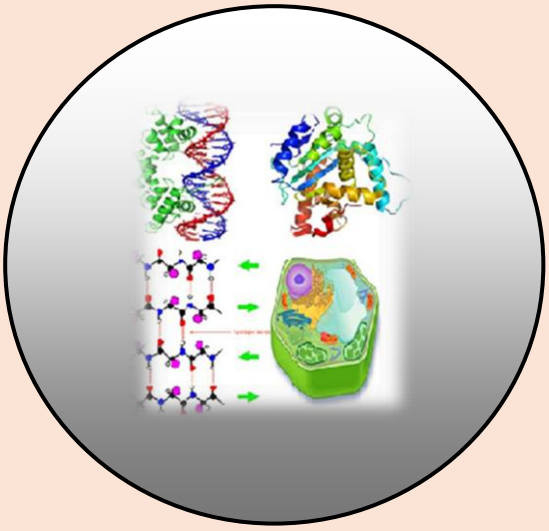
Studying the Effects of Soil Texture and Water Stress on the Physiological and Agricultural Properties of Potato

By

Hamid Kheyrodin

ISSN 2319-3077 Online/Electronic
ISSN 0970-4973 Print

Index Copernicus International Value
IC Value of Journal 82.43 Poland, Europe (2016)
Journal Impact Factor: 4.275
Global Impact factor of Journal: 0.876
Scientific Journals Impact Factor: 3.285
InfoBase Impact Factor: 3.66



J. Biol. Chem. Research
Volume 41 (1), 2024 Pages No. 22-37

Journal of Biological and Chemical Research

An International Peer Reviewed / Referred Journal of Life Sciences and Chemistry

Indexed, Abstracted and Cited in various International and National Scientific Databases

Published by Society for Advancement of Sciences®

J. Biol. Chem. Research. Vol. 41, No. 1, 22-37, 2024
Ms 41/01/04/2024

ISSN 2319-3077 (Online/Electronic)
ISSN 0970-4973 (Print)

Dr. Hamid Kheyrodin
http:// www.sasjournals.com
http:// www.jbcr.co.in
jbiolchemres@gmail.com

RESEARCH PAPER
Received: 30/01/2024 Revised: 08/05/2024 Accepted: 09/05/2024

Studying the Effects of Soil Texture and Water Stress on the Physiological and Agricultural Properties of Potato

Hamid Kheyrodin
Faculty of Desert Science, Semnan University, Semnan, Iran

ABSTRACT

By moving from its place of origin in the Andes Mountains in the American continent to Europe and other parts of the world, it has become one of the main sources of human food in the course of four centuries, and in Asian countries, including Iran, it ranks fourth in the last century food provider with the production of 4.5 million tons of vegetable tubers, Iran ranked 19th among vegetable producing countries in 2020. The comparison of the performance of this product in 20 main producing countries shows many differences, so that the United States of America has the highest performance with 51 tons per hectare. Ukraine has the lowest performance among these countries with 16 tons per hectare. The average yield of this product in all countries of the world is 5.18 tons and in Iran it is 34 tons per hectare, which shows the 21st rank in performance. In this study, the cultivation substrate was (Savalan cultivar) the main factor (sandy, clayey soil, compost) and drought stress in four control levels and -0.3, -0.6, -1 and -1.5 MPa of soil water potential in three replicates in the form of a split plot will come first, the physical and texture properties of soils, chemical properties and exchangeable ions, and some biochemical properties of enzymes such as urease are measured. Duncan's test will be used under SPSS conditions to compare the means and relationships between growth components and the effects of drought stress. The evaluated traits include potato yield, plant height, number of plant branches, number of tubers per plant, potato tuber weight average, tuber size, production leaf area. The results have shown that the evaluated traits are significantly influenced by the type of soil texture and water stress and the mutual effect of these two factors. This study showed that different soils will affect water-saving irrigation strategies that are worth knowing for suitable agricultural water management.

So, under non-limited water resources conditions, clay sand produces the highest yield under full irrigation but water-saving irrigations are not recommended due to considerable loss (50%) in yield.

Keywords: Potato, Soil texture, Drought stress, Physiological and Agricultural Properties.

INTRODUCTION

Potato with the scientific name *Solanum tuberosum* is a plant from the eggplant family that has compound and cut leaves and white or purple flowers. Its fruit is small, spherical, red, round and poisonous. Potato is the fourth most cultivated agricultural product in the world after corn, wheat and rice. The potato tuber is a non-photosynthetic organ whose performance depends on the activities of the source and reservoir and genetic factors, leaf area index, fertilization, temperature, soil (physical, chemical and biological properties), light intensity and humidity are involved in it and have mutual and sometimes misleading effects. The root of the potato plant is scattered and 85% of it is located at a depth of 30 cm, and for this reason, it is sensitive to drought stress and requires sufficient moisture in the light soil during the entire growth period. Drought stress occurs in the plant when the potential evaporation and transpiration (atmospheric evaporation demand of the plant) exceeds the actual evaporation and transpiration (the capacity and ability of the roots to extract water from the soil). Experiments by scientists have shown that drought stress up to 80 percent of the plant's water requirement, both before and after tuber formation, causes significant differences in potato production. The tuber bulking stage is one of the important stages of potato growth. At this stage, the plant invests most of its resources on newly formed tubers. At this stage, several factors are very important to get a good product. Among them are optimal soil moisture and temperature, availability of sufficient nutrients in the soil and their balance, and resistance to pest and disease attacks. The maturity stage of the tubers is very important for the food. Potatoes contain toxic compounds called glycoalkaloids. The most important of these poisons are solanine and chaconine. Solanine in potato is determined by the appearance of green color, especially in the cortex under its skin, which is necessary to study it in many soil tissues. Identification, determination and analysis, reserve root performance and shoot fresh weight, number of leaves, number of branches, reserve root weight, reserve root diameter, plant length and reserve root length are of particular importance [University of Wisconsin-Madison, 2005].

