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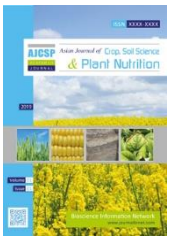

Organic fertilizer's proportion in soil: Evaluating growth and yield of potato

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ABSTRACT

The productivity of organic farming has mainly focused on its relative crop yields than the proportions of organic matters in soil. However, organically cultivation changes crop yields at the same time it depends on types of crops grown. Here, we provide a pot experiment on the rooftop in Latin Square Designs (LSD) with a Diamant variety of potato and four treatment combinations to evaluate variety's growth and yields. T_0: Control, T_1: 100% organic fertilizer, T_2: 75% organic fertilizer+25% soil and T_3: 50% organic fertilizer+50% soil was used for the present study with three replications. Our analysis showed the tallest (23.78 cm) plant was in T_2 followed by T_1 and T_3 (23.37 cm and 23.14 cm, respectively). T_2 produced the maximal (76.44) number of leaves per stem followed by T_2 and T_3 (73.44 and 74.11, respectively). T_1 generating the maximal number (6.89) of tubers per hill was significant than all the other treatments. The highest weight (19.13 gm) per tuber per hill was examined in T_2 followed by T_1 and T_3 (17.05 gm and 12.91 gm, respectively). T_2 produced the utmost tuber length (3.78 cm) followed by T_1 and T_3 (3.39 cm and 3.23 cm, respectively. 75% organic fertilizer+25% soil has concluded the potential to be grown successfully and the most suited treatment for production of potato (Diamant) in coastal areas of Bangladesh.

Key Words: *Diamant variety, Coastal area, Tuber weight and Tuber length.*

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I. Introduction

Potato *(Solanum tuberosum* L.) belonging to the family Solanaceae is the 4th important food crop of the world and the third most important crop of Bangladesh followed by rice and wheat (Illias, 1998). It contributes energy as well as a substantial amount of high-quality protein and essential vitamins, minerals to the daily human diet. It produces high yields, more energy than many crops. Nutritionally,

the tuber of potato is rich in starch and is a good source of potassium, phosphorus, iron, minerals and some important amino acids (Khurana, 2003). Growth and yield of potato depend on proper nutrients in soil, which depends on the proper application of manures and fertilizers. Nutrients can be applied through organic and inorganic sources. Farmers in Bangladesh generally used the inorganic fertilizers to get high yield (Arora, 2008). Due to increased use of inorganic fertilizer in soil, badly affects the soil's physical and chemical properties (Ansari, 2005). It has been realized that unwise use of chemical fertilizers has decreasing organic carbon contents in soil and development of micronutrients deficiencies and ultimately deterioration of produce quality (Naik and Khurana, 2003).

A proper proportion of organic matter in soil influences almost all bios of soil associated with crop production (Bhatt, 2012). Organic farming has potential for reducing the negative impacts of the environment (Ghosh, 1998). The micronutrient can be supplied through various organic manures thus favoring proper growth and development of crops. Organic manures have prolonged effects on fertility and soil moisture (Kumar, 2005). It also reduces the chemicals needed for pest control, besides improving soil physical properties in the long run. The growth parameters and the yield gradually increased with an increase in the rate of organic matter (Ahmed, 2004). Organic manures like cow dung, poultry litter, farmyard manure, vermicompost play a greater role in encouraging organic crop production which is socially acceptable, economically feasible, eco-friendly and sustainable in nature. The nutrient content of organic manures greatly depends on the input materials. It usually contains more nutrients and mineral elements which are in available forms than the parent material. It positively influences the physical, chemical and biological properties of soil. Approximately 4% organic matter is needed for any agricultural soil for better production while 60% cultivable soil of Bangladesh contains organic matter below 1% (Ferdoushi, 2010).

Production of potato is highly affected by various biotic and abiotic stress factors (Guo, 2006). Soil salinity is one of those factors that limit potato productivity and expansion of its cultivation in many parts of the world (Dasgupta, 2008). Soil salinity negatively influences crop growth, yield and quality (Razzouk and Whittington, 1991; Dong, 2008). Potatoes are very sensitive to soil salinity (Maas, 1977), particularly in the early growth stages (Levy, 1992; Nadler, 1995). High salt contents reduce the growth and production of potato by affecting physiological processes, including modification of ion balance, water movements, stomata behavior and chlorophyll content (Munns, 2002). The climatic conditions for potato growing are decreasing due to the salinity in many coastal areas of Bangladesh (Rahaman, 2015). So, the cultivation of potatoes in an eco-friendly method (Organically) in saline condition is still unclear whether it is good yielding or not. Our study was designed with this aspect and may give some clues for cultivating potatoes organically in saline soil.

