Studies on the Effect of Integrated Nutrient Management in Growth of Potato (Cv. Kufri Chandramukhi) Cultivation Under Telangana Conditions

ABSTRACT

Aim: To study the effect of integrated nutrient management in growth of potato

Study Design: The experiment was laid out in RBD with 13 treatments and replicated thrice

Place and duration of study: The present investigation was carried out at Sri Konda Laxman Telangana State Horticultural University, Mulugu, Siddipet district, Telangana during the *rabi*, 2021-22 and *rabi*, 2022-23

Results: Among the treatments, T_{12} treatment (75 % Recommended dose of NPK+ Organic NPK with micronutrients + Organic NPK + Organic based micronutrients + Organic phosphorus + Organic potash) was recorded significantly highest growth parameters like plant height (53.10 cm and 71.74 cm), leaf length (24.09 cm and 25.74 cm), leaf width (16.29 cm and 21.03 cm), leaf area (119.40 cm^2 and 157.41 cm^2), leaf area index (0.133 and 0.175), plant spreading (52.00 cm at E-W & 49.85 cm at N-S and 69.00 cm at E-W & 68.50 cm at N-S) and stem diameter (0.60 cm and 1.15 cm) at 30 and 60 DAP respectively. While number of main stems per plant was not effected by the imposed treatments during both the seasons.

Key-words: Growth, Nitrogen, Phosphorus, Potassium and Micronutrients

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is a popular tuber crop that contributes to global food security (Karam *et al*., 2009) and belongs to the family Solanaceae. It was originated in Peru Bolivia in the Andes (South America) with the fundamental chromosome number (x=12) (Hawkes, 1990). Potato has the highest food value in terms of dry matter and is also the most nutritious in terms of calorific value (Khurana, 1978). It also contains a high

Commented [SS1]: Follow journal pattern

Formatted: Font: Not Bold, Italic

Formatted: Font: Italic

Formatted: Indent: Left: 0", Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"

Formatted: Indent: First line: 0"

Commented [SS2]: Follow journal pattern when references given in running text and under bibliographic section

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

concentration of important amino acids like leucine, tryptophane and isoleucine (Khurana and Naik, 2003). The tubers are one of the richest sources of the B complex group of vitamins such as pyridoxine, thiamin, niacin, pantothenic acid and folates. Fresh potato is a good source of antioxidants and vitamin C (Gray and Hughes, 1978). In addition, it includes calcium, phosphorus and iron. Potato proteins are of equivalent quality to egg and milk proteins. Food and Agricultural Organization has selected this crop as a future food crop and based on its nutritional value and production capability declared the year 2008 as the "International Year of Potato". Potato is used to make potato flour, chips, puffs, ~~french~~French fries, frozen potato and raw material for alcohol production (Abdeldagir *et al*., 2003).

Potato necessitates a high quantity of soil nutrients due to its underdeveloped and shallow root system in proportion to yield (Perrenoud, 1983). Because of the fast rate of dry matter generation, substantial amounts of nutrients are withdrawn per unit time, which most soils are unable to replenish. As a result, nutrition application from outside sources such as fertilizers becomes critical. The indiscriminate applications of chemical fertilizers had a number of negative consequences, including a decrease in soil microbial activity, a decrease in soil humus and increased contamination of soil, water and air. Because of these problems, integrated nutrient management is used to produce a high yield in potato cultivation in which organic and inorganic fertilizers are utilized to keep soil healthy by lowering farmer's cultivation costs (Kumar *et al*., 2022) [26, 27, 28].

Adopting organic farming practices through proteino lacto gluconate based bioavailable nutrients enhances soil fertility, soil organic carbon (SOC), prevents mineral nutrients from forming insoluble precipitates, reduces the toxicity of some metal ions to plants, prevents nutrients from leaching, increases plant nutrient mobility and suppresses the growth of plant pathogens (Kumar *et al*., 2021) [26, 28, 29]. These products are made from natural ingredients with microbial actions through fermentation. These formulations are ideal substitutes for inorganic nutrients in organic farming. These nutrients increase the enzymatic activity like urease, phosphatase and dehydrogenase in soil resulting in more

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

microbial activity and greater uptake of nutrients from the soil (Reddy and Reddy, 2011). Keeping this in mind the current research work has been formulated with studies on the effect of integrated nutrient management in yield of potato (Cv. Kufri Chandramukhi) cultivation under Telangana conditions"