Wild potato species can be found from the southern United States to southern Chile [Agriculture & Horticulture Development Board, 2009]. The potato was originally believed to have been domesticated by Native Americans independently in multiple locations, but later genetic studies traced a single origin, in the area of present-day southern Peru and extreme Northwestern Bolivia. The importance of the potato as a food source and culinary ingredient varies by region and is still changing Figure 1 showing botanical composition of potato it remains an essential crop in Europe, especially Northern and Eastern Europe like the tomato, the potato is a nightshade in the genus Solanum, and the vegetative and fruiting parts of the potato contain the toxin solanine which is dangerous for human consumption. Normal potato tubers that have been grown and stored properly produce glycoalkaloids in negligible amounts, but, if green sections of the plant (namely sprouts and skins) are exposed to light, the tuber can accumulate a high enough concentration of glycoalkaloids to affect human health [BBC News. 12 August 2013].

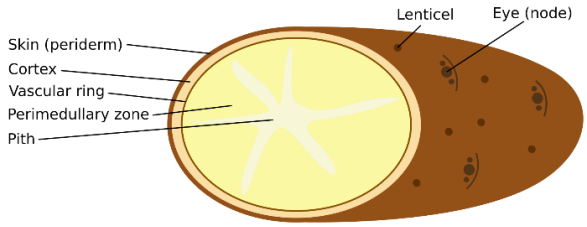


Figure 1. Showing botanical composition of potato.

MATERIAL AND METHODS

An experiment was conducted during 20 December 2023 through March 2024 to assess the effect of planting dates on growth and yield performance of three potential varieties of potato (Savalan varieties) at Plant Physiology research field in Iran, Semnan University. Three planting dates (November 30, December 25 and march 15) and three varieties (var. BARI Alu-35, BARI Alu-40 and BARI Alu-41) were the treatment variables. The experiment was laid out in a randomized complete block design with three replications. Maximum plant height (42.3 cm) was observed in 5 December sowing in var. BARI Alu-40. Highest number of tuber/plant (13) was recorded from December 5 sowing in var. BARI Alu-41.

In this experiment, seed tubers of potato plants are cultivated in soils with different textures in special plots in March. In this research, the effect of different levels of water stress on yield up to tuber size, percentage of dry matter and number of aerial stems, tuber length, tuber diameter, number of potato tuber are investigated in a split plot design with 3 replications. One of the methods of studying the effects of external factors of heat, humidity, cultivation environment, fertilizers and poisons on photosynthesis is by measuring chlorophylls (a, b) and total carotenoids. In this method, one gram of fresh sample of potato leaves is crushed and ground and mixed and homogenized using 10 ml of 80% acetone. One milliliter of it is selected and mixed with 9 milliliters of 80% acetone and centrifuged for 15 minutes at a speed of 8000 revolutions per minute. Then the supernatant phases are separated to measure chlorophyll a and b and carotenoids. The rest of our work is experimenting with a UV spectrophotometer method. Chlorophyll A and B and total carotenoids are determined at wavelengths of 663, 645, and 480 nm. Acetone 89% is used as blank and control (white) and the amount of chlorophylls is calculated from the Arnon equation. The amount of carotenoid is calculated using the Gross equation in 1991. Also, the components, number, length and diameter of the potato tuber and the amount of dry matter of the tuber are determined. Identifying the mutual effects of tissue and culture medium and water stress on average tuber weight, tuber size, number of tuber per plant, number of branches per plant, plant height are among the things that have not been studied at the province level and should be studied. Also, what effect does changes in the concentration and amount of NPK elements, soil texture and water stress have on the quantity and quality of potato texture. This is a list of potato varieties or cultivars. Potato cultivars can have a range of colors due to the accumulation of anthocyanins in the tubers. These potatoes also have coloured skin, but many varieties with pink or red skin have white or yellow flesh, as do the vast majority of cultivated potatoes. The yellow color, more or less marked, is due to the presence of carotenoids. Varieties with coloured flesh are common among native Andean potatoes, but relatively rare among modern varieties.

They are rarely cultivated because their yield is usually lower than that of improved varieties and are sought after by some amateurs as a curiosity Table 1. The monovalent potassium K and sodium Na ions of the culture substrate are measured photometrically in the laboratory. Divalent Ca and Mg ions are determined by titration.

A number of micro grains of the cultivation bed and heavy metals of the cultivation bed such as Cu, Zn, Ni are also determined by the atomic device. Also, the humidity percentage of the cultivation bed and the apparent and real specific gravity are also determined by accurate sampling and using a thermal oven. Soil texture is determined by the hydrometric method using sodium hexametaphosphate (calcene) using the soil texture triangle.

Table 1. Different potato varieties cultivated in world.

Potato varieties	**Potato varieties**
• *Battata tuberosa* (L. Hill) • *Larnax sylvarum* subsp. *novogranatensis* (N.W. Sawyer) • *Lycopersicon tuberosum* (L. Mill.) • *Parmentiera edulis* (Raf.) • *Solanum andigenum* (Juz. & Bukasov) • *Solanum andigenum* convar. *acutifolium* (Lechn.) • *Solanum andigenum* convar. *adpressipilosum* (Lechn.) • *Solanum andigenum* f. *alccai-huarmi* (Bukasov & Lechn.) • *Solanum andigenum* f. *ancacc-maquin* (Bukasov & Lechn.) • *Solanum andigenum* f. *arcuatum* (Bukasov & Lechn.) • *Solanum andigenum* subsp. *argentinicum* (Lechn.) • *Solanum andigenum* subsp. *australiperuvianum* (Lechn) • *Solanum andigenum* subsp. *aya-papa* (Bukasov & Lechn.) • *Solanum andigenum* var. *aymaranum* (Bukasov & Lechn.) • *Solanum andigenum* f. *basiscopum* (Bukasov & Lechn.) • *Solanum andigenum* f. *bifidum* (Bukasov & Lechn.) • *Solanum andigenum* var. *bolivianum* (Bukasov & Lechn.) • *Solanum andigenum* subsp. *bolivianum* (Lechn.)	• *Solanum stenotomum* f. *chojllu* (Hawkes) • *Solanum stenotomum* f. *cochicallo* (Hawkes) • *Solanum stenotomum* f. *cohuasa* (Hawkes) • *Solanum stenotomum* f. *cuchipacon* (Hawkes) • *Solanum stenotomum* var. *cyaneum* (Hawkes) • *Solanum stenotomum* f. *eucaliptae* (Hawkes) • *Solanum stenotomum* subsp. *goniocalyx* ((Juz. & Bukasov) Hawkes) • *Solanum stenotomum* f. *huallata-chinchi* (Hawkes) • *Solanum stenotomum* f. *huamanpa-uman* (Hawkes) • *Solanum stenotomum* f. *huanuchi* (Hawkes) • *Solanum stenotomum* var. *huicu* (Hawkes) • *Solanum stenotomum* f. *kamara* (Hawkes) • *Solanum stenotomum* f. *kantillero* (Hawkes) • *Solanum stenotomum* var. *keccrana* (Hawkes) • *Solanum stenotomum* f. *kehuillo* (Hawkes) • *Solanum stenotomum* f. *koso-nahui* (Hawkes) • *Solanum stenotomum* var. *megalocalyx* (Hawkes)

