International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 15, Issue 6, 2023, pp.-12432-12434.
Available online at https://bioinfopublication.org/pages/jouarchive.php?id=BPJ0000217

Research Article

DEVELOP SITE SPECIFIC NPK REQUIREMENTS OF POTATO (*Solanum tuberosum* L.) UNDER AGRO-CLIMATIC CONDITION OF NORTH GUJARAT

VAGHELA S.J., PATEL J.K.*, PATEL R.N. AND ZAPADIYA D.M.
Potato Research Station, Sardarkrushinagar Dantiwada Agricultural University, Deesa, 385535, Gujarat, India
*Corresponding Author: Email - jkpatel2489@gmail.com

Received: May 19, 2023; Revised: June 26, 2023; Accepted: June 28, 2023; Published: June 30, 2023

Abstract: Field experiment was conducted during *rabi* seasons of the years 2017-18 and 2018-19 to study the effect of NPK fertilizers on potato yield and its economics in North Gujarat Agro-climatic condition on loamy sand soils of Potato Research Station, Sardarkrushinagar Dantiwada Agricultural University, Deesa. The experiment was laid out by using Kufri Badshah cultivar in randomised block design with four replications comprising seven treatments *viz*., T_1 : 50 % RDF of NPK, T_2 : 100 % RDF of NPK, T_3 : 150 % RDF of NPK, T_4 : Without N fertilizer (PK), T_5 : Without P fertilizer (NK), T_6 : Without K fertilizer (NP), T_7: Without NPK (absolute control). The Recommended dose of fertilizer (RDF) of potato at North Gujarat is 275:138:275 NPK kg/ha. Based on two years pooled data significantly the highest total tuber yield was recorded under treatment T_3 (50.17 t/ha) which was at par with treatments T_2 (49.26 t/ha) and T_5 (46.71 t/ha). The crop fertilized with 100% RDF gave the highest net returns hence it is recommended to apply 100% RDF *i.e*., 275:138:275 NPK kg/ha for higher yield and net return.

Keywords: *Fertility level, Gross return, Net return, Tuber dry matter content, Tuber yield*

Citation: Vaghela S.J., *et al*., (2023) Develop Site Specific NPK Requirements of Potato (*Solanum tuberosum* L.) Under Agro-Climatic Condition of North Gujarat. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 15, Issue 6, pp.- 12432-12434.

Academic Editor / Reviewer: Aman Sharma, Dr S H Malve, Dr Ganesh Bansode

Introduction

Potato plant is perennial in the nightshade family Solanaceae [1]. The area and production of potato in the country during 2020-21 was around 22.48 lakhs ha and 542.30 lakhs MT, respectively [2]. The major potato growing states are Uttar Pradesh, West Bengal, Bihar, Gujarat, Madhya Pradesh, Punjab, and Assam. Potato- "Future food crop" owing to its remarkable potential of yielding highest food, energy, and protein per unit area. Gujarat produce 39.21 lakh MT of potato from nearly 1.28 lakh ha area with an average productivity of 30.46 t/ha in the year 2021-22 [3]. Potato crop require high amounts of potassium (K) and nitrogen (N) fertilizers for optimum growth, production, and tuber quality [4]. In the potato crop severe imbalance in the N: P: K application ratio and unbalanced fertilization in favour of N and lack of potash application is quite common among farmers [5]. The growth and development of the potato crop depend heavily on the essential macronutrient's nitrogen and potassium. Poor potato growth and yield are caused by insufficient N fertilization, while excessive N application causes delayed maturity, poor tuber quality, and sometimes a reduced tuber yield [6]. With rising environmental concerns for N fertilizer management practices, efficient N use is important for the economic sustainability of cropping systems [7]. In addition to N and P, potato is a heavy remover of soil potassium and its response to potassium varies with variety, source, and method of potassium fertilizer application [8,9]. The efficacy of NPK fertilizers can be further enhanced using micronutrients. However, response of these fertilizers varies depending upon the variety and location specific knowledge of crop nutrient management (SSNM) strategies that include site and season specific knowledge of crop nutrient requirements and indigenous nutrient supplies are required to increase productivity, yields and nutrient use efficiency. The current study's objective is to ascertain the impact of various fertilizer dosages on the nutritional makeup of the well-known local variety of potatoes, Kufri Badshah. The findings of this study would be valuable in enhancing the nutritional value of potatoes by using an appropriate combination of NPK fertilizers. Therefore, a field experiment was conducted at Potato Research Station, SDAU, Deesa.

