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Correlation and Path Analysis Between Yield and Yield Components in Potato (*Solanum tubersum* L.)

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Abstract: This experiment was conducted at Ardabil, Iran region during the rabbi crop season of 2008-2009 in a randomized complete Block with three replications using with ten genotypes to the relations among tuber yield and some traits of potato using correlation and path coefficient analysis. Stronger positive and significant correlations were found between starch content and dry matter content (R=1). Stronger positive correlations were found between tuber yield and main stems/plant (r= 0.925), plant tuber weight (r=0.992), plant height (r=0.843). Compared to the simple correlation analysis, path analysis of tuber yield and its traits demonstrated that plant height, medium tuber weight and big tuber weight evolved the highest direct influence, 2.19, 0.867 and 0.656, respectively. So, to increase the performance of these traits path analysis can be used.

Key words: Correlation · Path analysis · Potato · Yield component

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important food crops of Iran as well as of many countries of the world [1]. Potato (*Solanum tuberosum* L.) is one of the most important crops in Iran and is cultivated on 195,000 ha with 4,200,000 tons production [2]. High yield with good quality is the most important objective in potato breeding. Tuber yield is a complex character associated with many interrelated components. Generally, a path coefficient analysis is needed to clarify relationships between characteristics, because correlation coefficients describe relationships in a simple manner. Path coefficient analysis shows the extent of direct and indirect effects of the causal components on the response component. In most studies involving path analysis, researchers considered the predictor characters as first-order variables to analyze their effects over a dependent or response variable such as yield [3-8]. This approach might result in multi callinearity for variables, particularly when correlations among some of the characters are high [9]. There may also be difficulties in interpretation of the actual contribution of each variable, as the effects are mixed or confounded because of callinearity. Samonte *et al*. [9] Adopted a sequential path analysis for determining the relationships between yield and related characters in rice (*Oryza sativa* L.) by organizing and analyzing various predictor variables in first, second and third order paths. Agrama [10] and Mohammadi *et al*. [11] used this model for determining interrelationships among grain yield and related characters in maize. Yildirim *et al* [6] suggested that mass selection with few cycle of recurrent selection could be practiced for its improvement. Selection for storage root yield, which is a polygenic trait, often leads to changes in other characters. Therefore, know ledge of the relationship that exist between storage root yield and other characters and also interrelationships among various characters is necessary to be able to design appropriate selection criteria in sweet potato breeding program. According to Grafuis [12], increasing total yield would be made easier by selecting for components because the components are more simply inherited than be total yield itself. Thus, studies on correlation enable the breeder to know the mutual relationship between various characters and determine the component characters on which selection can be used for genetic environment. In study by Hossain *et al.* [13], average root weight and number of roots per plant had maximum positive direct effect on sweet potato root yield. The aim of this study is to evaluate tuber yield components and their interrelationship by path analysis.

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MATERIALS AND METHODS

The study was carried out at Ardabil region, Iran, during 2008 growing season under Rainfed condition. According to 10-year statistics of meteorological station, annual precipitation is 310 mm and means annual temperature is 8.6°C. Mean minimum temperature is -22°C (Dec-Jan) and mean maximum temperature is +30°C (Jul-Aug). The altitude is 1350 m from sea-level. To determine the physical and chemical characteristics of the soil, it was sampled from the depths of 0-30 and 30-60 cm before soil preparation (Table 1).

Ten potato genotypes were used for this study. The experiment was arranged in a randomized complete block design with three replications. Each genotype was planted on a 3 m long and 2.5 m wide plot consisting of five rows, which accommodated ten plants per row and thus forty plants per plot. A distance of 1 m was maintained between the plots. Nitrogenous fertilizer (ammonium sulfate 21% at 160 $kgha^{-1}$) was applied before sowing and all standard agronomic practices were applied. Samples were obtained in the second week. Agronomic characters ere determined on five plant randomly selected in the mid-rows all of plots. Tuber yield (kg ha^{-1}), plant height (cm), main stems/ plant, tuber/ plant, average tuber weight(g), plant tuber weight(kg), dry matter content(%), starch content(%), small tuber(20-35mm) percentage(%), medium tuber(30-55mm) percentage(%), big tuber(>55mm) percentage(%) were determined. F or analyzing test data from software MATATC, SPSS 10 was used and PATH2. Path analysis for performance based on characters remaining stepwise multivariate regression method was performed. Resulted data were subjected to analysis by SPSS procedure and means of treatments were compared using Duncan's multiple range tests in 0.01 percent.