II. Materials and Methods

Experimental site and design

The research work was conducted on the rooftop of Academic Building-2, the experimental site of Department of Agriculture of Noakhali Science and Technology University, Noakhali-3814, Bangladesh in Rabi season during 6th November 2019 to 4th February 2020. Location of the site is 24°75' N latitude and 90°5' E longitude which falls under the AEZ 18 i.e. Young Meghna Estuarine Flood plain. The growth and yield of potato (Diamant, a variety of potato of Bangladesh) was compared under organic fertilizer (Treatment) and non-fertilizers (control) conditions. The experiment was designed in a Latin Square Designs (LSD) with four treatments. Treatments viz. T_0: Control, T_1: 100% organic fertilizer, T_2: 75% organic fertilizer+25% soil, T_3: 50% organic fertilizer+50% soil and three replications. Four pots were prepared for sowing tubes. There were nine plants in every pot which were divided in three blocks, representing 3 replications, and the distance between plants to plant was 14 cm and row to row 13 cm. In three pots, organic fertilizers (Super Green Field, authorized by Bangladesh Government) (Table 01) were applied during final soil preparation except control (T_0). Seed sowing was done on 6th November, 2019. In this experiment water hyacinth was used as mulching materials to conserve soil moisture in all pots

Soil characteristics

The soil of the experimental pots was sandy loam in texture, medium high land and it is moderately alkaline with pH value 7.6 - 8.7 and salinity 8.67 dS/m. Generally, fertility is medium but low in organic matter (1.45 %). Particle size constitution of the soil of that site is Sand: Silt: Clay =52%: 30%: 18%.

The soil type is sandy loam with available N of 0.08 g kg^{-1} soil, P of 26.79 µg/g soil, K of 0.18 meq /100 g soil, Mg of 3.75 meq /100g soil, S of 10.43 µg/g soil, B of 0.12 µg/g soil, Cu of 3.45 µg/g soil, Fe of 256.6 µg/g soil, Mn of 162 µg/g soil and Zn of 0.53 µg/g soil. Physical and Chemical characteristics of soil of experimental pots were analysed by Soil Resource and Development Institute (SRDI), Noakhali, Bangladesh.

Table 01. Composition of organic fertilizer (Super Green Field):

Humidity (Max)	15-20%	Copper (Max)	0.05%
PH	6.0-8.5	Arsenic (Max)	20ppm
Organic Carbon	10-25%	Chromium (Max)	50ppm
Nitrogen	0.5-4.0%	Cadmium (Max)	5ppm
C:N (Max)	20:1	Led (Max)	30ppm
Phosphorus	0.5-1.5%	Mercury (Max)	0.1ppm
Potassium	1.0-0.5%	Nickel (Max)	30ppm
Sulfur	0.1-0.5%	Others	1%
Zinc (Max)	0.1%		

(Source: BCSIR, 2018)

Climate

The experimental area was under the subtropical climate. Monthly average air temperature was 18.45 °C, monthly average relative humidity was 64.13 %, monthly average rainfall was 25 mm and monthly average sunshine was 201.28 hours during November 2019 to February 2020.

Harvesting

The maturity of the plant was indicated by the plants showing 80 to 90% of leaf senescence and the top started drying. Haulm cutting (Specific technique of stem cutting for potato production in Bangladesh for tuber growth) was done before 5 days of harvesting. The yield of tuber was taken pot wise and measured as gm per tuber. Care was taken to avoid injury in potatoes during harvesting.