Materials and Methods

Field experiments was conducted at Potato Research Station, SDAU, Deesa (Gujarat) during *rabi* season in 2017-18 and 2018-19. The soil of the experimental site was loamy sand in texture, low in organic carbon (0.35%), pH (7.54), available nitrogen (130 kg N/ha), medium in available phosphorus (45.28 kg P_2O_5/ha) and available potassium (208.53 kg K_2O/ha). The experiment was laid out by using Kufri Badshah cultivar in randomised block design with four replications comprising seven treatments *viz*., T_1 : 50 % RDF of NPK, T_2 : 100 % RDF of NPK, T_3 : 150 % RDF of NPK, T_4 : Without N and RDF of PK fertilizer, T_5 : Without P and RDF of NK fertilizer, T_6 : Without K and RDF of NP fertilizer, T_7 : Without NPK (absolute control). The crop was irrigated by mini sprinkler system. Ammonium sulphate, urea, single superphosphate and muriate of potash were used to supply N, P and K, respectively. 50% of N dose was applied through ammonium sulphate at the time of planting and remaining N dose as top dressing during earthing up at 30 days after planting (DAP). Recommended package of practices was followed for management of potato crop. Two years data were collected on per cent emergence, plant height (cm), number of shoots/plant, grade wise tuber yield (0-25 g, 25-50 g, 50-75 g and >75 g), total tuber yield and per cent tuber dry matter then pooled and subjected to statistical analysis according to the standard method [10]. The calculated values of the tratments and error variance ratio were compared with Fisher and Yates F table at 5% level of significance. The differences between significant treatments means were tested against C.D. at 5 per cent probability.

Results and discussion

Plant Emergence & Number of shoots per plant

Per cent plant emergence and number of shoots per plant were not significantly influenced by different treatments in the year 2017-18 and pooled data, while in the year 2018-19 the significantly higher plant emergence (95.21%) was recorded under treatment T_3 *i.e.,* 150% RDF which was at par with treatments T_2 *i.e.,* 100% RDF and T_5 *i.e.,* without P which recorded 95.00 and 94.79 % plant emergence.

Table-1 Plant emergence number of shoots per plant and plant height as influenced by different treatments

Treatment	Emergence (%)			Number of shoots per plant			Plant Height		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1	91.60	93.13	92.36	3.61	3.53	3.57	42.94	41.50	42.22
T_2	91.43	95.00	93.22	3.70	4.03	3.86	51.10	50.70	50.90
T_3	90.89	95.21	93.05	3.83	4.23	4.03	52.53	52.50	52.52
T_4	91.56	93.13	92.34	2.82	3.65	3.24	43.65	42.43	43.04
T_5	90.79	94.79	92.79	3.65	3.61	3.58	51.6	47.58	49.59
T_6	92.03	93.13	92.58	3.22	3.60	3.41	51.63	48.15	49.89
T_7	92.04	90.84	91.44	2.97	3.30	3.14	41.38	37.53	39.45
S.Em.±	1.00	0.46	0.59	0.25	0.19	0.20	1.96	0.71	1.18
CD at 5 %	NS	1.38	NS	NS	0.56	NS	5.88	2.12	3.55
CV %	2.19	0.98	1.27	14.95	10.10	11.53	8.21	3.10	5.06

