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Growth and yield of potato (*Solanum tuberosum* L.) under irrigation scheduling and organic manures

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ABSTRACT

A field experiment was conducted to study the effect of irrigation scheduling and organic amendments on *Solanum tuberosum L.* under mid hills of Meghalaya during 2018-19 in the experimental farm of College of Agriculture, Kyrdemkulai. The different treatments under irrigation scheduling included irrigation at sprouting (S1); irrigation at sprouting + stolonisation (S2); irrigation at sprouting + stolonisation + tuber initiation (S3); irrigation at sprouting + stolonisation + tuber initiation + tuber bulking (S4). Organic treatments comprised of FYM (Farmyard manure) (M1), poultry manure (M2) and control (M0). The investigation concluded that irrigation at stolonisation, and tuberisation are most critical and performance of potato was significantly better under organic inputs rather than in control. Tuber yield was found to be significantly higher under S2 (17.52 t ha^{-1}) yielded the highest followed by S4 (16.62 t ha^{-1}) and S3 (14.87 t ha^{-1}), whereas, S1 (6.61 t ha^{-1}) recorded the lowest yield. Organic manure treatments yielded significant results. M2 (17.77 t ha^{-1}) showed the highest tuber yield closely followed by M1 (13.94 t ha^{-1}) and lowest yield was reported by M0 (10.22 t ha^{-1}). Hence, the organic manures had significantly influenced the growth and yield of potato. Therefore, better irrigation management under critical stages of crop along with efficient nutrient management is key for better production.

1. Introduction

Potato (*Solanum tuberosum L.*) is one of the most important food in the world ranking fourth in production after rice, wheat and maize. It ranks second in India in terms of production after China (Scott and Suarez, 2011). In Meghalaya, the total area under potato cultivation is 18,473 ha and total production is 1,82,285 metric tonnes. One of the promising varieties of potato is Kufri Megha. Potato is grown mainly under irrigated conditions during the rabi or post rabi season. The north eastern states of India contribute about 10 per cent of the total area under potato in the country and 4% of the total production in India (Gupta et al., 2004). But the potato productivity in this region is very low (8.64 t ha^{-1}) as scientific production technology has not been adopted (Burman *et al.,* 2007). Potato is highly sensitive to water stress and since it is being cultivated mostly during the rabi season, it is of utmost importance for water management through irrigation scheduling techniques for better potato production. Suitable irrigation scheduling during crop's critical stages (stolonisation, tuber initiation and tuber bulking) can help farmers to conjunctively use water whilst also increasing the yield. Also, being an exhaustive crop, proper nutrient management needs to be addressed to ensure potential output. Manures improve crop growth by enhancing uptake of nutrients by plants to the soil and improve soil fertility by increasing available nutrients. Organic manure application enhances soil porosity, soil moisture content and water holding capacity (Mahmood *et al.*, 2017).

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2. Materials and Methods

A field experiment was conducted during November - March, 2018-2019 at the College of Agriculture, Kyrdemkulai, Ri-bhoi district, Meghalaya with "Kufri Megha" potato variety. The experimental site is situated at 91° 18' to 92° 18' East longitude and 25° 40' to 26° 20' North latitude and at an altitude of 950 m above the mean sea level (MSL). The climate of Ri-bhoi is classified as subtropical humid type with high rainfall and cold winters. During the experimentation period, maximum weekly rainfall of 20.9 mm was received during 2nd standard week (January), the total amount of 81.73 mm was received during the crop-growing season. Mean weekly maximum temperature was highest during 11th standard week (27°C) and lowest in 1st standard week (18.20°C). Mean weekly minimum temperature was highest during 11th standard week (13.20°C) and lowest in 1st standard week (5.90°C). The average recorded weekly relative humidity was 90%. The red clay loam soil has initial organic carbon and pH of 1.8%, 5.1 respectively. The available nitrogen (N), phosphorus (P) and potassium (K) at 0-30 cm were 242.8 kg ha^{-1}, 19.25 kg ha^{-1} and 320 kg ha^{-1} respectively. Organic manures were incorporated before sowing. Potato crop is very sensitive to water deficit, hence, it requires frequent and shallow irrigations. Reduction in yield is often associated with water deficit during stolonisation, tuber initiation and tuber bulking (FAO, 2008). Taking this into consideration, the criteria based on crop's critical growth stages were utilized for scheduling of irrigations *viz.* Irrigation at sprouting (10 DAS); Irrigation at sprouting (10 DAS) and stolonization (30 DAS); Irrigation at sprouting (10 DAS), stolonization (30 DAS) and tuber initiation (50-55 DAS); Irrigation at sprouting (10 DAS), stolonization (30 DAS), tuber initiation (50-55 DAS) and tuber bulking (65-70 DAS) on respective plots. FYM and poultry manure were applied at the rate of 24 t ha^{-1} and 8 t ha^{-1}, respectively base on recommended nitrogen dose of potato. Seed rate and spacing adopted was 15 t ha^{-1} and 50 cm × 20 cm respectively. First irrigation was given after sowing for inducing germination. Total of 12 treatments consisted of four irrigation scheduling at critical stages and two organic manures and a control. The experiment was laid in strip plot experimental design The data obtained from various studies during investigation were statistically analysed by using the technique of analysis of variance for strip plot design over the computer. The difference between the treatment means was tested as for their statistical significance with appropriate critical difference (C.D.) value at 5% level of probability as explained by Gomez and Gomez (1984).

