International Journal of Economic Plants 2015, 2(2): 059-063

Full Research Article

Effect of Tuber Treatment with Inorganic Chemicals on Tuber Germination, Growth and Yield of Potato

Rakesh Kumar, S. K. Biswas*, Kishan Lal, Virendra Kumar and Surjeet Kumar

Dept. of Plant Pathology, CSA University of Agriculture & Technology, Kanpur (208 002), India

Article History

Manuscript No. IJEP37
Received in 27th March 2015
Received in revised form 24th April 2015
Accepted in final form 12th May 2015

Correspondence to

**E-mail*: samirkrbiswas@rediffmail.com

Keywords

Germination, inorganic chemical, potato, shoot length, yield

Abstract

Seven inorganic chemicals like salicylic acid, indole acetic acid, di potassium hydrogen orthophosphate, hydrogen peroxide, calcium chloride, ferric chloride and metalaxyl have been evaluated on seed tuber germination, growth parameter and yield of potato in pot culture. Tuber treated with inorganic chemicals stimulated the germination of potato tuber. Among the treatments, three inorganic chemicals namely salicylic acid, calcium chloride and hydrogen peroxide treated tuber have given 100% germination against 60% in case control. The growth promoting effect ofinorganic chemicals has also been observed in all the treatments. The maximum growth promoting effect was perceived from salicylic acid treated plant showing 25–30 cm shoot length against 14.67 cm in case of control at 30 days after sowing. The maximum number of large size tuber was harvested in salicylic acid treated plant, representing 3 tubers with total weight of 205.67 g followed by $CaCl_2$, which is 2 tuber, having total weight of 125.08 g. As per yield is concerned, the highest total yield 241.40 g plant^{-1} pot^{-1} was recorded from salicylic acid treatment, followed by calcium chloride. The other treatments were also showing significant effect in increasing growth and yield parameters potato of as compared to control.

1. Introduction

Potato (*Solanum tuberosum* L.) is popularly known as the 'King of Vegetables' and a native of South America. It is a most important food crops all over the world. It is also used as stock feed and in industries for manufacturing starch, alcoholic beverages and other processed products. Potato is gained a considerable importance as an export crop to European markets and other parts of the world andis considered asone of the important source for national income. (El-Sirafy et al., 2008; El-Mougy, 2009). The major countries to which India exports potato are Nepal (32.1%), Sri Lanka (30.4%), Russia (18.6%), Malaysia (5.8%) and Mauritius (4.9%). It has now become an indispensable part of Indian cuisine. Potato is the world's fourth important food crop after wheat, rice and maize because of its higher yield potential and high nutritive value. Potato occupied 19.24 mha of land in the world with a production of 374.38 mt during 2011–12. The top five potato producing country in the world are China (74.8 mMT), India (41.565 mMT), Russia (21.1 mMT), Ukraine (18.7 mMT) and US (18.3 mMT). India produced 41.565 mMT of potato from an area of 18.87 lakh ha of land during 2011–12 (Gracy et al., 2013). The leading potato producing states in India are Uttar Pradesh (32%), followed by West Bengal (30%), Bihar (14%), Punjab (5%) and Gujarat (4%) which constitute about 85% of the total domestic potato production (Gracy et al., 2013).

The production and productivity of potato in India are quite impressive. However, in the background of increasing population, there is a need more production from same piece of land. The various factors like HYV, use of healthy seed tubers, application of balance dose of fertilizers, use of bio-fertilizers etc. are responsible for increasing yield of potato. Satish et al. (2011) found that combine application of crop residues+azo tobacter+phosphobacteria+biodynamic approach+microbial culture increased the growth and yield of potato and also gave highest net return and B:C ratio. Upadhyay et al. (1994) have also observed a similarly beneficial effect of biofertilizer viz., Azotobacter in potato production.Biswas et al. (2015) also found that the highest fresh shoot and root weight was noted in case of *Azotobacter* treated plant as seed treatment and soil application. Keeping the points in view, the study entitled 'Effect of Tuber Treatment with Inorganic Chemicals on Tuber Germination, Growth and Yield of Potato' was undertaken.

2. Materials and Methods

2.1. Seed tuber treatment with inorganic chemical

The experiment was conducted at the Wire house complex, Department of Plant Pathology, C.S.A. University of Agriculture and Technology, Kanpur during 2011 and 2012. Truly labeled potato seed tubers of variety '*Kufri Sindhuri*' were collected from Vegetable Research Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur to conduct the experiment. Two seed tubers were placed in each jar containing require concentration of solution of each chemical for five hours. It was then removes from the jar and shaded dry and used for sowing in pots.