Table-2 Effect of different treatments on grade wise tuber yield

Treatment	Tuber yield (t/ha)											
	0-25 g			25-50 g			50-75 g			>75 g		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1	1.49	0.60	1.04	5.32	2.29	3.80	15.80	6.26	11.03	15.98	40.34	28.17
T_2	1.02	0.80	0.91	3.36	3.31	3.34	15.45	5.66	10.56	22.11	46.79	34.46
T_3	1.20	1.09	1.14	3.08	2.75	2.92	15.55	4.23	9.89	23.12	49.31	36.23
T_4	1.78	0.77	1.28	6.39	3.65	5.02	12.96	8.48	10.72	13.9	21.16	17.53
T_5	1.13	0.66	0.90	3.38	2.3	2.84	13.76	3.70	8.73	22.16	46.3	34.25
T_6	0.93	0.88	0.90	4.64	3.02	3.83	11.17	6.08	8.63	16.95	40.59	28.78
T_7	2.95	0.68	1.82	4.82	2.58	3.70	13.26	6.09	9.68	8.14	27.18	17.67
S.Em.±	0.12	0.22	0.10	0.40	0.57	0.33	0.98	0.73	0.69	1.60	1.58	1.31
CD at 5 %	0.36	NS	0.31	1.20	NS	1.00	2.95	2.18	NS	4.79	4.74	3.92

Table-3 Total tuber yield and tuber dry matter content as influenced by different treatments

Treatment	Total tuber yield (t/ha)			Tuber dry matter content (%)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1 : 50 % RDF of NPK	38.58	49.5	44.05	19.6	20.08	19.84
T_2 : 100 % RDF of NPK	41.93	56.56	49.26	20.49	20.60	20.55
T_3 : 150 % RDF of NPK	42.95	57.37	50.17	20.89	21.53	21.21
T_4 : Without N fertilizer (PK)	35.03	34.05	34.55	19.48	19.23	19.36
T_5 : Without P fertilizer (NK)	40.43	52.96	46.71	19.92	19.38	19.65
T_6 : Without K fertilizer (NP)	33.69	50.57	42.15	19.47	18.90	19.19
T_7 : Without NPK (absolute control)	29.17	36.53	32.86	18.83	18.70	18.77
S.Em.±	1.34	1.55	1.17	0.34	0.28	0.16
CD at 5 %	4.02	4.63	3.50	1.03	0.84	0.48
CV %	7.18	6.41	5.46	3.48	2.83	1.62

Table-4 Effect of different treatments on economics of potato (Pooled)

Treat	Yield (t/ha)	Cost of cultivation (₹/ha)			Cost of Cultivation (₹/ha)	Sale Price (₹/t)	Gross Return (₹/ha)	Net Return (₹/ha)	B:C ratio
		Seed	Fertilizer	Cultivation					
T_1	44.05	33000	8948	38500	80448	6250	273885	193437	2.42
T_2	49.26	33000	17896	38500	89396	6250	305953	216557	2.43
T_3	50.17	33000	26844	38500	98344	6250	311698	213354	2.17
T_4	34.55	33000	15568	38500	87068	6250	215998	128930	1.53
T_5	46.71	33000	12246	38500	83746	6250	290278	206532	2.47
T_6	42.15	33000	12305	38500	83805	6250	261203	177398	2.10
T_7	32.86	33000	0	38500	71500	6250	204393	132893	1.88

The significantly higher number of shoots per plant (4.23) was also recorded in treatment T_3 *i.e.,* 150% RDF and which was at par with treatment T_2 *i.e.,* 100% RDF recorded 4.03 numbers of shoots per plant [Table-1].

Plant height

The significantly highest plant height (52.53 cm) in the year 2017-18 was recorded in treatment T_3 *i.e.,* 150% RDF and which was found at par with treatment T_5 *i.e.,* without P (RDF of NK), T_4 *i.e.,* without N fertilizer (RDF of PK) and T_2 *i.e.,* 100% RDF which recorded 51.63, 51.60 and 51.10 cm, respectively. the similar trend was also recorded in pooled data while in 2018-19 the significantly taller plant (52.50 cm) was recorded under treatment T_3 *i.e.,* 150% RDF and which was at par with treatment T_2 *i.e.,* 100% RDF which recorded 50.70 cm taller plant [Table-1].