- *Solanum andigenum* convar. *brachistylum* (Lechn.)
- *Solanum andigenum* convar. *brevicalyces* (Lechn.)
- *Solanum andigenum* var. *brevicalyx* (Bukasov & Lechn.)
- *Solanum andigenum* convar. *brevipilosum* (Lechn.)
- *Solanum andigenum* f. *caesium* (Bukasov & Lechn.)
- *Solanum andigenum* f. *caiceda* (Bukasov)
- *Solanum andigenum* var. *carhua* (Vargas)
- *Solanum andigenum* f. *ccompetillo* (Bukasov & Lechn.)
- *Solanum andigenum* f. *ccompis* (Bukasov & Lechn.)
- *Solanum andigenum* var. *ccusi* (Bukasov & Lechn.)
- *Solanum andigenum* subsp. *centraliperuvianum* (Lechn)
- *Solanum andigenum* f. *cevallosii* (Bukasov & Lechn.)
- *Solanum andigenum* f. *chalcoense* (Bukasov)
- *Solanum andigenum* f. *chimaco* (Bukasov & Lechn.)
- *Solanum andigenum* var. *ckello-huaccoto* (Bukasov & Lechn.)
- *Solanum andigenum* f. *coeruleum* (Lechn. ex Bukasov)
- *Solanum andigenum* var. *colombianum* (Bukasov)
- *Solanum andigenum* subsp. *colombianum* ((Bukasov) Lechn.)
- *Solanum andigenum* f. *conicicolumnatum* (Bukasov & Lechn.)
- *Solanum andigenum* f. *cryptostylum* (Bukasov & Lechn.)
- *Solanum andigenum* convar. *curtibaccatum* (Lechn.)
- *Solanum andigenum* var. *cuzcoense* (Bukasov & Lechn.)
- *Solanum stenotomum* f. *negrum* (Hawkes)
- *Solanum stenotomum* f. *orcco-amajaya* (Hawkes)
- *Solanum stenotomum* f. *pallidum* (Hawkes)
- *Solanum stenotomum* var. *peruanum* (Hawkes)
- *Solanum stenotomum* f. *phinu* (Hawkes)
- *Solanum stenotomum* f. *phitu-huayacas* (Hawkes)
- *Solanum stenotomum* f. *piticana* (Hawkes)
- *Solanum stenotomum* var. *pitiquilla* (Hawkes)
- *Solanum stenotomum* f. *pitoca* (Hawkes)
- *Solanum stenotomum* var. *poccoya* (Vargas)
- *Solanum stenotomum* f. *puca* (Vargas)
- *Solanum stenotomum* var. *puca-lunca* (Hawkes)
- *Solanum stenotomum* var. *putis* (Hawkes)
- *Solanum stenotomum* f. *roseum* (Hawkes)
- *Solanum stenotomum* f. *tiele* (Hawkes)
- *Solanum stenotomum* f. *yana-cculi* (Hawkes)
- *Solanum stenotomum* f. *yuracc* (Vargas)
- *Solanum subandigenum* (Hawkes)
- *Solanum sylvestre* (Audib. ex Dunal)
- *Solanum tarmense* (Bukasov)
- *Solanum tascalense* (Brücher)
- *Solanum tenuifilamentum* (Juz. & Bukasov)
- *Solanum tuberosum* f. *acuminatum* (Bukasov & Lechn.)
- *Solanum tuberosum* var. *aethiopicum* (Alef.)
- *Solanum tuberosum* var. *alaudinum* (Alef.)

andigenum var. *digitotuberosum* (Vargas) • *Solanum andigenum* f. *dilatatum* (Bukasov & Lechn.) • *Solanum andigenum* f. *discolor* (Bukasov & Lechn.) • *Solanum andigenum* subsp. *ecuatorianum* (Lechn.) • *Solanum andigenum* convar. *elongatibaccatum* (Lechn.) • *Solanum andigenum* f. *elongatipedicellatum* (Lechn.) • *Solanum andigenum* f. *globosum* (Bukasov & Lechn.) • *Solanum andigenum* var. *grauense* (Vargas) • *Solanum andigenum* f. *guatemalense* (Bukasov) • *Solanum andigenum* var. *hederiforme* (Bukasov) • *Solanum andigenum* var. *herrerae* (Bukasov & Lechn.) • *Solanum andigenum* f. *huaca-layra* (Bukasov & Lechn.) • *Solanum andigenum* var. *huairuru* (Bukasov & Lechn.) • *Solanum andigenum* f. *huallata* (Bukasov & Lechn.) • *Solanum andigenum* f. *huaman-uma* (Bukasov & Lechn.) • *Solanum andigenum* var. *imilla* (Bukasov & Lechn.) • *Solanum andigenum* f. *incrassatum* (Bukasov & Lechn.) • *Solanum andigenum* var. *juninum* (Bukasov) • *Solanum andigenum* f. *lanciacuminatum* (Bukasov & Lechn.) • *Solanum andigenum* f. *lapazense* (Bukasov & Lechn.) • *Solanum andigenum* var. *latius* (Bukasov & Lechn.) • *Solanum andigenum* f. *lecke-umo* (Bukasov & Lechn.) • *Solanum andigenum* f. *lilacinoflorum* (Bukasov) • *Solanum*	• *Solanum tuberosum* var. *album* (Alef.) • *Solanum tuberosum* f. *alkka-imilla* (Ochoa) • *Solanum tuberosum* f. *alkka-silla* (Ochoa) • *Solanum tuberosum* f. *amajaya* (Ochoa) • *Solanum tuberosum* subsp. *andigenum* ((Juz. & Bukasov) Hawkes) • *Solanum tuberosum* var. *anglicum* (Alef.) • *Solanum tuberosum* f. *araucanum* (Bukasov & Lechn.) • *Solanum tuberosum* f. *auriculatum* (Bukasov & Lechn.) • *Solanum tuberosum* f. *azul-runa* (Ochoa) • *Solanum tuberosum* var. *batatinum* (Alef.) • *Solanum tuberosum* var. *bertuchii* (Alef.) • *Solanum tuberosum* var. *borsdorfianum* (Alef.) • *Solanum tuberosum* var. *brachyceras* (Alef.) • *Solanum tuberosum* f. *brachykalukon* (Bukasov & Lechn.) • *Solanum tuberosum* f. *brevipapillosum* (Bukasov & Lechn.) • *Solanum tuberosum* var. *brevipilosum* (Bukasov & Lechn.) • *Solanum tuberosum* var. *bufoninum* (Alef.) • *Solanum tuberosum* var. *californicum* (Alef.) • *Solanum tuberosum* f. *camota* (Bukasov & Lechn.) • *Solanum tuberosum* var. *cepinum* (Alef.) • *Solanum tuberosum* f. *chaped* (Bukasov & Lechn.) • *Solanum tuberosum* f. *chiar-*

