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Research Paper

Development of site specific NPK requirement of potato

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ABSTRACT

The experiment to standardize NPK requirement of potato (var. Kufri Jyoti) was conducted at Experimental Farm of Division of Vegetable Science, SKUAST Kashmir during 2021-23. The experiment consisted of seven treatments viz. T_1: 50% RFD NPK/ha, T_2: 100% RFD NPK/ha, T_3: 150% RFD NPK/ha, T_4: N0 +100% RFD P&K/ha, T_5: P0 +100% RFD N&K/ha, T_6: K0 +100% RFD N&P/ha and T_7: No NPK/ha (control) replicated four times and was laid out in RCBD. The study revealed that maximum plant height at 60 days after planting (33.43 cm), number of shoots/plant at 60 days after planting (5.41), number of tubers/plant (6.88), tuber yield (36.46 t/ha) was recorded with treatment T_3 (150% RFD NPK/ha) with maximum net returns of Rs. 285942.66 and B:C ratio of 2.98 followed by treatment T_2 (100% RFD NPK/ha).

Key words: Potato, Kufri Jyoti, NPK requirement

Potato (*Solanum tuberosum* L.) is one of the most commonly grown vegetable crops of the world. Potato crop has always been the ‘poor man’s friend’ and is being cultivated in the country for more than 300 years. It is a temperate crop grown under subtropical conditions in India. Potatoes play a key role in ensuring food security for the world’s ever-increasing population (Thiele *et al.,* 2010; Scott and Suarez, 2012). They are grown for their edible underground tubers, which are high in carbohydrates, especially starch, as well as vitamins, minerals, and phytochemicals like carotenoids and natural phenols (Zarzecka *et al.,* 2015). Potatoes contain 0.3 per cent fat, 20.6 per cent carbohydrates, 1.1 per cent crude fiber, 2.1 per cent protein, and 0.9 per cent ash. They also possess a substantial quantity of essential amino acids like isoleucine, leucine and tryptophan (Choudhary *et al.,* 2023). After rice and wheat, potato is the third most valuable food crop of the world (Pinhero *et al.,* 2016). It has a very important place among India's cash crops and can meet a greater portion of the country's food needs (Banjare *et al.,* 2014). In India, potato occupies an area of 2203 thousand hectares with a production of 56173 thousand MT (Anonymous, 2021). Optimal potato development and economic output rely on numerous management aspects, one of which is the provision of adequate nutrients. During the late nineteenth century and early twentieth century, considerable effort was devoted to examining the correlations between production parameters, such as nutrient availability for plants, and crop yields (De Wit 1994). The most renowned yield-response principle from this period is the law of the minimum, formulated by Carl Sprengel and subsequently disseminated by Justus von Liebig in the beginning of the nineteenth century. The law of the minimum states that optimal crop growth occurs only when all necessary nutrients are at their ideal levels (van der Ploeg *et al*., 1999). It specifies that plant growth is regulated not by the overall nutrient availability but by the quantity of the most limited nutrient. This law emphasizes the significance of balanced nutrition for good plant development. The law of declining returns, initially articulated by Eilhard Alfred Mitscherlich, holds comparable significance. This law posits that as nutrient supply increases, the yield increment resulting from additional fertilization diminishes, indicating that the yield response to fertilization adheres to a saturation curve. Another principle is the law of the optimal, articulated by Georg Liebscher. Liebscher asserted that the production component in minimal supply enhances yield (output) incrementally as the other production variables approach their optimal levels (Nijland *et al.*, 2008). These laws underpin contemporary methodologies for formulating plans aimed at the efficient utilization of resources in plant production (Koch *et al.*, 2019). In light of the rising issues in contemporary agriculture, De Wit (1992) proposed that the principles established by Liebig, Mitscherlich, and Liebscher may serve as specific alternatives within a singular dynamic model. He determined that both agriculture and the environment should prioritize minimizing production resources essential for optimizing the utilization of other resources.The potato generates significantly more dry matter in a shorter growth cycle, necessitating a substantial quantity of nutrients per unit of time, which most soils are typically unable to provide. Effective nutrient management is crucial for optimizing potato yield and maintaining agricultural productivity while minimizing adverse effects on soil fertility. When soil nutrient supply is insufficient to satisfy growth requirements, the use of fertilizer is essential. Potatoes possess a superficial root system, resulting in a considerable requirement for various nutrients. Increased use of external inputs and blanket fertiliser recommendations over a large area have been driving up potato yields in recent years (Kumar *et al.*, 2016). For potato, the nitrogen (N), phosphorus (P), and potassium (K) are required in the ratio of 150:100:100 kg/ha. The management of these macronutrients (especially N, P, and K) is the most important factor for exploiting the full productive capacity of any potato cultivar (Kumar *et al.*, 2004), and the use of balanced fertiliser is crucial for increasing yield. Therefore, a complete nitrogen management program is crucial for sustaining a healthy potato crop, maximizing tuber output and quality, and reducing negative environmental impacts. With this context in mind, the current study was designed to optimise the N, P, and K levels in order to maximise the yield of the potato variety Kufri Jyoti in Kashmir region.