2.2. Effect of inorganic chemicals on germination and growth parameter of potato

Seed tuber treated with different inorganic chemicals was responsible for early breaking of seed tuber dormancy thereby increasing the germination percentage of seed tuber. The treated tubers seeds were planted in 30 cm pots which were previously filled up with a mixture of sterilized sandy loam soil and FYM in the ratio of 2:1. Two treated tubers were placed in each pot and watered as per need based. Four replications were kept for each treatment. In one experiment, untreated tubers were sown served as control. The observation on germination of tuber was taken at every 24 hours upto 10 days. Germination percentage was calculated by use of following formula:-

Germination %=Number of germinated seed tubers/ No. of total seeds×100

Similarly, observations pertaining to effect of different treatments on the growth of plant (Shoot length) were observed every 5 days interval from date of sowing up to 30 days age of plants. At 45 days after sowing, plants were sprayed with different concentration of inorganic chemicals and observation pertaining the effect of inorganic chemicals on number of tubers, size and yield of potato was recorded after harvesting of potato.

3. Results and Discussion

3.1. Effect of inorganic chemical on seed tuber germination and plant height of potato

3.1.1. Seed tuber germination

Tuber treated with inorganic chemicals stimulated the germination of potato tuber. Among the treatments, three inorganic chemicals namely salicylic acid, calcium chloride and hydrogen peroxide have given 100% germination against 60% in case of control. The other treatments like indole acetic acid, di potassium hydrogen orthophosphate, ferric chloride and metalaxyl showed 80% tuber germination. From the Table 1, it is cleared that all theinorganic chemicals treated tubers significantly increased seed tuber germination of potato. Lynn and Chang (1990) also noted that salicylic acid plays an essential role for germination and stimulate plant growth. Koda et al. (1992) also found that SA induced potato tuberization *in vitro*. Some chemical inducers act as an endogenous growth regulator, which influence a range of diverse processes in plants, including seed germination (Abdel-Monaim 2010; Gharib and Hegazi, 2010), ion uptake and transport, membrane permeability (Barkosky and Eiinihellig, 1993), photosynthetic and growth rate (El-Mohamedy, 2014).

3.1.2. Plant height

The effects of tuber treatment with inorganic chemicals on plant height of potato were studied under Wire House Complex in

Table 1: Effect of inorganic chemicals on germination and growth parameters of potato at different days of interval

Inorganic chemical as inducers	Concentration	Germination %	Effect of inorganic chemicals on plant height (cm) at different days					% Increase of plant height growth over control after 30 days
			10 DAS	15 DAS	20 DAS	25 DAS	30 DAS	
SA	10 mM	100.00	3.75	6.43	10.10	18.50	25.30	42.02
$CaCl_2$	10 mM	100.00	2.66	5.67	9.67	17.50	22.67	35.29
HP	10 ppm	100.00	2.59	5.80	8.73	15.33	21.83	32.80
IAA	1%	80.00	2.54	4.90	8.47	15.07	20.97	30.04
DPHP	0.20%	80.00	1.57	4.07	8.22	13.67	19.17	23.51
FC	5 mM	80.00	1.52	3.97	5.47	11.53	17.83	17.72
Metalaxyl	0.20%	80.00	0.80	2.13	5.00	11.05	16.50	12.47
Control	-	60.00	0.17	1.17	3.87	8.33	14.67	
CD (p=0.05)		3.492	0.141	0.290	0.487	0.897	1.268	
SEm±		1.155	0.047	0.096	0.161	0.297	0.419	
SE(d)		1.633	0.066	0.136	0.228	0.419	0.593	
CV		2.353	4.144	3.898	3.751	3.703	3.655	

pot culture experiment. The observations on plant height were taken at 10 days, 15 days, 20 days, 25 days and 30 days after sowing. The data presented in Table 1 shows that the plant height of potato was increase in all the treatments over control. The maximum plant height was found in Salicylic acid treated seed tubers, representing the value 3.75, 6.43, 10.10, 18.50 and 25.30 cm at 10, 15, 20, 25 and 30 days age of seedling, respectively against 0.17, 1.17, 3.87, 8.33 and 14.67 in case of control (Figure 1). The $CaCl_2$ treated plant showing 2.66, 5.67, 9.67, 17.50 and 22.67 cm at 10, 15, 20, 25 and 30 days age of plant, respectively, representing second highest among the treatment. The minimum plant height was recorded in case of indole acetic acid treated plant. From the table, it is cleared that all inorganic chemicals treated plant were statistically significant in respect to plant height at 10, 15, 20, 25 and 30 days age of plant. Krantev et al. (2008) found that salicylic acids perform important actions in growth and development of plants. They also found that it is a potent signaling molecule in plants and is involved in eliciting responses to biotic and abiotic stresses. The positive effects of organic manure on the plant height, shoot dry matter and LAI have been previously reported by several workers (Abou-Hussein et al., 2003). Organic manure of cattle and/or chicken influence the absorption of nutrients resulted increased vegetative plant growth and subsequently the total crop yield and its nutritional values (Abou-Hussein et al., 2003; Al-Moshileh and Motwei, 2005). Gunes et al. (2007) reported that exogenous application of SA increased plant growth significantly both in saline and non saline conditions.The use of animal manure has been reported as a potential factor for better vegetative growth of potato (Abou-Hussein et al., 2003; Al-Moshieh and Motawei, 2005).