andigenum f. *lisarassa* (Bukasov) • *Solanum andigenum* f. *llutuc-runtum* (Lechn. ex Bukasov) • *Solanum andigenum* convar. *longiacuminatum* (Lechn.) • *Solanum andigenum* var. *longibaccatum* (Bukasov & Lechn.) • *Solanum andigenum* convar. *macron* (Lechn.) • *Solanum andigenum* f. *magnicorollatum* (Bukasov & Lechn.) • *Solanum andigenum* var. *mexicanum* (Bukasov) • *Solanum andigenum* f. *microstigma* (Bukasov & Lechn.) • *Solanum andigenum* convar. *microstigmatum* (Lechn.) • *Solanum andigenum* f. *nodosum* (Bukasov) • *Solanum andigenum* convar. *nudiculum* (Lechn.) • *Solanum andigenum* convar. *obtusiacuminatum* (Lechn) • *Solanum andigenum* f. *ovatibaccatum* (Bukasov & Lechn.) • *Solanum andigenum* f. *pacus* (Lechn. ex Bukasov) • *Solanum andigenum* f. *pallidum* (Bukasov & Lechn.) • *Solanum andigenum* var. *platyantherum* (Bukasov & Lechn.) • *Solanum andigenum* f. *pomacanchicum* (Bukasov & Lechn.) • *Solanum andigenum* f. *ppacc-nacha* (Bukasov & Lechn.) • *Solanum andigenum* f. *ppaqui* (Bukasov & Lechn.) • *Solanum andigenum* convar. *puca-mata* (Lechn.) • *Solanum andigenum* var. *quechuanum* (Bukasov & Lechn.)	*lelekkoya* (Ochoa) • *Solanum tuberosum* f. *chiar-pala* (Ochoa) • *Solanum tuberosum* subsp. *chiloense* ((A.DC.) L.I.Kostina) • *Solanum tuberosum* var. *chiloense* (A.DC.) • *Solanum tuberosum* var. *chilotanum* (Bukasov & Lechn.) • *Solanum tuberosum* f. *chojo-sajama* (Ochoa) • *Solanum tuberosum* var. *chubutense* ((Bitter) Hawkes) • *Solanum tuberosum* f. *conicum* (Bukasov & Lechn.) • *Solanum tuberosum* var. *conocarpum* (Alef.) • *Solanum tuberosum* f. *contortum* (Bukasov & Lechn.) • *Solanum tuberosum* f. *coraila* (Bukasov & Lechn.) • *Solanum tuberosum* var. *cordiforme* (Alef.) • *Solanum tuberosum* var. *corsicanum* (Alef.) • *Solanum tuberosum* f. *crassifilamentum* (Bukasov & Lechn.) • *Solanum tuberosum* var. *crassipedicellatum* (Bukasov & Lechn.) • *Solanum tuberosum* var. *cucumerinum* (Alef.) • *Solanum tuberosum* var. *cultum* • *Solanum tuberosum* var. *drakeanum* (Alef.) • *Solanum tuberosum* var. *elegans* (Bukasov & Lechn.) • *Solanum tuberosum* f. *elongatum* (Bukasov & Lechn.) • *Solanum tuberosum* var. *elongatum* (Alef.) • *Solanum tuberosum* f. *enode* (Bukasov & Lechn.) • *Solanum*

