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Research Article

EFFECT OF DIFFERENT FERTILITY LEVELS ON TUBER YIELDS, INPUT USE EFFICIENCY AND ECONOMICS OF POTATO VARIETY KUFRI CHIPSONA-3

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Abstract- A field study on different levels of NPK *i.e.*,-0-0, 165-84-165,330-168-330, 495-252-495 and 660-336-660 kg N-P_2O^5-K2O/ha were conducted on processing potato variety Kufri Chipsona-3 at Potato Research Station, SDAU, Deesa (Gujarat) during rabi season for two consecutive years 2012-13 and 2013-14. Results clearly revealed that application of 330-168-330kg N-P2O5-K2O/ha had significantly higher tuber yield (23.13 t/ha) over lower dose of NPK (165-84-165kg N-P2O5-K2O/ha), while reducing tuber cracking than higher doses of NPK (495-252-495 and 660-336-660 kg N-P2O5-K2O/ha). Nutrient use efficiency of NPK decreased with subsequent increase in levels of NPK, while water use efficiency and crop productivity registered significant improvement under elevated doses of NPK up to 330-168-330 kg N-P2O5-K2O/ha. From economic point of view, 330-168-330kg N-P2O5-K2O/ha registered highest net income (₹27,032/ha) and return per day (₹275.84/ha/day).

Keywords- Cracked tuber, Fertility level, Net income, Return per day, Tuber yield

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Introduction

With the advent of rapid urbanization, improved living standards and expanding tourist trade, people are shifting towards ready-to-eat foods to match the rapid pace of the present world. Consequently, there has been considerable rise in demand for processed potato products like chips and French fries in the present scenario, making potato-processing industry as one of the fastest growing industries in the globe. During the last decade, India has witnessed a rapid growth in demand for processed potato products in the market [1] and this has elevated the need for various processing-grade potatoes with desirable processing traits. As per estimates of CPRI, Shimla there will be rise in demand for processing quality potatoes from present level of 2.7 MT to 25 MT, while the imposition for potato seed may increase by about 2.1 times by the year 2050. In order to meet the future requirement of processing potato, the country requires to expand potato acreage to 3.62 million ha with productivity of 34.5 t/ ha. CPRI is striving continuously to develop improved varieties of processing potato and in the year 2005 a new processing variety Kufri Chipsona-3 was released, which is a higher processing-grade tuber yielder with better shape than previous processing varieties Kufri Chipsona-1 and Kufri Chipsona-2. However, each cultivar has specific nutritional requirements, which is obvious from the case of Kufri Chipsona-1 and Kufri Chipona-2, requiring 50% more N and K than ware varieties to achieve full yield potential with good processing quality [2].Several research works have shown that fertilizer levels or regimes influences tuber quality and tuber yield of different grades [3,4]. Keeping this in view, the present study was conducted at Potato Research Station, SDAU, Deesa, (Gujarat) to evaluate the response of Kufri Chipsona-3 on different levels of fertility in terms of tuber yields, cracking tubers, input use efficiency and economics.

Materials and Methods

A field study was carried out at Potato Research Station, SDAU, Deesa, during *rabi season of* 2012-13 and 2013-14 to evaluate NPK requirement of potato variety of Kufri Chipsona-3. The experimental site had soil with loamy sand texture, low in organic carbon (0.33%), available nitrogen (178.12 kg/ha), medium in available phosphorus (15.20 kg P/ha) and available potassium (235.11 kg K_2O/ha). Five levels of fertility i.e; control(No fertilizer applied), 165-84-165,330-168-330, 495-252-495 and 660-336-660kg N-P_2O_5-K_2O/ha which corresponds to 0, 60, 120, 180 and 240% of recommended dose of fertilizer (RDF) for table potato (275-140-257 kgN-P_2O_5-K_2O/ha) were laid out in randomized block design and replicated four times. 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 25 days after planting (DAP). Recommended package of practices were followed for management of potato crop. Two years data were collected on different grades of tuber (0-40, 40-100, 100-150 and >150 g) and total tuber yield, then pooled and analyzed statistically using OPSTAT software developed by CCSHAU, Hisar. Number of cracked tubers (0-40, 40-100, 100-150 and >150 g) per plot were recorded at harvest and then converted in terms of number of cracked tubers per hectare. Nutrient use efficiency (NUE) of N, P and K was worked out by using the formula:

$$\text{NUE (N, P and K)} = \frac{\text{Increase in yield (kg/ha) over control}}{\text{Nutrient (N, } P_2O_5\text{, } K_2O\text{) applied (kg/ha)}}$$

Water use efficiency (WUE) was calculated by using the formula

$$WUE = \frac{\text{Total yield (kg/ha)}}{\text{Total amount of irrigation water applied (mm)}}$$

Total amount of irrigation water used was 700 mm.
Crop productivity was estimated by using the formula:

$$\text{Crop productivity (kg/ha/day)} = \frac{\text{Total yield (kg/ha)}}{\text{Total crop duration (days)}}$$

Average crop duration of Kufri Chipsona-3 was 100 days.
Net return was calculated as per prevailing market price of inputs during the experimentation. Return per day of potato was evaluated by using the formula

$$\text{Return per day (₹/ha/day)} = \frac{\text{Net return (₹/ha)}}{\text{Crop duration (days)}}$$