MATERIALS AND METHODS

The experiment to develop site specific NPK requirement of potato (var. Kufri Jyoti) was conducted at Experimental Farm of Division of Vegetable Science, SKUAST Kashmir during 2021-23. The experiment was laid out in Randomized Complete Block Design and consisted of seven treatments and four replications. The field was divided into plots of $3.6 \times 3.6 m^2$ size and the plants were planted at a spacing of 60 × 20 cm. Nitrogen, phosphorous and Potassium were applied in accordance to the recommended fertilizer dose i.e., 150:100:100 kg/ha respectively. Whole of P and K was given as basal dose whereas N was applied in two split doses i.e., half as basal dose and remaining half as top dressing during earthing up. Various intercultural operations were followed according to the package of practices. The treatment details are presented in table

Table 1: Treatment details

Treatment	Details
T_1	50% RFD NPK/ha
T_2	100% RFD NPK/ha
T_3	150% RFD NPK/ha
T_4	N0 + 100% RFD P&K/ha
T_5	P0 + 100% RFD N&K/ha
T_6	K0 + 100% RFD N&P/ha
T_7	No NPK/ha (control)

Observations on plant height (cm), number of shoots/plant, number of tubers/plant and total tuber yield (q/ha) were recorded following standard procedures.

RESULTS AND DISCUSSION

Five plants from each treatment were selected randomly from each replication for recording the observations. The data was analysed following standard statistical procedures outlined by Gomez and Gomez (1983). Pooled data over the years depicted that treatment T_3 with 150% RFD NPK/ha recorded maximum plant height of 33.43 cm after 60 days of planting as well as maximum number of shoots/plants i.e. 5.41 whereas minimum plant height (226.75cm) as well as minimum number of shoots/plant (2.54) was documented by treatment T_7 with No NPK/ha (control). (Table 2and 3). The enhanced height and robust growth of potato plants with escalating fertilizer doses may be due to the improved nitrogen absorption by the plants, which positively influences the synthesis and accumulation of proteins and carbohydrates essential for cell division and elongation, thereby facilitating plant growth.

Table 2: Effect of different levels of NPK on plant height (cm) (60 days after planting) of potato cultivation

Treatment	Plant height (cm)			Mean over years (cm)
	2021	2022	2023	
T_1	31.66	30.29	31.28	31.08
T_2	32.44	32.64	33.04	32.71
T_3	32.92	33.49	33.88	33.43
T_4	31.54	32.08	32.31	31.98
T_5	31.1	30.69	30.82	30.87
T_6	30.31	29.93	30.54	30.26
T_7	26.25	27.26	26.74	26.75

Table 3: Effect of different levels of NPK on number of shoots/plant (50 days after planting) of potato cultivation

Treatment	No. of shoots/plant			Mean over years
	2021	2022	2023	
T_1	4.31	4.04	4.22	4.19
T_2	5.06	4.93	5.11	5.03
T_3	5.4	5.31	5.53	5.41
T_4	4.61	4.72	4.94	4.76
T_5	4.07	3.91	3.82	3.93
T_6	3.78	3.7	3.86	3.78
T_7	2.44	2.65	2.54	2.54