- *Solanum andigenum* var. *sihuanum* (Bukasov & Lechn.)
- *Solanum andigenum* var. *socco-huaccoto* (Bukasov & Lechn.)
- *Solanum andigenum* convar. *stenon* (Lechn.)
- *Solanum andigenum* var. *stenophyllum* (Bukasov & Lechn.)
- *Solanum andigenum* f. *sunchchu* (Bukasov & Lechn.)
- *Solanum andigenum* subsp. *tarmense* (Bukasov & Lechn.)
- *Solanum andigenum* f. *tenue* (Bukasov & Lechn.)
- *Solanum andigenum* f. *tiahuanacense* (Bukasov & Lechn.)
- *Solanum andigenum* convar. *titicacense* (Lechn.)
- *Solanum andigenum* f. *tocanum* (Bukasov)
- *Solanum andigenum* f. *tolucanum* (Bukasov)
- *Solanum andigenum* f. *uncuna* (Bukasov & Lechn.)
- *Solanum apurimacense* (Vargas)
- *Solanum aracatscha* (Besser)
- *Solanum aracc-papa* (Juz. ex Rybin)
- *Solanum ascasabii* (Hawkes)
- *Solanum boyacense* (Juz. & Bukasov)
- *Solanum caniarense* (Juz. & Bukasov)
- *Solanum cardenasii* (Hawkes)
- *Solanum cayeuxi* (Berthault)
- *Solanum chariense* (A.Chev.)
- *Solanum chaucha* (Juz. & Bukasov)
- *Solanum chaucha* var. *ccoe-sulla* (Ochoa)
- *Solanum chaucha* var. *ckati* (Ochoa)
- *Solanum chaucha* var. *khoyllu* (Ochoa)
- *Solanum chaucha* var. *puca-suitu* (Ochoa)
- *Solanum chaucha* f. *purpureum* (Hawkes)
- *Solanum chaucha* f. *roseum* (Hawkes)
- *Solanum tuberosum* var. *erythroceras* (Alef.)
- *Solanum tuberosum* var. *fragariinum* (Alef.)
- *Solanum tuberosum* var. *guaytecarum* ((Bitter) Hawkes)
- *Solanum tuberosum* var. *hassicum* (Alef.)
- *Solanum tuberosum* var. *helenanum* (Alef.)
- *Solanum tuberosum* var. *hispanicum* (Alef.)
- *Solanum tuberosum* var. *holsaticum* (Alef.)
- *Solanum tuberosum* f. *huaca-zapato* (Ochoa)
- *Solanum tuberosum* f. *huichinkka* (Ochoa)
- *Solanum tuberosum* f. *indianum* (Lechn. ex Bukasov)
- *Solanum tuberosum* f. *infectum* (Bukasov & Lechn.)
- *Solanum tuberosum* f. *isla-imilla* (Ochoa)
- *Solanum tuberosum* f. *jancck'o-kkoyllu* (Ochoa)
- *Solanum tuberosum* f. *janck'o-chockella* (Ochoa)
- *Solanum tuberosum* f. *janck'o-pala* (Ochoa)
- *Solanum tuberosum* var. *julianum* (Alef.)
- *Solanum tuberosum* var. *kaunitzii* (Alef.)
- *Solanum tuberosum* f. *kunurana* (Ochoa)
- *Solanum tuberosum* f. *laram-lelekkoya* (Ochoa)
- *Solanum tuberosum* f. *latum* (Bukasov & Lechn.)
- *Solanum tuberosum* var. *laurentianum* (Alef.)
- *Solanum tuberosum* var. *lelekkoya* (Ochoa)
- *Solanum tuberosum* var. *leonhardianum* (Alef.)
- *Solanum*

chaucha var. *surimana* (Ochoa)
- *Solanum chiloense* ((A.DC.) Berthault)
- *Solanum chilotanum* (Hawkes)
- *Solanum chilotanum* var. *angustifurcatum* (Lechn.)
- *Solanum chilotanum* f. *magnicorollatum* (Lechn.)
- *Solanum chilotanum* f. *parvicorollatum* (Lechn.)
- *Solanum chilotanum* var. *talukdarii* (Lechn.)
- *Solanum chocclo* (Bukasov & Lechn.)
- *Solanum churuspi* (Hawkes)
- *Solanum coeruleiflorum* (Hawkes)
- *Solanum cultum* ((A.DC.) Berthault)
- *Solanum diemii* (E.Brucher)
- *Solanum dubium* (E.H.L.Krause)
- *Solanum erlansonii* (Anon.)
- *Solanum esculentum* (Neck.)
- *Solanum estradea* (L.E.López)
- *Solanum goniocalyx* (Juz. & Bukasov)
- *Solanum goniocalyx* var. *caeruleum* (Vargas)
- *Solanum herrerae* (Juz.)
- *Solanum hygrothermicum* (Ochoa)
- *Solanum kesselbrenneri* (Juz. & Bukasov)
- *Solanum leptostigma* (Juz.)
- *Solanum leptostigma* (Juz. ex Bukasov)
- *Solanum macmillanii* (Bukasov)
- *Solanum maglia* var. *chubutense* (Bitter)
- *Solanum maglia* var. *guaytecarum* (Bitter)
- *Solanum mamilliferum* (Juz. & Bukasov)
- *Solanum molinae* (Juz.)
- *Solanum oceanicum* (Brücher)
- *Solanum ochoanum* (Lechn.)
- *Solanum paramoense* (Bitter ex Pittier)
- *Solanum parmentieri* (Molina ex Walp.)
- *Solanum parvicorollatum* (Lechn.)
- *Solanum phureja* (Juz. & Bukasov)
- *Solanum phureja* var. *caeruleum* (Ochoa)
- *Solanum tuberosum* f. *mahuinhue* (Bukasov & Lechn.)
- *Solanum tuberosum* var. *malcachu* (Ochoa)
- *Solanum tuberosum* var. *melanoceras* (Alef.)
- *Solanum tuberosum* var. *menapianum* (Alef.)
- *Solanum tuberosum* var. *merceri* (Alef.)
- *Solanum tuberosum* f. *milagro* (Ochoa)
- *Solanum tuberosum* f. *montticum* (Bukasov & Lechn.)
- *Solanum tuberosum* var. *multibaccatum* (Bukasov & Lechn.)
- *Solanum tuberosum* var. *murukewillu* (Ochoa)
- *Solanum tuberosum* f. *nigrum* (Ochoa)
- *Solanum tuberosum* var. *nobile* (Alef.)
- *Solanum tuberosum* var. *norfolcicum* (Alef.)
- *Solanum tuberosum* var. *nucinum* (Alef.)
- *Solanum tuberosum* f. *oculosum* (Bukasov & Lechn.)
- *Solanum tuberosum* f. *ovatum* (Bukasov & Lechn.)
- *Solanum tuberosum* f. *overita* (Ochoa)
- *Solanum tuberosum* var. *palatinatum* (Alef.)
- *Solanum tuberosum* var. *pecorum* (Alef.)
- *Solanum tuberosum* var. *peruvianum* (Alef.)
- *Solanum tuberosum* f. *pichuna* (Bukasov & Lechn.)
- *Solanum tuberosum* f. *pillicuma* (Bukasov & Lechn.)
- *Solanum tuberosum* var. *platyceras* (Alef.)
- *Solanum tuberosum* var. *polemoniifolium* (J.Rémy)
- *Solanum tuberosum* var. *praecox* (Alef.)