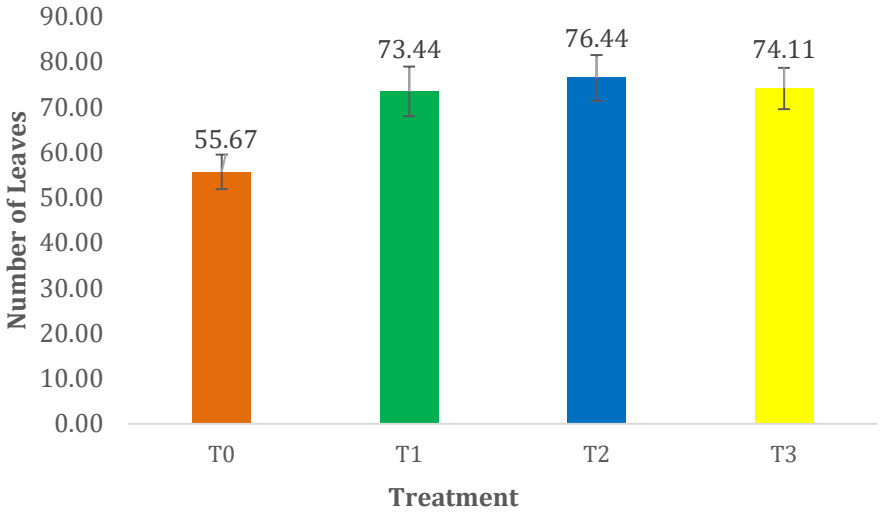
Data collection and analysis

Data were recorded on Number of leaves per stem, Plant height (cm), Number of tubers per hill, Weight per tuber per hill (gm), Tuber length (cm). Data were analyzed statistically using the Microsoft Excel data sheet. The significance of differences among pairs of treatment means were analyzed statistically using Analysis of variance (ANOVA) at 5% level of probability (Gomez and Gomez, 1984).

III. Results

Number of leaves per stem

We have found the number of leaves per stem was the most under T_2 (76.44). However, T_1 and T_3 were also significant over the number of leaves per stem (73.44 and 74.11 individually) according to our descriptive data analysis. (Figure 01)

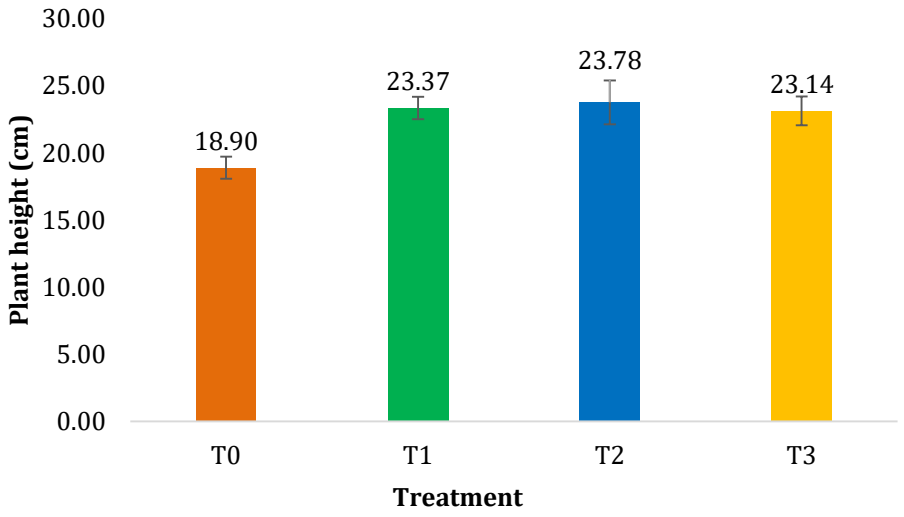


T_0= Control, T_1= 100% organic fertilizer, T_2= 75% organic fertilizer+25% soil, T_3= 50% organic fertilizer+50% soil

Figure 01. Impact of Treatments on Number of Leaves per Stem

Plant Height (cm)

The final analyzed data revealed that significant variations were found in plant height. Plants were grown under T_2 showed the highest (23.78 cm). T_1 and T_3 were found effective also (23.37 cm and 23.14 cm, respectively) (Figure 02).