Plant height (cm)

The height of the plant in cm was determined from the sample tagged plants by measuring the height from the ground level to the tip of the longest stem or at 15 days interval and their mean was computed as plant height.

Weight of tubers per plant:

The weight of tubers measured from the five tagged plants was taken separately and the mean value was expressed as the weight of tubers per plant

Tuber yield (t ha^{-1})

Total tuber, yield was calculated by excluding the yield of the plant from boundary but by including the yield of sample plants and the yield from plots was converted into tonnes per hectare.

Benefit cost ratio(BCR):

Utility of adopting different practices was compared by using the following economic parameters.

The treatments were,

	Vertical strips	Horizontal strips
i.	Irrigation at sprouting (10 DAS) (S_1)	a. Control (no manure) (M_0)
ii.	Irrigation at sprouting(10 DAS) and stolonization (30 DAS) (S_2)	b. Farmyard manure (M_1)
iii.	Irrigation at sprouting(10 DAS), stolonization (30 DAS) and tuber initiation (50-55 DAS) (S_3)	c. Poultry manure (M_2)
iv.	Irrigation at sprouting(10 DAS), stolonization (30 DAS), tuber initiation (50-55 DAS) and tuber bulking (65-70 DAS) (S_4)	

Gross return = Tuber yield (kg ha^{-1}) x local market price of potato tubers (` kg^{-1})

Net return= Gross return – Cost of cultivation

$$\text{Benefit cost ratio} = \frac{\text{Gross returns }(Rs. ha^{-1})}{\text{Cost of cultivation }(Rs. ha^{-1})}$$

3. Results and Discussion

Plant height:

Plant height is an important parameter for determining the growth of plant. The maximum plant height was recorded at 105 DAS 29.98 cm. Plant heights of potato decreases with decrease of irrigation frequency (Kumar *et al.*, 2007). It is readily influenced by the prevailing meteorological conditions during the growing season. At the time of maturity, the maximum plant height recorded was 29.98 cm under poultry manure treatment (M_2). Irrigation scheduling at crops' critical stages, *viz.* irrigation at sprouting (S_1); irrigation at sprouting + stolonization (S_2); irrigation at sprouting + stolonization + tuber initiation (S_3) and irrigation at sprouting + stolonization + tuber initiation + tuber bulking (S_4), did not show significant results on plant height and this may be due to the occurrence of light showers throughout the growing period. However, significant increase in plant height was observed with the application of organic amendments. The application of poultry manure showed the highest plant height (29.98 cm) and the shortest height was recorded under control treatment (23.73 cm) at 105 DAS as shown in Table 1. It might be due to the ability of poultry manure to decompose rapidly thereby, releasing the nutrients essential for plant growth Boateng *et al.*, 2006. Other organic manures including FYM, has slow release of nutrients (Souza *et al.*, 2008). The results reported a significant difference in plant height in plants derived in poultry manure and FYM compared with that of control. These results were in agreement to the findings of Karim *et al.* (2016). The increase in plant height from 90 DAS to 105 DAS is very small and this is due to the starting of senescence period where growth becomes stagnant.