Grade wise tuber yield (t/ha)

In the year 2017-18 the significantly lower yield (0.93 t/ha) of 0-25 g tuber was recorded under treatment T_6 : Without K fertilizer (RDF of NP) which was at par with treatments T_2 : 100 % RDF of NPK, T_5 : Without P fertilizer (RDF of NK) and T_3 : 150 % RDF of NPK which noted 1.02, 1.13 and 1.20 t/ha, respectively while in the year 2018-19 0-25 g tuber yield was not significantly influenced by different treatments. The pooled data of 25-50 g tuber yield shows that significantly the highest 25-50 g tuber yield (5.02 t/ha) was recorded in treatment T_4 : Without N fertilizer (RDF of PK) and which was followed by treatment T_1 : 50 % RDF of NPK which recorded 3.80 t/ha 25-50 g tuber yield. The pooled data of 50-75 g tuber yield was not significantly influenced by different treatments, while the pooled data of >75 g tuber indicate that the significantly higher >75 g tuber yield was noted in treatment T_3 *i.e.,* 150% RDF and it was found at par with treatments T_2 *i.e.,* 100% RDF & T_5 *i.e.,* Without P which (RDF of NK) noted 34.46 and 34.25 t/ha >75 g tuber yield [Table-2].

Total tuber yield (t/ha)

In the year 2017-18 significantly the higher total tuber yield (42.95 t/ha) was recorded under treatment T_3 *i.e.,* 150% RDF and it was found at par with treatments T_2 *i.e.,* 100% RDF, T_5 *i.e.,* Without P (RDF of NK) and T_1 *i.e.,* 50% RDF which were recorded 43.93, 40.93 and 38.58 t/ha total tuber yield, respectively, while in year 2018-19 treatment T_3 *i.e.,* 150% RDF had highest total tuber yield (57.37 t/ha) which was significantly better than other treatments and found at par with treatments T_2 *i.e.,* 100% RDF and T_5 *i.e.,* without P (RDF of NK) which noted 56.56 and 52.96 t/ha total tuber yield, respectively. The similar trend was also recorded in the pooled data [Table-3].

Tuber dry matter content (%)

In the year 2017-18 significantly the highest tuber dry matter content (20.89%) was recorded under treatment T_3 *i.e.,* 150% RDF which was statistically at par with treatments T_2 *i.e.,* 100% RDF and T_5 *i.e.,* without P (RDF of NK) which recorded 20.49 & 19.92 per cent dry matter content, respectively while in year 2018-19 significantly the highest dry matter content (21.53%) was recorded under

treatment T_3 *i.e.,* 150% RDF which was statistically better than rest of treatments and the similar trend was also noted in pooled data of per cent tuber dry matter content [Table-3].

Economics

The crop fertilized with 100% RDF gave the highest net returns (₹ 216557/-) which was followed by treatment T_1: 50 % RDF of NPK which recorded (₹ 216557/-) net returns hence, it is recommended to apply 100% RDF *i.e.,* 275: 138: 275 NPK kg/ha for higher yield and net return [Table-4].