The results of plant height aligned with the findings of Mozumder *et al.,* 2014, whereas the number of shoots per plant corresponded with the results of Patel, 2013. Perusal of tables 4 and 5 revealed that maximum number of tubers/plant (6.88) as well as maximum tuber yield of 36.46t/ha was recorded by treatment T_3 with 150% RFD NPK/ha whereas treatment T_7 with No NPK/ha (control) documented minimum number of tubers/plant (4.72) as well as minimum tuber yield of 26.89t/ha. Similar findings were reported by Nagar and Yadav, 2019, Amarananjundeswara *et al*, 2018 and Kumar *et al.,* 2001. The augmentation in the quantity of potato tubers, resulting from elevated fertilizer applications, may also be ascribed to enhanced gibberellin biosynthesis in the plant, which led to stem and root elongation, premature flowering and fertilization, ultimately facilitating tuber formation (Abdella *et al.,* 1995). Patel and Patel (2001) observed analogous findings for total tuber output, indicating that elevated levels of NPK enhanced growth, development, and the transfer of photosynthates to tubers, potentially leading to increased tuber yield. Kapoor et al. (2013) and Kapoor (2016) observed analogous findings. With the increment in fertiliser dozes, better results and patterns were observed. Shunka *et al.*, 2016 and Nizamuddin *et al.*, 2003 reported similar results. Nitrogen is the first critical factor in cultivation of potato crop. Nitrogen has a major effect on the average tuber weight (De la Morena *et al.*, 1994).

Table 4: Effect of different levels of NPK on number of tubers/plant of potato cultivation

Treatment	No. of tubers/plant			Mean over years
	2021	2022	2023	
T_1	6.14	5.88	5.95	5.99
T_2	6.39	6.43	6.58	6.47
T_3	6.79	6.87	6.98	6.88
T_4	6.01	5.99	6.08	6.03
T_5	5.86	5.71	5.62	5.73
T_6	5.41	5.51	5.62	5.51
T_7	4.72	4.84	4.61	4.72

Table 5: Effect of different levels of NPK on tuber yield (t/ha) and B:C ratio of potato cultivation

Treatment	Tuber Yield (t/ha)			Mean over years (t/ha)	Net Returns (Rs.)	B:C ratio over years
	2021	2022	2023			
T_1	33.20	30.51	32.84	32.18	253388.66	2.91
T_2	34.85	34.84	35.12	34.93	271649.00	2.96
T_3	35.85	36.43	37.10	36.46	285942.66	2.98
T_4	29.80	33.73	33.64	32.39	245486.66	2.79
T_5	31.12	31.31	31.12	31.18	234319.20	2.79
T_6	32.76	29.86	30.75	31.12	228670.20	2.68
T_7	28.40	26.79	25.50	26.89	199761.66	2.77

It also plays a pivotal role on the number of emerging leaves and the leaf expansion rate (Ospina *et al.*, 2014), in-turn affecting photosynthetic efficiency of the plant (Mauromicale *et al.*, 2006) and subsequently partitioning of dry matter to tubers, formation of tubers and eventually tuber yield formation (Ahmed *et al.*, 2015). Nitrogen is also needed during tuber bulking. Phosphorous is also needed by the potato crop in large amount when compared to other crops as it has a significant economic impact on the setting of potato tubers (Hopkins *et al.*, 2014), and also during later stages of growth where P improves tuber maturity (Rosen *et al.*, 2014). Potassium (K) is the macronutrient with the highest concentration in potato tubers and plays an important role in the enzyme functions of the potato crop, such as stimulating starch synthase for starch synthesis (Hawker *et al.*, 1979). Net return from potato cultivation followed the same trend as that of tuber yield. The highest values of Rs. 285942.66/ha was recorded by treatment T_3 with 150% RFD NPK/ha and was closely followed by treatment T_2 with 100% RFD NPK/ha which recorded a value of Rs. 271649.00. The lowest net returns of Rs. 199761.66 was observed with treatment T_2 with 100% RFD NPK/ha Consequently, the highest B:C ratio of 2.98 was recorded in treatment T_3 with 150% RFD NPK/ha followed by a B:C ratio of 2.96 recorded in treatment T_2 with 100% RFD NPK/ha. Lowest B:C ratio of 2.77 was observed in treatment T_2 with 100% RFD NPK/ha. Similar findings were reported by Amarananjundeswara *et al,* 2018.

CONCLUSION

Pooled data over the years depicted that maximum plant height (33.43cm), number of shoots/plant (5.41), number of tubers/plant (6.88) and tuber yield (36.46t/ha) was recorded with 150% RFD NPK/ha with maximum net returns of Rs. 285942.66 and B:C ratio of 2.98. Hence, the practice can be recommended for harnessing maximum tuber yield and better economic benefits for potato cultivation in Kashmir region.