Yield attributes:

Significant results were recorded in irrigation scheduling treatments on weight of tubers per plant. Even so, treatments with only one irrigation, *i.e.* S_1 produced the lowest weight of tubers per plant. This indicates that water availability at the root zone of plant plays an important role on the final yield. And clearly, irrigation at stolonisation proves to be the most critical stage for better crop performance (Table 1). This is in conformity with results reported by Saikia, 2011; Bora and Karmakar, 2012. Hence, it can be concluded that the availability of water at root zone during potato growth helps in better yield and produce produce (Bisht *et al.,* 2012). Among organic manure treatment M_2 (205.91 g) closely followed by M_1 (172.79 g) and M_0 (108.78 g). The findings are in accordance with Lemaga and Caesar, 1990; Amara and Mourad, 2013; Karim *et al.* 2016. Tuber yield was found to be significantly higher under S_2 (17.52 t ha^{-1}) yielded the highest followed by S_4 (16.62 t ha^{-1}) and S_3 (14.87 t ha^{-1}), whereas, S_1 (6.61 t ha^{-1}) recorded the lowest yield. Organic manure treatments yielded significant results. M_2 (17.77 t ha^{-1}) showed the highest tuber yield closely followed by M_1 (13.94 t ha^{-1}) and lowest yield was reported by M_0 (10.22 t ha^{-1}). Crop irrigated only at sprouting might have experienced water stress during

Table 1. Effect of irrigation scheduling and organic manures on performance of potato

Treatments	Plant height (cm)	Weight of tuber per plant (g)	Tuber yield (t ha^{-1})
Irrigation at sprouting (S_1)	25.02	156.92	6.61
Irrigation at sprouting + stolonization (S_2)	28.05	169.01	17.52
Irrigation at sprouting + stolonization + tuber initiation (S_3)	26.89	161.62	14.87
Irrigation at sprouting + stolonization + tuber initiation+tuber bulking (S_4)	26.85	162.45	16.62
S.E.(m) ±	**0.58**	**3.11**	**0.37**
C.D(P=0.05)	**NS**	**NS**	**1.27**
Control (M_0)	23.73	108.81	10.02
FYM (M_1)	26.40	172.79	13.94
Poultry manure (M_2)	29.98	205.91	17.77
S.E.(m) ±	**0.38**	**2.25**	**0.24**
C.D(P=0.05)	**1.49**	**8.91**	**0.74**

***NS= Non significant**

the vegetative phase, reproduction phase and maturity phase causing a reduction in final tuber yield. The reduction in yield with treatment S_1 can also be attributed to the lesser number of tubers per plant and lower tuber weight per plant. High water requirement needs to be emphasized especially during potato critical stages of stolonisation, tuber initiation and tuber bulking (Hassan *et al.*, 2002; Saikia, 2011; Bora and Karmakar, 2012). Among organic manure treatment M_2 (17.77 t ha^{-1}) closely followed by M_1 (13.94 t ha^{-1}) and M_0 (10.2 t ha^{-1}).

Poultry manure has been reported to have a favourable effect on soil physical, chemical and biological properties (Demir *et al.*, 2010, Outstani *et al.*, 2015). The yield of potato is favourably higher under manure fertilisation and this may be attributed to the improvement of soil water retention and supplementation of required nutrient. Under control treatment, the yield is extremely low due to less number of tubers, small tuber size and low weight of tubers per plant. These findings are in line with those reported by Chandrakar *et al.* 2017.

Gross return reported significant results under irrigation scheduling treatments, S_2 (Rs. 2,71,511.11 ha^{-1}) recorded highest gross return over S_4 (Rs. 2,57,511.11 ha^{-1}) followed by S_3 (Rs. 2,30,888.89 ha^{-1}) and S_1 (Rs. 1,06,777.78 ha^{-1}) being the lowest. For net return S_2 (Rs. 1,76,483.25 ha^{-1}) recorded highest net return closely followed by S_4 (Rs. 1,60,418.25 ha^{-1}) followed by S_3 (Rs. 1,34,828.53 ha^{-1}) and S_1 (Rs. 12,782.44 ha^{-1}) being the lowest. BCR also showed significant difference among the irrigation scheduling treatments, S_2 (2.83) produced the highest BCR over S_4 (2.63) and S_3 (2.39) but the lowest is S_1 (1.13). Similar findings were reported by Bisht *et al.,* 2012; Chandrakar *et al.,* 2017. For organic manure treatment, significant results were reported from gross return, net return and BCR. Gross return of M_2 (Rs. 2,75,708.91 ha^{-1}) showed significantly higher results compared to M_1 (Rs. 2,17,945.83 ha^{-1}) and M_0 (Rs. 1,56,362.50 ha^{-1}). For net return, M_2 (Rs. 1,77,961.56 ha^{-1}) showed significantly higher results compared to M_1 (Rs. 1,16,069.06 ha^{-1}) and M_0 (Rs. 69,353.73 ha^{-1}). BCR also showed significant difference among the organic manure treatments, M_2 (2.82) produced the highest BCR over M_1 (2.13) and M_0 (1.79). This can be attributed to the significantly larger amount of yield reported from poultry manure and FYM treatments over control treatment.