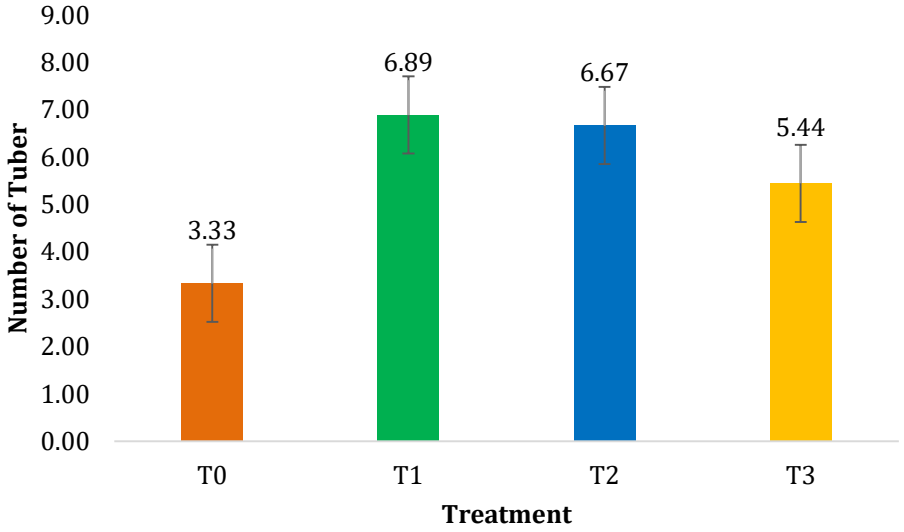


T_0= Control, T_1= 100% organic fertilizer, T_2= 75% organic fertilizer+25% soil, T_3= 50% organic fertilizer+50% soil

Figure 02. Impact of Treatments on Plant Height

Number of tubers per hill

There were significant differences in the number of tubers per hill among treatments. T_1 produced a supreme number of tubers per hill (6.89 tubers/hill). T_2 was found effective too (6.67 tubers/hill) (Figure 03).

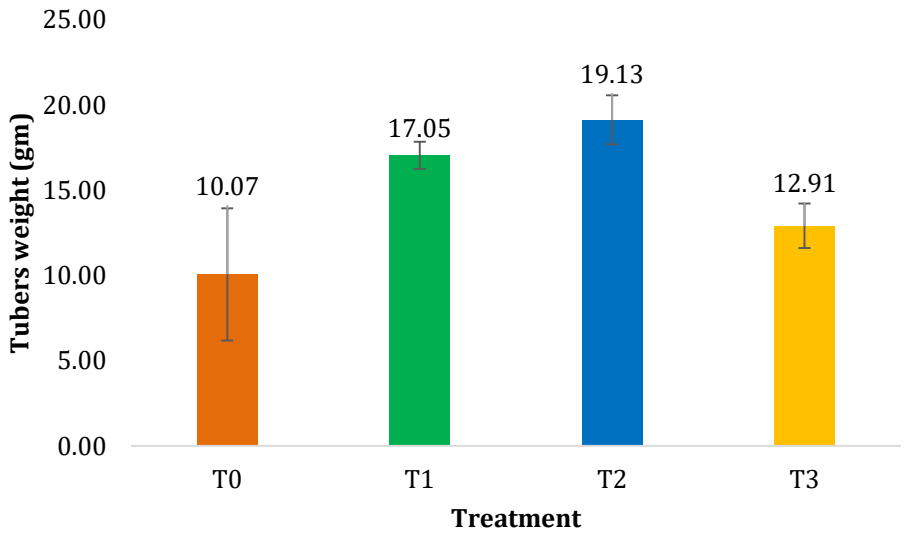


T_0= Control, T_1= 100% organic fertilizer, T_2= 75% organic fertilizer+25% soil, T_3= 50% organic fertilizer+50% soil

Figure 03. Impact of Treatments on Number of Tubers per Hill

Weight per tuber per hill (gm)

We have found T_2 was the most significant than other treatments and produced the highest weight per tuber per hill (19.13 gm) (Figure 04).

