2) and standard error of the estimate for the regression of yield on ten attributes at different locations and based on combined data

Attributes	location									
	Kuru		Toro		Saminaka			Combined	
	R^2	Std error of Estimate	R^2	Std error of Estimate	R^2	Std error of Estimate		R^2	Std error of Estimate
Plant emergence(4WAP)	0.006	122.68	0.046	69.76	0.000	47.221		.050	128.144
Number of stems /plant	0.305	106.77	0.000	71.42	0.060	45.772		.053	127.944
Plant height(cm)	0.148	113.59	0.208	63.58	0.042	46.209		.049	128.225
Number of leaves/plant	0.089	117.45	0.114	67.21	0.056	45.873		.015	130.452
Days to tuber initiation	0.032	121.08	0.001	71.40	0.081	45.280		.490	93.866
Days to maturity	0.063	119.17	0.012	70.99	0.027	46.578		.277	111.784
Early blight severity	0.007	122.65	0.002	71.37	0.001	47.192		.009	130.891
Number of wilted stands/m^2	0.005	122.75	0.032	70.28	0.005	47.115		.209	116.56
Number of tubers /plant	0.363	98.93	0.324	58.71	0.383	37.096		.479	94.907
Average tuber wt./plant	0.083	117.86	0.451	52.94	0.125	44.161		.428	99.400

Table 8: Partial correlation coefficient between tuber yield and ten potato attributes based on combined data of 3 locations

Attribute	Partial correlation coefficient
Plant emergence 4WAP	0.079 ns
Number of stems /plant	0.071 ns
Plant height(cm)	0.060 ns
Number of leaves/plant	0.100 ns
Days to tuber initiation	0.048 ns
Days to maturity	-0.013 ns
Early blight severity	0.141 ns
Number of wilted stands/m^2	0.104 ns
Number of tubers/plant	0.863 ***
Average tuber weight/plant	0.786***

*** = P<0.001,
ns = not significant

Table 9: Path analysis showing direct and indirect influences of ten attributes on tuber yield of potato genotypes based on the combined data from three locations

Character	Direct effect	Indirect effect via										Corr. Coef. (r)
		Plant emergence (4WAP)	Number of stems /Plant	Plant Height (cm)	Number of leaves/pt	Days to Tuber initiation	Days to maturity	Early Blight Severity	Number of wilted stands/m²	Number Of tubers /plant	Average Tuber Weight /plant	
Plant Emergence (4WAP)	0.013	1	-0.00108	0.00006	0.00341	0.00690	0.00015	-0.00115	0.00566	0.09094	0.10512	0.223
Number of stems /Plant	0.072	-0.00020	1	-0.00027	0.00229	-0.00058	0.00006	-0.00216	0.00010	0.21352	-0.05577	0.229
Plant Height (cm)	-0.002	-0.00416	0.00986	1	0.00900	-0.01514	-0.00031	0.00529	-0.0096	-0.08765	-0.13012	-0.221
Number of leaves/plant	0.026	0.00170	0.00634	-0.00069	1	-0.00316	-0.00014	0.00814	-0.00234	0.02900	0.05833	0.124
Days to Tuber initiation	-0.029	-0.00309	0.00014	-0.00104	0.00283	1	-0.00068	0.00072	-0.01728	-0.29194	-0.36152	-0.700
Days to maturity	-0.001	-0.00191	-0.00432	-0.00063	0.00372	-0.01960	1	0.00436	-0.01210	-0.23790	-0.25768	-0.526
Early Blight Severity	-0.036	0.00042	0.00432	0.00029	-0.00588	0.00058	0.00012	1	0.00051	0.01779	-0.07500	-0.093
Number of wilted stands/m²	-0.032	-0.00230	-0.00022	-0.00060	0.00190	-0.01586	-0.00038	0.00058	1	-0.20693	-0.20127	-0.457
Number Of tubers/plant.	0.659	0.00179	0.02333	0.00027	0.00114	0.01285	0.0036	-0.00097	0.01005	1	-0.01538	0.692
Average Tuber weight/plant	0.641	0.00213	-0.00626	0.00041	0.00237	0.01636	0.00040	0.00421	0.01048	-0.01582	1	0.655

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Table 10: Multiple correlation and regression of tuber yield on ten potato plant attributes based on the combined data from 3 locations.

Source of variation	degree of freedom	sum of squares	mean squares	f value
Regression	10	258650.96	25865.096	59.544***
Residual	133	57773.035	434.384	
Total	143	316424.00		

*** Significant at P<0.001

Coefficient of determination = 0.938

Multiple correlation = 0.904***

Standard error of estimate = 20.842

$Y = -161.412 -1.368X_1 +3.154X_2 +0.195X_3 +0.115X_4 +0.273X_5 -0.066X+5.580X_7+2.400X_8 +30.366X_9 +3.017X_{10}$

Where X1 = Plant emergence, X2 = Number of stems/ plant, X3 =Plant height (cm), X4 =Number of leaves/plant, X5 =Days to tuber initiation, X6 =Days to maturity, X7 = Early blight, X8 = Number of wilted stands/m², X9 = Number of tubers/plant X10 = Average tuber weight/plant

CONCLUSION

Results obtained from this study indicate that tuber number and average tuber weight are the important determinants of tuber yield and could be relied upon as selection indices for high yielding potato genotypes in both cool and warm environments.

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