4. Conclusion

Irrigation scheduled at sprouting + stolonization (S_2) is the most suitable for better performance and better economics of potato. It may be concluded that among the organic amendments treatments there is significant differences in the yield and in BCR therefore, poultry manure may be preferred over the other manures.

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6. References

Bisht, P., Raghav, M. and V.K. Singh, 2012. Effect of different irrigation schedules on the growth and yield of drip irrigated potato. *Potato J.,* 39(2): 202-204.

Boateng, S. A., Zickermann, J. and M. Kornahrens, 2006. Poultry manure effect on growth and yield of maize. *West African Journal of Applied Ecology.*, 9: 12-18.

Bora, P.K. and Karmakar, R.M., 2012. Productivity of potato under limited irrigation regime in relation to weather parameters. *Indian Journal of Dryland Agricultural Research and Development* 27(1): 52-57.

Burman, R.R., Kumar, M. and K.M. Nagaraj, 2007. Organic potato production- practices and extension strategy. In: Advances in Organic Farming Technology in India, (eds.) Munda, G. C., Ghosh, P.K., Das, A., Nagchan, S.V. and Bujarbaruah, K.M. Umiam, India: ICAR Research Complex for NEH Region. pp. 271–279.

Chandrakar, C.K., Shrivastava, G.K., Dwivedi, S.K., Sharma, D., Pandey, K.K. and S.K. Singh, 2017. Advance Agro- Techniques for Yield Efficiency and Economics of Potato (*Solanum tuberosum*) Crop for Chhattisgarh Plains. *International Journal of Current Microbiology and Applied Sciences* 6(2): 766-777.

Demir, K., Sahin, O., Kadioglu, Y.K., Pilbeam, D.J. and A

Lemaga, B. and K. Caesar, 1990. Relationships between

Gunes, 2010. Essential and nonessential element composition of tomato plants fertilized with poultry manure. *Scientia Horticultural* 127: 16-22.

FAO., 2008. Potato and water resources. http://www. Potato 2008.org/ Accessed 2 June 2019.

Gomez KA and AA Gomez, 1984. Statistical procedure for agriculture research. 2nd Edn. International Rice Research Institute, Los Banos, Philipines. John Wily and Sons, New York. 324 pp.

Gupta, V.K., Thakur, K.C., Kumar, S., Pandey, S.K. and U. Sah, 2004. True Potato Seed- An alternative technology for potato production in North eastern hill region. Technical bulletin no 64. Central Potato Research Institute, Shimla. pp. 1.

Hassan, A.A., Sarkar, A.A., Ali, M.H. and N.N. Karim, 2002. Effect of deficit irrigation at different growth stages on yield of potato. *Pakistan Journal of Biological Sciences* 5(2): 128-134.Karim, K.H., Maful, M.T. and F.M Mahmut, (2016). Effect of different poultry and cattle manure rates on yield and yield components of potato (*Solanum tuberosum*) cv-Sante. *Egyptian Journal of Biology,* 12(2): 155-162.

Kumar, P., Pandey, S.K., Singh, S.V. and D. Kumar, 2007. Irrigation requirements of chipping potato cultivars under west-central Indian plains. *Potato J.,* 34(3 - 4): 193- 198.

numbers of main stems and yield components of potato (*Solanum tuberosum* L. cv. Erntestolz) as influenced by different day lengths. *Potato Research.,* 33: 257-267.

Mahmood, F., Khan, I., Ashraf, U., Shahzad, T., Hussain, S., Shahid, M., Abid, M. and S. Ullah, 2017. Effects of organic and inorganic manures on maize and their residual impact on soil physico-chemical properties. *Journal of Soil Science and Plant Nutrition,* 17(1): 22-32.Oustani, M., Halilat, M.T. and H. Chenchouni, (2015). Effect of poultry manure on the yield and nutriments uptake of potato under saline conditions of arid regions. *Emirates Journal of Food and Agriculture* 27(1): 106-120.

Scott, G. and V. Suarez, 2011. Growth rates for potato in India 1961-2009 and their implications for industry. *Potato J.,* 38(2): 100-12.

Saikia M., 2011. Effect of irrigation and mulching on growth, yield and water use efficiency of potato in Assam. *Potato J.,* 38(1): 81-83.

Souza, P.A, Souza, G.L.F.M., Menezes, J.B and N.F. Bezerra, 2008. Evaluations of cabbage cultivar grown under organic compost and mixed mineral fertilizers. *Hortic. Bras.*, 26: 143-145.