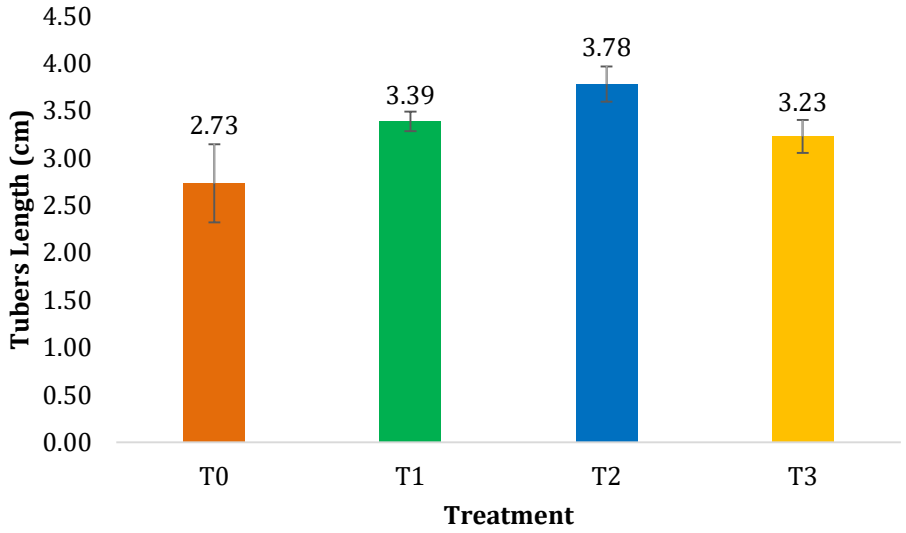


T_0= Control, T_1= 100% organic fertilizer, T_2= 75% organic fertilizer+25% soil, T_3= 50% organic fertilizer+50% soil

Figure 04. Impact of Treatments on Weight per Tuber per Hill

Tubers length (cm)

T_2 was found also the most effective in case of tuber length after harvesting (3.78 cm). Plants were grown under T_1 and T_3 were also found effective as they increase tuber length by 3.39 cm and 3.23 cm individually (Figure 05).



T_0= Control, T_1= 100% organic fertilizer, T_2= 75% organic fertilizer+25% soil, T_3= 50% organic fertilizer+50% soil

Figure 05. Impact of Treatments on Tubers Length

IV. Discussion

In this study, we have identified important cultivation factors and cultivars suitable for organic production of potato (*Solanum tuberosum* L.) in the southern coastal and saline prone area of Bangladesh. In terms of "suitable" was defined as a cultivar giving potential yield, a good grade of tuber and better aboveground parts for animals or for residues. Our analysis revealed that cultivating potato three fourths of organic matter mixed with total soil has a positive impact on potato in a selective location (Noakhali). Duer (1996) found that cultivating potatoes organically with the residues of barley straw had a higher potential of releasing N-NO_3 (Nitrate-nitrogen) thus helping to increase yield but it caused more losses of nutrients. In respect to this experiment, we showed that organic fertilizer (commercial) also helped to increase yield and less loss of nutrients.

Incorporating residues in the field to get more nutrients had sometimes resulted in some new pathogens emerging in the field, sometimes decreasing microbial compositions (Amara et al., 2013;

Mekonnen et al., 2008). We used commercial organic fertilizer in our experiments. Sikder (2017) experimented on two varieties (Asterix and Diamant) under 75% organic fertilizer and 25% vermicompost and found it increased tuber weight and yield with the similarities of the study we found that 75% organic fertilizer and 25% soil increased yield. Organic fertilizers help plants to get more N in soil resulting yield improvement as they increase microbial activity in soil (Nogales et al. 2015). Potato yielded more when treated with manure application along with inorganic fertilizers (Johnston 1986, Nyiraneza and Snapp 2007; Amara et al. 2013). In contrast with that, we used only organic fertilizer and yielded more. Ghemam (2013) applied poultry manure and sheep manure (1:1) and found that it increased foliar area, stem number and yield in agreement with Al Sahaf (2007), he also found that organic chicken manure increased tubers/plants. Our data also agreed with them that organic fertilizers resulted in an increase of yields, leaf number and tubers/hill. Keisham, (2015) experimented on potato under 75% recommended dose of N and 25% vermicompost and found that it increased leaves number with regards this our study also found the highest number of leaves in 75% organic fertilizer and 25% soil.

Sikder (2017) found organic fertilizers were more effective in Asterix (a local variety of Potato in Bangladesh) not in Diamant variety in contrast with the study we found Diamant variety (a local variety of Potato in Bangladesh) was also effective under organic cultivation. Eco-friendly cultivation of any crops should be encouraged in respect of environmental welfare and sustainability of agriculture. People should concentrate on sustainability and the environment besides other traits of interest (Pretty et al. 1995; Hobbs et al. 2008).