3.2. Effect of inorganic chemicals on tuber size and yield of potato

The effect of tubers treatment and foliar spray with inorganic chemical on tuber size and yield was studied after harvesting. Tubers were graded as large (more than 50 g), medium (25 g – 49.5 g) and small (less than 25 g) in size. The data represented in Table 2 showed that maximum number of large size tuber were harvested in salicylic acid treated plant representing 3 tuber with total weight of 135.7 g $plant^{-1}$ followed by $CaCl_2$, which is 2 tuber, having total weight of 80.45 g $plant^{-1}$. The maximum number of medium size tuber was obtained in $CaCl_2$ and ferric chloride treated plant, representing the 2 tubers for each treatment with the total weight of 75.50 and 75.80 g/ plant, respectively and regarding small size, maximum number tuber was found in indole acetic acid treated plant, followed by Metalaxyl representing the 12 and 10 tubers, respectively. From the Table 2 it is also cleared that the plant treated with ferric chloride, IAA and control plants are not produced any large size tubers.

As per yield is concerned, the highest total yield 241.40 g $plant^{-1}$ pot^{-1} was recorded from salicylic acid treated plant. The calcium chloride treated plant was showing 225.95 g $plant^{-1}$ pot^{-1} representing, second highest among the treatment, which was followed by Hydrogen peroxide, Metalaxyl, Di potassium hydrogen orthophosphate and Ferric chloride, representing total yield 195.75, 171.35, 178.70, 171.30 g $plant^{-1}$ pot^{-1}, respectively. Lowest yield was recorded IAA

Table 2: Effect of inorganic chemical as inducers on tuber size and yield of potato (wire house condition)

Name of inorganic chemical	Concentration of inorganic chemical	Large (>50 g)		Medium (25–49.5 g)		Small <25 g		Total yield (g $plan^{-1}$ pot^{-1})	% Increase yield over control
		Total no. of tuber	Weight	Total no. of tuber	Weight	Total no. of tuber	Weight		
SA	10 mM	3	135.75	1	45.65	4	60.00	241.40	35.58
$CaCl_2$	10 mM	2	80.45	2	75.50	5	70.00	225.95	31.18
HP	10 ppm	1	55.50	1	48.50	7	91.75	195.75	20.56
Metalaxyl	1%	1	52.25	1	38.60	5	90.50	181.35	14.25
DPHP	0.20%	1	50.50	1	35.75	7	92.45	178.70	12.98
FC	5 mM	0	0.00	2	75.80	10	95.50	171.30	9.22
IAA	0.20%	0	0.00	1	32.90	12	124.30	157.20	1.08
Control		0	0.00	1	30.50	13	125.00	155.50	
CD (p=0.05)		0.089	5.666	0.080	2.158	0.897	6.289	12.219	
SEm±		0.029	1.874	0.027	0.714	0.297	2.080	4.041	
SE(d)		0.042	2.650	0.038	1.009	0.419	2.941	5.715	
CV		5.099	5.501	4.085	4.227	4.194	3.706	3.774	