phureja var. *erlansonii* ((Bukasov & Lechnovitch) Ochoa)
- *Solanum phureja* subsp. *estradae* ((L.E.López) Hawkes)
- *Solanum phureja* var. *flavum* (Ochoa)
- *Solanum phureja* subsp. *hygrothermicum* ((Ochoa) Hawkes)
- *Solanum phureja* var. *janck'o-phureja* (Ochoa)
- *Solanum phureja* var. *macmillanii* ((Bukasov & Lechnovitch) Ochoa)
- *Solanum phureja* f. *orbiculatum* (Ochoa)
- *Solanum phureja* var. *pujeri* (Hawkes)
- *Solanum phureja* var. *rubroroseum* (Ochoa)
- *Solanum phureja* var. *sanguineum* (Ochoa)
- *Solanum phureja* f. *sayhuanimayo* (Ochoa)
- *Solanum phureja* f. *timusi* (Ochoa)
- *Solanum phureja* f. *viuda* (Ochoa)
- *Solanum riobambense* (Juz. & Bukasov)
- *Solanum rybinii* (Juz. & Bukasov)
- *Solanum rybinii* var. *bogotense* (Hawkes)
- *Solanum rybinii* var. *boyacense* ((Juz. & Bukasov) Hawkes)
- *Solanum rybinii* var. *pastoense* (Hawkes)
- *Solanum rybinii* var. *popayanum* (Hawkes)
- *Solanum sabinei* ((A.DC.) Berthault)
- *Solanum sanmartinense* (Brücher)
- *Solanum sendigena* (Juz. & Bukasov)
- *Solanum sinense* (Blanco)
- *Solanum stenotomum* (Juz. & Bukasov)
- *Solanum stenotomum* f. *alcay-imilla* (Hawkes)
- *Solanum stenotomum* f. *canasense* (Vargas)
- *Solanum stenotomum* f. *canastilla* (Hawkes)
- *Solanum stenotomum* f. *catari-papa* (Hawkes)
- *Solanum tuberosum* var. *praedicandum* (Alef.)
- *Solanum tuberosum* f. *pulo* (Ochoa)
- *Solanum tuberosum* var. *putscheanum* (Alef.)
- *Solanum tuberosum* var. *recurvatum* (Bukasov & Lechn.)
- *Solanum tuberosum* var. *reniforme* (Alef.)
- *Solanum tuberosum* var. *rockii* (Alef.)
- *Solanum tuberosum* var. *rossicum* (Alef.)
- *Solanum tuberosum* var. *rubrisuturatum* (Bukasov & Lechn.)
- *Solanum tuberosum* var. *rugiorum* (Alef.)
- *Solanum tuberosum* var. *runa* (Ochoa)
- *Solanum tuberosum* var. *sabinei* (A.DC.)
- *Solanum tuberosum* var. *saccharatum* (Alef.)
- *Solanum tuberosum* var. *salamandrinum* (Alef.)
- *Solanum tuberosum* f. *sani-imilla* (Ochoa)
- *Solanum tuberosum* var. *schnittspahnii* (Alef.)
- *Solanum tuberosum* f. *sebastianum* (Bukasov & Lechn.)
- *Solanum tuberosum* var. *sesquimensale* (Alef.)
- *Solanum tuberosum* var. *sicha* (Ochoa)
- *Solanum tuberosum* var. *sipancachi* (Ochoa)
- *Solanum tuberosum* var. *strobilinum* (Alef.)
- *Solanum tuberosum* f. *surico* (Ochoa)
- *Solanum tuberosum* var. *taraco* (Ochoa)
- *Solanum tuberosum* var. *tener* (Alef.)
- *Solanum tuberosum* f. *tenuipedicellatum* (Bukasov &

• *Solanum stenotomum* f. *ccami* ((Bukasov) Hawkes) • *Solanum stenotomum* var. *ccami* (Bukasov) • *Solanum stenotomum* var. *chapina* (Hawkes) • *Solanum stenotomum* f. *chilcas* (Hawkes) • *Solanum stenotomum* f. *chincherae* (Hawkes)	Lechn.) • *Solanum tuberosum* f. *thalassinum* (Bukasov & Lechn.) • *Solanum tuberosum* var. *tinctorium* (Alef.) • *Solanum tuberosum* f. *tinguipaya* (Ochoa) • *Solanum tuberosum* var. *ulmense* (Alef.) • *Solanum tuberosum* var. *versicolor* (Alef.) • *Solanum tuberosum* var. *villaroella* (Bukasov & Lechn.) • *Solanum tuberosum* f. *viride* (Bukasov & Lechn.) • *Solanum tuberosum* var. *vuchefeldicum* (Alef.) • *Solanum tuberosum* var. *vulgare* (Macloskie) • *Solanum tuberosum* var. *vulgare* (Hook.f.) • *Solanum tuberosum* f. *wila-huaycku* (Ochoa) • *Solanum tuberosum* f. *wila-imilla* (Ochoa) • *Solanum tuberosum* f. *wila-k'oyu* (Ochoa) • *Solanum tuberosum* f. *wila-monda* (Ochoa) • *Solanum tuberosum* f. *wila-pala* (Ochoa) • *Solanum tuberosum* var. *xanthoceras* (Alef.) • *Solanum tuberosum* f. *yurac-taraco* (Ochoa) • *Solanum tuberosum* var. *yutuense* (Bukasov & Lechn.)

Figure 2. Showing Savalan cultivar experiment in green house in Semnan University.

Figure 3. Germination of Savalan cultivar potato experiment in green house in Semnan University.

RESULTS

This research is carried out in the winter of 1402 in the form of split-plot randomized complete blocks design with three replications in the desert research greenhouse of the Faculty of Desertology of Semnan University. So that the type of cultivation bed as the main factor has three levels (sandy clay soil, clay soil, compost soil) and the sub-factor includes water stress in 4 levels.

The results show in Table 2, and Figure 2, 3, 4 and 5. Soil salinity is one of the important characteristics of arid and semi-arid regions in the world. Salinity and water stress affect plant growth and development. Sweet potato (*Ipomoea batatas* L.) is a crop with economic importance in the world.

Sweet potato is an efficient and low production cost crop that is grown during almost the whole year under stressful conditions, vegetable plants and their response to drought and salinity are mainly based on the type of species, cultivars, and even landraces.

Table 2. Effect of Water stress and salinity on leaf area and Growth traits potato.

Salinity (dS/m)	Watering	Cultivar	Dry weight leaves (g)	Leaf area (dm^2)	Dry weight tuber roots (g)	Fresh weight tuber roots (g)
2.00	W1	H	20.95	24.34	87.57	365.3
		U	14.50	20.97	78.50	433.3
	W2	H	14.18	18.31	57.40	234.5
		U	12.65	18.12	56.74	302.0
3.00	W1	H	28.58	31.67	60.88	237.3
		U	11.93	16.25	54.20	299.0
	W2	H	15.55	18.20	64.02	249.8
		U	11.93	16.87	70.91	267.3
3.50	W1	H	19.68	23.73	62.70	243.3
		U	12.73	18.50	85.73	353.7
	W2	H	13.30	16.67	62.43	236.0
		U	8.93	13.14	49.31	267.3

H: 'Huambachero'; U: 'Untacip'; W1: watering each 2 days; W2: watering each 4 days.