V. Conclusion

We provide the information about the Diamant variety of potato cultivation under different organic fertilizer conditions in Bangladesh. Remarkable, we found T_2 was the most successful treatment in every parameter. The data indicate that T_2 is better for production of potatoes in the coastal area of Bangladesh. It produced the highest number of leaves per stem (76.44), highest plant height (23.78 cm), utmost tuber length (3.78 cm) and highest tuber weight (19.13 gm). On the other hand, T_3 and control (T_0) exhibited low weight of tuber per hill and low yield, compared to the other treatments. It is thus recommended that farmers in the coastal area of Bangladesh grow potatoes (Diamant) with 75% organic fertilizer+25% soil because of its greatest tuber weight, high yield and resistance to salinity. 100% organic fertilizer is the second best treatment for potato production in saline prone area. Further study should be continued for better production in the coastal area of Bangladesh.

References

[1]. Ahmed, M. (2004). Effect of cowdung, boron and sulphur on the growth and yield of potato (Doctoral dissertation, MS thesis, Department of Horticulture, Bangladesh Agricultural University, Mynmensingh, Bangladesh).

[2]. Al-Sahaf, F. H. and Atee, A. S. (2007). Potato production by organic farming 3-effect of organic fertilizer and whey on plant growth, yield and tubers quality characteristics. Iraqi Journal of Agricultural Sciences, 38 (4), 65-82.

[3]. Amara, D. and Mourad, S. M. (2013). Influence of organic manure on the vegetative growth and tuber production of potato (*Solanum tuberosum* L var Spunta) in a Sahara desert region. International Journal of Agriculture and Crop Sciences (IJACS), 5(22), 2724-2731.

[4]. Ansari, A. (2005). Effect of organic farming on soil nutrients and quality of carrot (Doctoral dissertation, MS Thesis, Department of Environmental Science, Bangladesh Agricultural University, Mymensingh. 101p).

[5]. Arora, M., Kiran, B., Rani, S., Rani, A., Kaur, B. and Mittal, N. (2008). Heavy metal accumulation in vegetables irrigated with water from different sources. Food chemistry, 111(4), 811-815. https://doi.org/10.1016/j.foodchem.2008.04.049

[6]. Bhatt, B., Chandra, R. and Ram, S. (2012). Long-term application of fertilizer and manure on rice productivity and soil biological properties. International Journal of Agriculture, Environment and Biotechnology, 5(4), 429-433.

[7]. Dasgupta, M., Sahoo, M. R., Kole, P. C. and Mukherjee, A. (2008). Evaluation of orange-fleshed sweet potato (*Ipomoea batatas* L.) genotypes for salt tolerance through shoot apex culture under

in vitro NaCl mediated salinity stress conditions. Plant Cell, Tissue and Organ Culture, 94(2), 161-170. https://doi.org/10.1007/s11240-008-9400-2

[8]. Dong, H., Li, W., Tang, W. and Zhang, D. (2008). Furrow seeding with plastic mulching increases stand establishment and lint yield of cotton in a saline field. Agronomy Journal, 100(6), 1640-1646. https://doi.org/10.2134/agronj2008.0074

[9]. Duer, I. (1996). Mulching effect of catch crop on barley yield, soil water and nitrogen storage. Fragmenta Agronomica (Poland), 13(1), 29-43.

[10]. Ferdoushi, S. N., Farooque, A. M. and Alam, M. S. (2010). Effects of organic and inorganic fertilizer management practices and mulch on the growth and yield of potato. Journal of Agroforestry and Environment, 3 (2), 175-178.

[11]. Ghemam Amarad, D. and Senoussi, M. M. (2013). The Effect of natural organic manure on the growth and productivity of potato (*Solanum tuberosum* Z var spunta) in a Sahara desert region.

[12]. Ghosh, D. C. and Das, A. K. (1998). Effect of biofertilizers and growth regulators on growth and productivity of potato (*Solanum tuberosum* L.). Indian Agriculturist, 42(2), 109-113.

[13]. Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures for agricultural research. John Wiley and Sons. p. 12. ISBN 0-471-87092-7

[14]. Guo, J. M., Liu, Q. C., Zhai, H. and Wang, Y. P. (2006). Regeneration of plants from *Ipomoea cairica* L. protoplasts and production of somatic hybrids between *I. cairica* L. and sweetpotato, *I. batatas* (L.) Lam. Plant cell, tissue and organ culture, 87(3), 321-327. https://doi.org/10.1007/s11240-006-9135-x

[15]. Hobbs, P. R., Sayre, K. and Gupta, R. (2008). The role of conservation agriculture in sustainable agriculture. Philosophical Transactions of the Royal Society B: Biological Sciences, 363(1491), 543-555. https://doi.org/10.1098/rstb.2007.2169

[16]. Illias, S. M. (1998). Production technology of high yielding potato variety (Leaflet in Bangla). Bangladesh Agricultural Research Institute Gazipur, 12(3), 76-90.