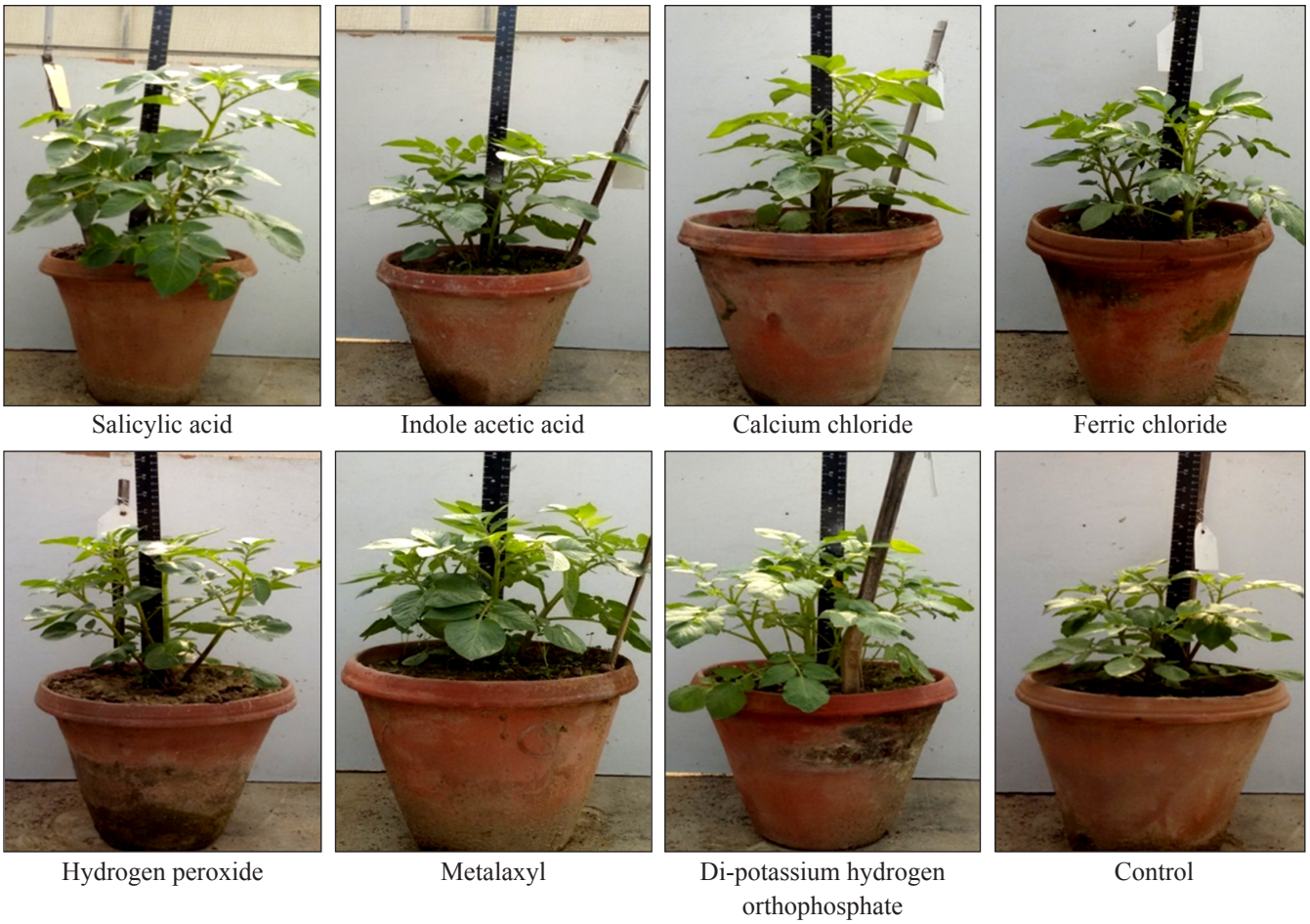

Figure 1: Effect of seed treatment with inorganic chemicals on growth of potatoplant at 30 days age of plant

treated plant representing only 157.20 g plant^{-1} pot^{-1}. From the table, it is cleared that all the inorganic chemicals were statistically significant in respect of potato yield. Stromberg and Brishammar (1991) have also been found that treatment of potato plants with phosphate, provided induced resistance against late blight disease and tended to positively influence yield and dry matter. Abd-El-Kareem (1998) stated that spraying cucumber plants with K_2HPO_4 (100 mM) provided induced resistance against downy and powdery mildews and increased fruit yield plant^{-1} under commercial greenhouse conditions. Abd-El-Kareem et al. (2001) also reported that treated potato plants with chitosan provided induced resistance against late and early blight diseases and increased tuber yield under field conditions. El-Gamal et al. (2007) also found that the calcium chloride showed an increase of potato yield which was between 36.4 to 50.0% over control.

4. Conclusion

It may be concluded from the present finding that inorganic chemicals can play an important role in enhancing the germination of seed potato tuber, increase vegetative growth as well as yield of potato. Therefore, application these inorganic chemicals practically use for further investigation.

5. References

Abd-El-Kareem, F., 1998. Induction of resistance to some diseases of cucumber plants grown under greenhouse conditions. Ph.D., Thesis, Faculty of Agriculture Ain Shams University, 116.