RESULTS AND DISCUSSION

Means of tuber yield varied between 85600 and 24000 kg/ha. Plant height ranged from 28.4 to 71.2 cm. the average tuber weight was between 39 to 127 g, whereas tuber weight was between 202 to 564g. The main stems/plant, tuber/plant, dry matter content, starch content, small tuber percentage were between 2.8 and 4.4%, 6.1 and 7.2%, 14.3 and 22.7%, 9.7 and 14.3%, 10.1 and 25.5%, 20.4 and 29.3%, 27.8 and 64.3% respectively (Table 2). In addition to, the lowest CV was Determined for main stem/plant as 4.2%, the highest CV was determined for the small tuber percentage (22.1%). Similar results were obtained by previous researches [14-16].

Stronger positive correlations were found between tuber yield and main stems/plant (r= 0.925), plant tuber weight (r=0.992), plant height (r=0.843). These results showed that any positive increase in such characters will suffice the boast in tuber yield. These findings were in similar with the results of other researches[16]. On the other hand, negative and significant correlations were determined between tuber yield and medium tuber

Table 1: Soil analysis

Soil type	Soil texture Sand	Silt	Clay	Absorbent Potassium (ppm)	Absorbent Phosphorus (ppm)	Total nitrogen (percent)	Organic carbon (percent)	Neutral-reacting material (percent)	Total acidity (PH)	Electrical conductivity (ds / m)	Saturation	Depth (cm)
Clay loam	31	41	28	460	4/8	0/103	0/97	4/8	7/8	2/66	48	0-30
Clay	40	36	24	290	2	0/056	0/47	7	8/2	2/4	45	30-60

Table2: Some statistical parameters of potatoes cultivars

Traits	Minimum	Maximum	Mean	CV%
Plant height (cm)	28.4	71.2	51.22	16.8
Main stem/plant	2.8	4.4	3.94	4.2
Tuber/plant	6.1	7.2	6.4	14.3
Average tuber weight (g)	39	127	84.5	19.5
Tuber weight (g)	202	564	325.4	16.9
Tuber yield (kg/ ha)	85600	24000	16920.42	18.4
Dry matter content (%)	14.3	22.7	17.94	11.6
Starch content (%)	9.7	14.3	12.27	18.3
Small tuber percentage	9.3	14.2	18.9	22.1
Medium tuber percentage	20.4	29.3	24.3	14.8
Big tuber percentage	27.8	64.3	48.59	19.7

Tbale 3: Correlation coefficient among potato traits

	TY	PH	MS	TN	ATW	PTW	DMC	SC	STP	MTP	BTP
TY	1	0.84**	0.92**	0.74**	0.81**	0.99**	0.40	0.11	0.12	-0.67**	0.64**
PH		1	0.694**	0.749**	0.849**	0.925**	0.246	0.104	0.312	-0.69**	0.597**
MS			1	0.894**	0.927**	0.749**	0.128	0.047	-0.097	-0.56**	0.677**
TN				1	0.746**	0.904**	0.199	0.411	-0.128	-0.409*	0.328*
ATW					1	0.947**	0.407*	0.411*	0.247	-0.42**	0.411**
PTW						1	0.410*	0.396*	0.0411	-0.50**	0.517**
DMC							1	1**	0.117	-0.162	0.041
SC								1	0.164	-0.185	0.005
STP									1	-0.091	0.014
MTP										1	-0.82**
BTP											1

*: significant at 0.05 level, **: significant at 0.01 level, TY: tuber yield (kg/ha-1), PH: plant height (cm), MS: main stem/plant, TN: tuber No./plant, ATW: average tuber

Table 4: Results of path analysis

		Indirect effect through									
Traits	Direct effect	PH	MS	TN	ATW	PTW	DMC	SC	STP	MTP	BTP
PH	2.197	1	0.128	0.262	0.215	-1.72	0.113	0.014	-0.15	-0.603	0.391
MS	0.184	1.525	1	0.312	0.234	-1.39	0.059	0.006	0.048	-0.48	0.437
TN	0.349	1.64	0.165	1	0.188	-1.68	0.092	0.057	0.064	-0.35	0.215
ATW	0.253	1.86	0.171	0.261	1	-1.76	0.18	0.057	-0.125	-0.371	0.269
PTW	-1.86	2.03	0.138	0.316	0.239	1	0.189	0.055	-0.021	-0.438	0.339
DMC	0.462	0.54	0.023	0.069	0.103	-0.76	1	0.139	-0.05	-0.141	0.026
SC	0.139	0.228	0.008	0.143	0.104	-0.737	0.462	1	-0.083	-0.161	0.003
STP	-0.503	0.685	-0.018	-0.045	0.062	-0.077	0.054	0.022	1	-0.079	0.009
MTP	0.867	-1.52	-0.105	-0.144	-0.109	0.937	-0.075	-0.026	0.045	1	-0.543
BTP	0.656	1.312	0.123	0.114	0.104	-0.962	0.018	0	-0.008	-0.718	1