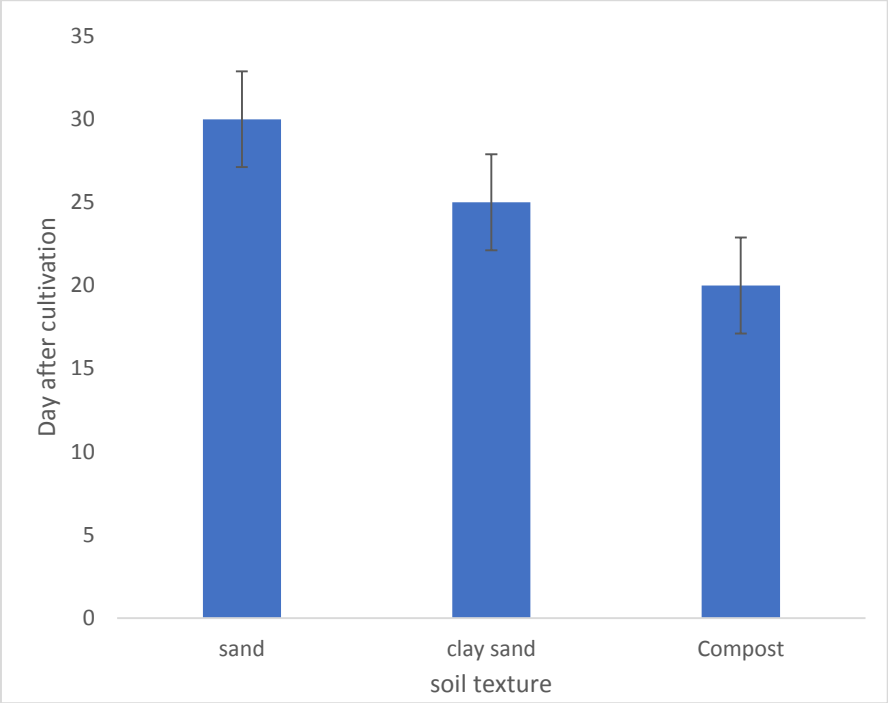


Figure 4. Germination of potato tuber in different soil.

It has been studied that Cl − ions are effective for the catabolism of numerous enzymatic and non-enzymatic activities, and these are also known as co-factors for the regulation of the photosynthesis process.

This study show that the K uptake decreased by 28 % when the salinity level increased to 14.0 mmol NaCl. K uptake decreases when plants are grown with high salinity levels, which affects yield. Salinity reduces the ability of plants to take up water, and this quickly causes reductions in growth rate, along with a suite of metabolic changes identical to those caused by water stress. The initial reduction in shoot growth is probably due to hormonal signals generated by the roots. The obtained results showed that the length of phenological stages was affected by fertilization and water stress. An increase in animal manure or an increase in irrigation caused acceleration of greening and delay in processing. With the increase of animal manure or the decrease of water, the number of tubers in the plant increased. Tuber weight was not affected by compost, but it increased with increasing planting depth. Tuber performance was affected by compost and water stress. With the increase of compost fertilizer, tuber yield increased and the highest tuber yield (29.01 tons/ha) was obtained from the treatment of 55 tons/ha of fertilizer.

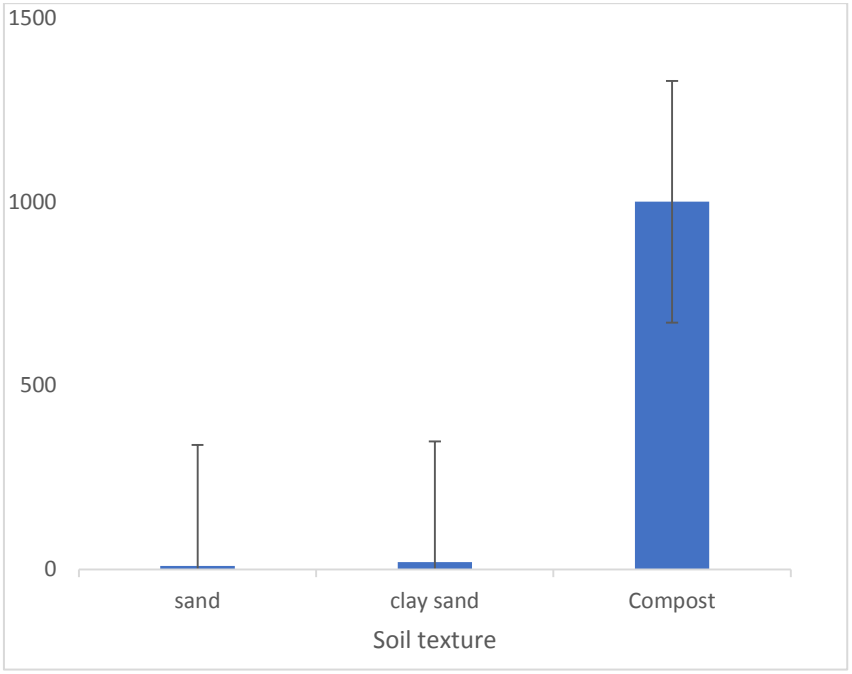


Figure 5. Gr fresh weight of aerial part one month after planting potato.

Also, the highest tuber yield was obtained from the planting depth of sand and clay tissue. With the increase in planting depth, the percentage of land cover, the number of stems per plant per square meter, the length of the main stem, the number of tubers per square meter and the amount of tuber waste decreased, but the number of days from planting to greening, tuberization, and flowering, and the average tuber weight increased. The tuber yield in the plant and the final tuber yield first increased with the increase of planting depth from 5 to 15 cm and then decreased from 15 to 20 cm. In this experiment, the interaction effect of planting density and depth with the assessed traits was not significant except for the number of days from planting to flowering. The earliest flowering time was obtained at a planting density of 65 thousand plants per hectare with a planting depth of 15 cm and the latest flowering time at a planting density of 45 thousand plants per hectare with a planting depth of 5 cm.