[17]. Johnston, A.E. (1986). Soil organic matter, effects on soils and crops. Soil use and management, 2(3), 97-105. https://doi.org/10.1111/j.1475-2743.1986.tb00690.x

[18]. Keisham, A. N. J. U., Heisnam, P. U. N. A. B. A. T. I., Moirangthem, A. B. H. I. N. A. S. H., Das, T. A. P. A. S., Singh, N. I. and Singh, L. N. (2015). Effect on growth and yield of potato (*Solanum tuberosum* L.) var. Kufri Jyoti by nitrogen integration with different organic sources and its after effect on soil. The Bioscan, 10(13), 1335-1338.

[19]. Khurana, S. P., Minhas, J. S. and Pandey, S. K. (2003). The Potato: production and utilization in sub-tropics. p. 445. ISBN 8188039187

[20]. Kumar, M., Gupta, V. K., Gogoi, M. B., Kumar, S., Lal, S. S. and Baishya, L. K. (2005). Effect of poultry manure on potato production under rainfed condition of Meghalaya. Potato Journal, 32(3), 483-486.

[21]. Levy, D. (1992). The response of potatoes (*Solunum tuberosum* L.) to salinity: plant growth and tuber yields in the arid desert of Israel. Annals of Applied Biology, 120(3), 547-555. https://doi.org/10.1111/j.1744-7348.1992.tb04914.x

[22]. Maas, E. V. and Hoffman, G. J. (1977). Crop salt tolerance–current assessment. Journal of the irrigation and drainage division, 103(2), 115-134.

[23]. Mekonnen, D., Pant, L. M. and Dechassa, N. (2008). Effect of integrated nutrient management on yield of Potato and soil Nutrient status at Bako, west Shoa. Ethiopian Journal of Natural Resources, 85-101.

[24]. Munns, R. (2002). Comparative physiology of salt and water stress. Plant, cell and environment, 25(2), 239-250. https://doi.org/10.1046/j.0016-8025.2001.00808.x

[25]. Nadler, A. and Heuer, B. (1995). Effect of saline irrigation and water deficit on tuber quality. Potato Research, 38(1), 119-123. https://doi.org/10.1007/BF02358078

[26]. Naik, P. S. and Karihaloo, J. L. (2007). Micropropagation for Production of Quality Potato Seed in Asia-Pacific. Asia-Pacific Consortium on Agricultural Biotechnology, New Delhi, India. p. 54.

[27]. Nogales, R., Cifuentes, C. and Benitez, E. (2005). Vermicomposting of winery wastes: a laboratory study. Journal of Environmental Science and Health Part B, 40(4), 659-673. https://doi.org/10.1081/PFC-200061595

[28]. Nyiraneza, J. and Snapp, S. (2007). Integrated management of inorganic and organic nitrogen and efficiency in potato systems. Soil Science Society of America Journal, 71(5), 1508-1515. https://doi.org/10.2136/sssaj2006.0261

[29]. Pretty, J. N. (1995). Participatory learning for sustainable agriculture. World development, 23(8), 1247-1263. https://doi.org/10.1016/0305-750X(95)00046-F

[30]. Rahaman, E. H. M. S., Mahmud, A. A., Hossain, M., Mohanta, H. C., Rahman, M. A., Khan, M. S. I. and Merideth, B. (2015). Field performance of sweet potato varieties in saline zone of Bangladesh. Bangladesh Horticulture, 1(1), 67-76.
[31]. Razzouk, S. and Whittington, W. J. (1991). Effects of salinity on cotton yield and quality. Field Crops Research, 26(4), 305-314. https://doi.org/10.1016/0378-4290(91)90007-I
[32]. Sikder, R. K., Rahman, M. M., Bari, S. W. and Mehraj, H. (2017). Effect of organic fertilizers on the performance of seed potato. Tropical Plant Research, 4(1), 104-108. https://doi.org/10.22271/tpr.2017.v4.i1.016

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