percentage (r=-0.671). Main stem/plant and medium tuber percentage (r=-0.567), tubers/plant and medium tuber percentage (r=-0.409). Average tuber weight and medium tuber percentage (r=-0.428), tuber weight/plant and medium tuber percentage (r= -0.504), (Table 2). Yildirim *et al*. [6] found the similar results for plant height, main stem/plant, average tuber weight, tuber weight/plant and tuber yield. Galarreta *et al*. [17] determined that a significant correlation between tuber yield with tuber number and tuber weight. Er [18] stated that tubers/plant and tuber yield were increased when used big tubers in sowing. Gunel *et al*. [19] determined that highly positive and significant correlation between tuber yield with big tubers percentage and vegetation period. Yildirim *et al*. [6] observed that both yield components (tuber number and tuber weight) were associated with tuber yield, but they indicated that tuber numbers were important than average tuber weight. These results are in agreement with our findings.

Starch content associates with dry matter content. For this reason, the highest positive correlation was determined among dry matter content and starch content (r=1). Plant height exhibited significant and positive correlation with mean stems/plant (r=0.694), tuber numbers (r=0.749), average tuber weight (r= 0.849), tuber weight/plant (r= 0.925), big tuber percentage (r= 0.597). Aytac and Esendal [14] reported that tuber yield exhibited positive and significant correlations with average tuber weight, tubers/plant, big tuber percentage, but a significantly negative correlation with small tuber percentage. They also reported positive and significant correlation between average tuber weight and big tuber percentage, main stems/plant and vegetation period, but significant and negative correlations between average tuber weight and main stems/plant, average tuber weight and small tuber percentage, main stems/plant and big tuber percentage. Gunel *et al*. [19] reported that negative and significant correlations between small tuber percentage and tuber yield. Er [18] reported that positive and significant correlation between main stems/plant and small tuber percentage. These findings were in accordance with the results of present study except small tuber percentage.

In order to get a clear picture of the interrelationships between different traits, the direct and indirect effects of different characters were worked out using path coefficient analysis in respect of the yield [20]. The path coefficient analysis based on tuber yield as a dependent variable revealed that all traits, except main stem/plant, dry matter content and medium tuber percentage showed positive direct effects (Table 4).

Compared to the simple correlation analysis, path analysis of tuber yield and its traits demonstrated that plant height, medium tuber weight and big tuber weight evolved the highest direct influence, 2.19, 0.867 and 0.656, respectively. Conversely, main stems/plant had a positive and low direct effect 0.184 with an indirect negative effect via tuber weight/plant (-1.39) and positive effect with average tuber weight (0.234) and tubers/plant (0.312) on tuber yield. In addition to, the indirect effects of plant height, tubers/plant was stronger than its direct effects. These analysis showed that tuber weight/plant, average tuber weight, tubers/plant were the main characters for tuber yield. Yildirim *et al*. [6] stated that average tuber weight, tubers/plant, tuber weight/plant and plant height had positive and high direct effects on tuber weight/plant. He also reported that main stems/plant; plant height had positive and high direct effects on tuber yield. Maris [21] found that tuber number and average tuber weight had equal effects on total yield. These findings were in accordance with the results of present study.

Correlation and path analyses indicated that tuber weight/plant, average tuber weight and tubers/plant were the main components to tuber yield. For this reason, these traits could be used more significantly for potato improvement. Similar research results with our study were published by others [16-19, 21]

In conclusion, correlation coefficient analysis measures the magnitude of relationship between various plant characters and determines the component character on which selection can be based for improvement in potato tuber yield. However, path coefficient analysis helps to determine the direct effect of traits and their indirect effects on yield. Tuber weight/ plant, average tuber weight and number of tubers/plant had major contributions on tuber yield and hence selection for these traits can possibly lead to improvement in tuber yield of potato.

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