Discussion

The recommended dose of fertilization of NPK showed a positive effect on the productivity of potato with an increasing dose of NPK from 50 to 150 %. A similar result was also recorded by Banerjee *et al.* [11]. Yadav *et al.* [12] also noted that significantly the higher plant height, number of shoots/plant and total tuber yield with 150% RDF fertilization in Patna, Bihar. Kumar *et al*., [8] also noted that the higher fertilizer dose was proved to be most effective to grow parameters like increased plant height, number of leaves, number of shoots per plant fresh weight and dry weight of shoots, yield attributes and yield of potato *viz*., maximum number of stolen, fresh weight and dry weight of tuber, number of tubers per plant, grade wise number of tubers, number of total tuber, grade wise yield of tuber and tuber yield per plot. Chongtham *et al.* [13] clearly revealed that application of 330-168-330kg N-P_2O_5-K_2O/ha had significantly higher tuber yield (23.13 t/ha) over lower dose of NPK (165-84-165 kg N-P_2O_5-K_2O/ha) in North Gujarat. Chongtham *et al.* [14] clearly reported that application of 150 kg N/ha improved tuber yield and crop productivity with higher remuneration and efficient use of phosphorus, potassium, and water. Kumar *et al.* [15] reported that highest tuber yield was recorded under combined application of nitrogen @ 375 kg/ha + potassium @ 175 kg/ha with @ 80 kg/ha of phosphorus.

Conclusion

It can be concluded that the potato crop fertilized with 100% RDF gave the highest net returns (216557 ₹/ha) hence it is recommended to apply 100% RDF *i.e.,* 275:138 :275 NPK kg/ha for higher yield and net return.

Application of research: This research will be helpful to potato growers as well as scientists for fertilization or fertilization-based experiments in potato crop.

Research Category: Agro-Climatic Condition

Acknowledgement / Funding: Authors are thankful to ICAR-AICRP (Potato) and Potato Research Station, Deesa, 385535, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, 385506, Gujarat, India for financial assistance and support

****Principal Investigator or Chairperson of research: Dr S.J. Vaghela**
University: Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, 385506, Gujarat, India
Research project name or number: Research station trials

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Potato Research Station, Deesa, 385535

Cultivar / Variety / Breed name: Potato (*Solanum tuberosum* L.)- K. Badshah

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] Hijmans R.J., Spooner D.M. (2001) *American Journal of Botany*, 88 (11), 2101-12.
[2] Food and Agriculture Statistics (2021) http://fao.stat.org/
[3] Director Of Horticulture (2022) Gujarat State https://doh.gujarat.gov.in/index.htm
[4] Torabian S., Salar F., Qin R., Noulas C., Sathuvalli V., Charlton B. and Loka DA. (2021) *Agronomy*, 11(3), 543.
[5] Singh S.K. and Rai R.P. (2011) *The potato crop in bihar: status and future challenges. Electronic International Fertilizer Correspondent e-ifc No*, 27, 1-8.
[6] Cerny J., Balk J., Kulhanek M., Casova K. and Nedved V. (2010) *Plant Soil Env.,* 56, 28-36.
[7] Shrestha R.K., Cooperb L.R. and MacGuidwin A.E. (2010) *Am. J. Potato Res.*, 87, 229-244.
[8] Kumar V., Malik A., Sharma S., Rai D.V. (2017) *International Journal of Scientific & Engineering Research*, 8(7).
[9] Sharma R.C., Sud K.C. (2001) *Potassium and management for yield and quality of potato. Central Potato Research Institute*, 363- 381.
[10] Panse V. G. and Sukhatme P. V. (1985) *Statistical methods for agricultural worker. 4th edition. ICAR, New Delhi.*
[11] Banerjee H., Rana L., Ray K., Sarkar S., Bhattacharyya K. and Dutta S. (2016) *Indian Journal of Plant Physiology*, 21, 129-136.
[12] Yadav S.K., Singh R.K., Singh S.K., Yadav S. and Bakade R. R. (2020) *Journal of AgriSearch*, 7(2), 59-62.
[13] Chongtham S. K., Patel R. N., Patel I. M., Patel J. K. and Zapadiya D. M. (2016) *Int. J. Agril. Sci*., 8(49), 2066-68.
[14] Chonmgtham S.K., Patel R.N., Patel J.K., Patel C.K., Patel D.H., Patel C.R. and Zapadiya D.M. (2015) *Int. J. Agril. Sci.,* 7(12), 785-787.
[15] Kumar P., Pandey S. K., Singh S. V., Kumar D., Singh B. P., Singh S., Rawal S. and Meena R. L. (2012) *Potato Journal,* 39 (2), 191-196.