CONCLUSION

In 2022, consumption potato production in the North-Western European Potato Growers (NEPG) zone is forecast to fall to 21.2 million metric tonnes, a decline of 6.0% year-on-year (y-o-y), based on current yield estimations. This is attributable to a drop in production in Belgium, France and Germany, which offsets the growth in the Netherlands.

Local weather influences led to a huge variation in yields across the NEPG zone. Yields are estimated to decline by 7.8% y-o-y, to 42.1t/ha in the NEPG zone, with the highest drop in Belgium, estimated down 21.3% y-o-y, to 38.9t/ha. Furthermore, yields fell in Belgium, Germany and France, on the back of adverse summer drought conditions, a critical development period for potatoes. Warmer than average temperatures, combined with a lack of rain, affected the early growth of the potatoes and limited development during bulking before harvest. Potato is a cold-friendly vegetable, except for vegetables. It is a cool season. One of the important factors in growth and performance potato is the date of cultivation. Tuber production and quality in potato under the influence of several factors, including moisture stress, weather and so on nutrition is determined. The effect of temperature fluctuations on growth and Abnormalities of the glands and their unfavorable quality in certain area geography is related to the climate characteristics of the region and beyond the power of control are the farmers. But if by adopting the appropriate planting date in each region can avoid the collision of growth stages with temperature stress It changed the possible conditions in favor of optimal tuber formation in potato. It is possible to prevent damage to the quality of the production glands at the same time, he also improved the production quantity they stated that due to the delay in planting our research has shown that potato, the number of tubers increases, but the average weight of the tubers increases decreases. In the study of the effect of planting date on indices physiologically, we concluded that leaf area index and speed the growth of CGR and total dry matter is affected by the cultivation date takes. The critical period of growth in the potato plant is its nodulation stage which is the most sensitive to changes in temperature and photoperiod (photoperiod) that can be harvested by choosing the right planting dat. The above step was prevented by high temperature Results of composite variance analysis of experimental data He said that the effect of planting date and soil texture required time to obtain at least 50% it was significant P ≥0.05. But the effect of water stress and its interactions with soil texture were not significant. The average comparison of the obtained data indicates that in Total in the date of planting 20 months in the longest possible time 50% green crop has been achieved in history December crops, 20 meaningful differences from the point of view 50% green crop did not occur. In this date, plantings in the shortest time, 50% green crop was obtained.

ACKNOWLEDGEMENTS

I thanks Dr. Mohammad Rahimi for his support during the course of this research.

REFERENCES

Hijmans, R.J. and Spooner, D.M. (2001). "Geographic distribution of wild potato species". *American Journal of Botany*. 88 (11): 2101–12. doi: 10.2307/3558435. JSTOR 3558435. PMID 21669641.

Hirsch, C.N., Hirsch, C.D., Felcher, K., Coombs, J., Zarka, D., Van Deynze, A. De Jong, W., Veilleux, R.E., Jansky, S., Bethke, P., Douches, D.S. and Buell, C.R. (2013). "Retrospective View of North American Potato (*Solanum tuberosum* L.) Breeding in the 20th and 21st Centuries". *G3: Genes, Genomes, Genetics*. 3 (6): 1003–13. doi:10.1534/g3.113.005595. PMC 3689798. PMID 23589519.

Jemison, John M. Jr., Sexton, Peter and Camire, Mary Ellen (2008). "Factors Influencing Consumer Preference of Fresh Potato Varieties in Maine". *American Journal of Potato Research*. 85 (2): 140. doi: 10.1007/s12230-008-9017-3. S2CID 34297429.

Mattoo, A.K., Shukla, V., Fatima, T., Handa, A.K. and Yachha, S.K. (2010). "Genetic Engineering to Enhance Crop-Based Phytonutrients (Nutraceuticals) to Alleviate Diet-Related Diseases". Bio-Farms for Nutraceuticals. *Advances in Experimental Medicine and Biology*. Vol. 698. pp. 122–43. doi: 10.1007/978-1-4419-7347-4_10. ISBN 978-1-4419-7346-7. PMID 21520708.

Burger Ludwig (2011). BASF applies for EU approval for Fortuna GM potato Archived 10 November 2015 at the Wayback Machine Reuters, Frankfurt. Retrieved 29 December 2011.

"*Solanum tuberosum* L." Plants of the World Online. Board of Trustees of the Royal Botanic Gardens, Kew. 2017. Retrieved 7 September 2020.

University of Wisconsin-Madison, Finding rewrites the evolutionary history of the origin of potatoes (2005).

Potato Council. "Potato Varieties". Agriculture & Horticulture Development Board. Archived from the original on 8 September 2009. Retrieved 13 September 2009.

"Varieties". potato.org.uk. Archived from the original on 2015-04-20. Retrieved 2015-04-24.

Seed Potato NAVAN - Vegetables - Potatoes - Seed Potato NAVAN - Sycamore Trading"

"Potato Primer" (PDF). Cooks Illustrated. Archived from the original (PDF) on 17 December 2008. Retrieved 8 December 2008.

Agricultural Marketing Service. "Potatoes for Chipping Grades and Standards". Retrieved 27 August 2018.

"Creamer Potato". recipetips.com. Retrieved 18 July 2008.

"What is a new potato? New guidelines issued". BBC News. 12 August 2013. Retrieved 13 June 2021.

"Europotato.org". Europotato.org. Archived from the original on 28 November 2009. Retrieved 16 July 2010.

"So many varieties, so many choices". Wisconsin Potato and Vegetable Growers Association. 2017.

"Genetically Engineered Organisms Public Issues Education Project/Am I eating GE potatoes?". Cornell University. Retrieved 16 December 2008.

"GMO compass database". Archived from the original on 9 October 2014. Retrieved 6 October 2014.

GM Potatoes: BASF at work Archived 31 May 2010 at the Wayback Machine GMO Compass 5 March 2010. Retrieved 19 October 2011.

Research in Germany, 17 November 2011. Business BASF applies for approval for another biotech potato Archived 2 June 2013 at the Wayback Machine.

Corresponding author: Dr. Hamid Kheyrodin, Assistant Professor, Faculty of Desert Science, Semnan University, Semnan, Iran. Email: hamidkheyrodin@semnan.ac.ir