Abd-El-Kareem, F., Abd-Alla, M.A., El-Mohamedy, R.S.R., 2001. Induced resistance in potato plants for controlling late blight disease under field conditions. Egyptian Journal of Phytopathology 29(2), 29–41.

Abdel-Monaim, M.F., 2010. Induced systemic resistance in tomato plants against Fusarium wilt disease Minia 2nd Conference on Agricultural Environmental Science, 253–263.

Abou-Hussein, S.D., Abou-Hadid, A.F., El-Shorbagy, T., El-Behairy, U., 2003. Effect of cattle and chicken manure with or without mineral fertilizers on vegetative growth. chemical composition and yield of potato crops. Acta Horticulturae (ISHS) 608, 73–79.

Al-Moshileh, A.M., Motawei, M.I., 2005. Effect of Bio-

fertilization (Chicken and Pigeon Manures) on growth and yield of potato under central Saudi Arabia Conditions. Acta Horticulturae (ISHS) 742, 168–173.

Barkosky, R.R., Einhellig, F.A., 1993. Effect of salicylic acid plant-water relationships. Journal of Chemical Ecology19, 237–247.

Biswas, S.K., Shankar, U., Kumar, S., Kumar, A., Kumar, V., Lal, K., 2015. Impact of bio-fertilizers for the management of spot blotch disease and growth and yield contributing parameters of wheat. Journal of Pure and Applied Microbiology, 9(4).

El-Gamal, N.G., Abd-El-Karem, F., Fotouh, Y.O., El-Mougy, N.S., 2007. Induction of systemic resistance in potato plants against late and early blight diseases using chemical inducers under green house and field conditions. Research Journal of Agriculture and Biological Sciences 6, 212–216.

El-Mohamedy, R.S.R., Jabnoun-Khiareddine, H., Daami-Remadi, M., 2014. Control of root rot diseases of tomato plants caused by *Fusarium solani*, *Rhizoctonia solani* and *Sclerotium rolfsii* using different chemical plant resistance inducers. Tunisian Journal of Plant Protection 9, 45–55.

El-Mougy, N.S., Abdel-Kader, M.M., 2009. Salts application for suppressing potato early blight.Journal of Plant Protection Research 49(4), 353–361.

El-Sirafy, Z.M., Abbady, K.A., El-Ghamry, A.M., El-Dissoky, R.A., 2008. Potato yield quality, quantity and profitabilty as affected by soil and foliar potassium application. Research journal of agriculture and biological sciences 4(6), 912–922.

Gharib, F.A., Hegazi, A.Z., 2010. Salicylic acid ameliorates germination, seedling growth,phytohormone and enzymes activity in bean (*Phaseolus vulgaris* L.) under cold stress. The Journal of American Science 6, 675–683.

Gracy, C.P., Naik, J., Nagashree, N., 2013. Store Potato and sell in May. Agropedia, Department of Agricultural marketing co-operation and business Management UAS, GKVK, Bangalore-65.

Gunes, A., Inal, A., Alpaslan, M., Eraslan, F., Bagci, E.G., Cicek, N., 2007. Salicylic acid induced changes on some physiological parameters symptomatic for oxidative stress and mineral nutrition in maize (*Zea mays*) grown under salinity. Journal of Plant Physiology 164, 728–736.

Koda, Y., 1992. The role of jasmonic acid and related compounds in the regulation of plant development. International Review of Cytology 135, 155–199.

Krantev, A., Yordanova, R., Janda, T.G., Popova, L., 2008. Treatment with salicylic acid decreases the effect of cadmium on photosynthesis in maize plants. Journal of Plant Physiology 165, 920–931.

Lynn, D.G., Chang, M., 1990. Phenolic signals in cohabitation: implications for plant development. Annu. Annual review of plant physiology and plant molecular biology, 41, 497–526.

Verma, S.K., Asati, B.S., Tamrakar, S.K., Nanda, H.C., Gupta, C.R., 2011. Effect of organic components ongrowth, yield and economic returns in potato. Potato Journal 38(1), 51–55, 2011.

Stromberg, A., Brishammer, S., 1991. Induction of systemic resistance in potato (*Solanum tuberosum* L.) plants to late blight by local treatment with *Phytophthora infestans* (Mont.) de Bary, *Phytophthora cryptogaea*, Laff. ordipotassium phosphate. Potato Research 34, 219–225.

Upadhyay, N.C., Sharma, R.C., Chand, P., 1994. Efficiency of Azotobacter culture as influenced bymethod of its application in potato crop. journal of the indian potato association 21, 83.