Results and Discussion

Impact on tuber yield and cracked tuber

With regard to the tuber yield data [Table-1], it can be inferred that different fertility levels of NPK had no significant effect on tuber yield grades 0-40 g and 40-100 g. However, in case of tuber grade 100-150 g, application of 330-168-330 kg N-P_2O_5-K_2O/ha/ha recorded highest tuber yield (11.83 t/ha), which was statistically at par with rest of treatments except the control. Potato responded significantly up to 330-168-330 kgN-P_2O_5-K_2O/ha for the grade <150 g, highest tuber yield (2.64 t/ha) being noted under 660-336-660kgN-P_2O_5-K_2O/ha. Maximum value of total tuber yield (23.13 t/ha) was observed under 330-168-330 kgN-P_2O_5-K_2O/ha which was significantly better than 165-84-165kg N-P_2O_5-K_2O/ha and the control. Increment of in total tuber yield due to application of 330-168-330 kgN-P_2O_5-K_2O/ha was in the tune of 98.54% over the control. Singh *et al.* [5] opined that potato, despite being shallow rooted with limited foraging capacity, has very high uptake of fertilizer nutrients (NPK) per unit area and time attributing this to it srapid early growth and tuber bulking.

With increasing dose of NPK levels, there observed increased number of cracked tubers in higher grades especially 100-150g and >150 g. Also, highest total cracked tuber (1770.83 per ha)was recorded at 660-336-660kg N-P_2O_5-K_2O/ha [Table-1]. This might be attributed to excessive tuber growth under higher dose of fertilizer which resulted in tuber cracking due to immense internal pressure beyond the tensile strength of surface tissue during tuber development.

Table-1 *Tuber yields and number of cracked tubers as influenced by different levels of fertility in Kufri Chipsona-3 (pooled and average of two years data)*

Treatment	Grade wise tuber yield (t/ha)					Number of cracked tubers (no./ha)				
	0-40g	40-100 g	100-150 g	>150 g	Total	0-40 g	40-100 g	100-150 g	>150 g	Total
0-0-0 NPK kg/ha	3.50	2.74	5.13	0.29	11.65	208.33	312.50	0.00	0.00	520.83
165-84-165 NPK kg/ha	4.49	4.18	10.11	0.84	19.61	833.33	208.33	0.00	104.17	1145.83
330-168-330 NPK kg/ha	4.17	5.06	11.83	2.07	23.13	104.17	0.00	0.00	312.50	416.67
495-252-495 NPK kg/ha	3.61	5.18	11.07	2.42	22.29	0.00	0.00	104.17	312.50	416.67
660-336-660 NPK kg/ha	2.73	4.11	11.40	2.64	20.87	0.00	416.67	729.17	625.00	1770.83
SE(m)	0.53	0.54	0.75	0.34	0.74	-	-	-		
C.D. (P=0.05)	NS	NS	2.33	1.07	2.30	-	-	-	-	-

Impact on input use efficiency

Increase in level of nutrient (NPK) application decreased the nutrient use efficiency of potato, as evident from [Table-2]. Highest and lowest NUE of NPK was recorded under 165-84-165kg N-P_2O_5-K_2O/ha and 660-336-660kg N-P_2O_5-K_2O/ha, respectively. Marginal yield response to subsequent increase in amount of nutrient applied might have resulted to this phenomenon. Similar findings were also reported by Chongtham*et al.*[6] in which nutrient use efficiency decreased with subsequent increase in nutrient levels in potato.

Gradual increase in nutrient dose markedly improved WUE of potato up to the level of 330-168-330 kgN-P_2O_5-K_2O/ha(33.04 kg/ha/mm). This might be ascribed to highest total tuber yield at 330-168-330 kgN-P_2O_5-K_2O/ha under same water management.

Table-2 *Nutrient and water use efficiency, crop productivity and economics as influenced by different levels of fertility in Kufri Chipsona-3 (pooled and average of two years data)*

Treatment	NUE (kg increase in yield per kg nutrient applied)			Water use efficiency (kg/ha/mm)	Crop productivity (kg/ha/day)	Net income (₹ x 1000/ha)	Return per day (₹/ha/day)
	N	P	K				
0-0-0 NPK kg/ha	-	-	-	16.65	116.52	-12.837	-128.27
165-84-165 NPK kg/ha	48.24	94.76	48.24	28.01	196.09	18.752	187.49
330-168-330 NPK kg/ha	34.79	68.33	34.79	33.04	231.28	27.032	270.23
495-252-495 NPK kg/ha	21.49	42.22	21.49	31.84	222.86	12.422	124.04
660-336-660 NPK kg/ha	13.97	27.44	13.97	29.81	208.66	-5.232	-52.55
SE(m)	-	-	-	1.06	7.38	3.88	38.76
C.D. (P=0.05)	-	-	-	3.29	24.00	12.08	120.75

Impact on productivity and income

Perusal of data in [Table-1] revealed that significantly highest crop productivity (231.28 kg/ha/day) was noted at 330-168-330 kgN-P_2O_5-K_2O/ha among all fertility levels. Similarly, highest net income (₹56830/ha) and return per day (₹275.84/ha/day)were registered under 330-168-330 kgN-P_2O_5-K_2O/ha. These might be ascribed to highest total tuber yield, which consequently increased net return.

So, it may be concluded that application of 330-168-330kg N-P_2O_5-K_2O/ha should be followed by potato growers for cultivation of Kufri Chipsona-3 to achieve higher processing grade tuber yield with reduced tuber cracking while ensuring efficient input utilization and more economic profit.

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Conflict of Interest: None declared

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