CONFLIT OF INTEREST

All the authors affirm that there is no conflict of interest among them. All research activities comply with relevant legal, institutional and ethical standards.

AUTHOR CONTRIBUTION

All the authors contributed equally in the present study.

REFERENCES

Abdella, G., Guinazu, M., Tizio, R., Pearce, D. W. and Pharis, R. P. 1995. Effect of chloroethyl trimethyl ammonium chlorides on tuberization and endogenous GA_3 in roots of potato cuttings. *Plant Growth Regulators,* **17**: 95-100.

Ahmed, A., Zaki, M., Shafeek, M., Helmy, Y. and El-Baky, M.A. 2015. Integrated use of farmyard manure and inorganic nitrogen fertilizer on growth, yield and quality of potato (*Solanum tuberosum* L.). I*nternational Journal of Current Microbiology and Applied Science*, **4**:325–349.

Amarananjundeswara, H., Prasad P.S., Shetty, S. and Sandhya, G.C. 2018. Response of potato variety Kufri Jyoti to different levels of NPK and their cost economics in southern dry zone of Karnataka. *International Journal of Chemical Studies*, **6**: 908-911.

Anonymous, 2018. Horticultural Statistics at a Glance 2017, Department of Agriculture.

Banjare S, Sharma, G. and Verma, S.K. 2014. Potato crop growth and yield response to different levels of nitrogen under Chhattisgarh Plains Agro-climatic Zone. *Indian Journal of Science and Technology,* **7**:1504-1508.

Choudhary, B., Dongre, R., Sant, K. and Bakode, S. 2023. Nutrient Management in Potato (*Solanum tuberosum* L.) through Evaluation of the Fertility Status of Soils in Satpura Zone of Madhya Pradesh. *Biological Forum – An International Journal*, **15**:99-103.

De la Morena, I., Guillén, A. and del Moral, L.F.G. 1994. Yield development in potatoes as influenced by cultivar and the timing and level of nitrogen fertilization. *American Potato Journal*, **71**:165–173.

De Wit, C.T. 1992. Resource use efficiency in agriculture. *Agric Syst.,* **40**:125–151.

De Wit, C.T. 1994. Resource use analysis in agriculture: a struggle for interdisciplinarity. In: Fresco LO, Stroosnijder L, Bouma J, van Keulen H (eds) The future of the land: mobilising and integrating knowledge for land use options. John Wiley & Sons, Wageningen, pp 41–55

G. Thiele, G., Theisen, K., Bonierbale, M. and Walker, T. 2010. Targeting the poor and hungry with potato science. *Potato J.,* **37**: 75-86

G.J. Scott, V. Suarez, The rise of Asia as the centre of global potato production and some implications for industry. *Potato J.,* **39**:1-22.

Gomez, K.A. and Gomez, A.A. 1983. Statistical procedures for agricultural research. John Wiley and sons, New York. 691.

Hawker, J.S., Marschner, H. and Krauss, A. 1979. Starch synthesis in developing potato tubers. *Physiologia Plantarum*, **46**:25– 30.

Hopkins, B.G., Horneck, D.A. and MacGuidwin, A.E. 2014. Improving phosphorus use efficiency through potato rhizosphere modification and extension. *American Journal of Potato Research,* **91**:161–174.

Kapoor, R., Sandal, S. K., Sharma Sanjay, K., Kumar, A. and Saroch, K. 2013. Effect of varying drip irrigation levels and NPK fertigation on soil water dynamics, productivity and water use efficiency of cauliflower (*Brassica oleracea* var. *Botrytis)* in wet temperate zone of Himachal Pradesh. *Indian Journal of Soil Conservation,* **42**: 249-254.

Kapoor, R. 2016. Effect of drip irrigation on soil-plant water dynamics, nutrient use and productivity of capsicum and broccoli under varying NPK fertigation in an acid alfisol. Ph. D. *Thesis,* p 197. CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India.

Koch, M., Naumann, M., Pawelzik, E., Gransee, A. and Thiel, H. 2019.The Importance of Nutrient Management for Potato Production Part I: Plant Nutrition and Yield. *Potato Res.* **63**:97–119.

Koch, M., Busse, M., Naumann, M., Jákli, B., Smit, I., Cakmak, I., Hermans, C., and Pawelzik, E. 2019. Differential effects of varied potassium and magnesium nutrition on production and partitioning of photoassimilates in potato plants. *Physiol Plant.*

Kumar, D., Praharaj, C.S., Sharma, R.C. and Khurana, S.M.P. 2001. Respose of potato varieties to fertility levels in indogangetic plains of Bihar. *Journal of Indian Potato Association*, **28**:56-57.

Kumar, P., Byju, G., Singh, B.P., Minhas, J.S. and Dua,V.K. 2016. Application of QUEFTS model for site specific nutrient management of NPK in sweet potato (*Ipomoea batatas* L. Lam). *Communications in Soil Science and Plant Analysis*, **47**:1599–1611.

Kumar P, Pandey, S.K., Singh, B.P., Rawal, S., Singh, S.V. and Kumar, D. 2004. Fertilizer requirement of chipping potato (*Solanum tuberosum* L.) cultivars in west-central plains. *Potato Journal,* **31**:177-81.

Mauromicale, G., Ierna, A. and Marchese, M. 2006. Chlorophyll fluorescence and chlorophyll content in fieldgrown potato as affected by nitrogen supply, genotype, and plant age. *Photosynthetica*, **44**:76–82.

Mozumder, M., Banerjee, H., Ray, K. and Paul, T. 2014. Evaluation of potato (*Solanum tuberosum*) cultivars for productivity, nitrogen requirement and eco-friendly indices under different nitrogen levels. *Indian Journal of Agronomy* **59**(2): 327-335.

Nagar, B.L. and Yadav, D.L. 2019. Effect of Different Levels of NPK Fertilizer on Potato Tuber Yield In South Eastern Rajasthan. *Chemical Science Review and Letters*, **8:** 195-199.

Nizamuddin, Mahmood, M.M., Farooq, K. and Riaz, S. 2003. Response of potato crop to various levels of NPK. *Asian Journal of Plant Sciences,* **2**:149-151.

Nijland, G.O., Schouls, J. and Goudriaan, J. 2008. Integrating the production functions of Liebig, Michaelis–Menten, Mitscherlich and Liebscher into one system dynamics model. *NJAS* **55**:199–224

Ospina, C.A., Lammerts van Bueren, E.T., Allefs, J.J.H.M., Engel, B., van der Putten, P.E.L., van der Linden, C.G. and Struik, P.C. 2014. Diversity of crop development traits and nitrogen use efficiency among potato cultivars grown under contrasting nitrogen regimes. *Euphytica*, **199**:13–29.

Patel, B. 2013. Effect of different levels of NPk on growth, development and yield of potato cv. *Kufri Ashoka* under Chhattisgarh plain condition (doctoral dissertation, indira Gandhi Krishi Vishwa Vidyalaya, Raipur).

Patel, J. C. and Patel, B. K. 2001. Response of potato to N fertilizer under trickle and furrow irrigation. *Indian Journal of Potato Association,* **28**: 195-200.

Pinhero, R. G., Waduge, R.N., Liu, Q., Sullivan, J.A., Tsao, R., Bizimungu, B. and Yada, R.Y. 2016. Evaluation of nutritional profiles of starch and dry matter from early potato varieties and its estimated glycemic impact. *Food Chemistry,* 203:356–66.

Rosen, C.J., Kelling, K.A., Stark, J.C. and Porter, G.A. 2014. Optimizing phosphorus fertilizer management in potato production. *American Journal of Potato Research*, **91**:145–160.

Shunka, E., Chindi, A., Woldegiorgis, G., Seid, E. and Tessema, L. 2016. Response of potato (*Solanum tuberosum* L.) varieties to nitrogen and potassium fertilizers rates in central highlands of Ethiopia. *Advances in Crop Science and Technology,* **4**:1000250.

van der Ploeg, R.R., Böhm, W. and Kirkham, M.B. 1999.On the origin of the theory of mineral nutrition of plants and the law of the minimum. *Soil Science Society of America Journal*, **63**:1055–1062.

Zarzecka, K., Gugała, M., Mystkowska, I. and Zarzecka, M. 2015. Chemical composition of edible potato tubers in retail outlets in east-Central Poland. *Journal of Ecological Engineering,* **16**:57–61.