2. MATERIAL AND METHODS

The present experiment was conducted for two seasons during *rabi*, 2021-22 and *rabi*, 2022-23 at the PG research farm, Sri Konda Laxman Telangana State Horticultural University, Mulugu, Siddipet district, Telangana. The experimental site is located at a ~~latitiude~~latitude of 17°43'02'' N and a longitude of 78°37'34'' E. The soil of the experimental site was sandy loam in texture having organic carbon (0.87 and 0.89 %), p~~P~~H (7.73 and 7.85), ~~Elecrtical~~Electrical conductivity (0.16 and 0.20 Ds/m), available nitrogen (136.67 and 143.26 kg/ha), available phosphorus (14.49 and 16.00 kg/ha) and available potassium (181.31 and 265 kg/ha) during *rabi*, 2021-22 and *rabi*, 2022-23 respectively. The experiment was laid out in RBD with 13 treatments *i.e.*, T_1: 50 % Recommended dose of NPK + Organic NPK with micronutrients, T_2: 50 % Recommended dose of NPK + Organic NPK, T_3: 50 % Recommended dose of NPK + Organic based micronutrients, T_4: 50 % Recommended dose of NPK + Organic phosphorus, T_5: 50 % Recommended dose of NPK + Organic potash, T_6: 75 % Recommended dose of NPK + Organic NPK with micronutrients, T_7: 75 % Recommended dose of NPK + Organic NPK, T_8: 75 % Recommended dose of NPK + Organic based micronutrients, T_9: 75 % Recommended dose of NPK+ Organic phosphorus, T_{10}: 75 % Recommended dose of NPK + Organic potash, T_{11}: 50 % Recommended dose of NPK+ Organic NPK with micronutrients + Organic NPK + Organic based micronutrients + Organic phosphorus + Organic potash, T_{12}: 75 % Recommended dose of NPK+ Organic NPK with micronutrients + Organic NPK + Organic based micronutrients + Organic phosphorus + Organic potash and T_{13}: 100 % Recommended dose of NPK (120:240:120 kg NPK/ha) and replicated thrice.

The data on the growth parameters of the crop were recorded at different intervals at 30, 60 DAT and at harvest. The plant height was measured from ground level to the tip of the main shoot with the help of a scale. The number of main stems per plant was recorded in selected five tagged plants in each plot. The leaf length, leaf width and leaf area was measured with the help of a leaf area meter in five randomly selected plants. The data on the leaf area index was calculated using the formula given by Williams (1946).

Formatted: Highlight

Formatted: Indent: Left: 0", Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"

Formatted: Indent: First line: 0"

Commented [SS3]: What is the source of organic NPK with micronutrients, organic NPK, organic phosphorus and organic potash?

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

Commented [SS4]: Full form?

Formatted: Highlight

$$\text{Leaf Area Idex/Index (LAI)} = \frac{\text{Total leaf area (cm}^2\text{)}}{\text{Ground area (cm}^2\text{)}}$$

The plant spreading was measured in the North-South and East-West directions with the help of scale. The stem diameter was measured with the help of ~~vernier~~Vernier ~~callipers~~calipers in each tagged five plants. The data pertaining to all characters studied were subjected to statistical analysis by using variance technique.

3. RESULTS AND DISCUSSION

The experimental result revealed that there was a significant difference observed in all growth parameters at all stages of crop growth in both the seasons due to integrated nutrient management. Obtained results revealed that a rapid increase in growth was observed up to 60 DAP and recorded maximum value at 60 DAP in both the seasons, while due to senescence the crop was completely ceased at harvest.

The results related to pooled data of two seasons on growth parameters revealed that among the treatments, T_{12} was recorded highest values for plant height (53.10 cm and 71.74 cm), leaf length (24.09 cm and 25.74 cm), leaf width (16.29 cm and 21.03 cm), leaf area (119.40 cm^2 and 157.41 cm^2), leaf area index (0.133 and 0.175), plant spreading (52.00 cm at E-W & 49.85 cm at N-S and 69.00 cm at E-W & 68.50 cm at N-S) and stem diameter (0.60 cm and 1.15 cm) at 30 and 60 DAP, respectively.

Plant height is an important growth index to study the accumulation of dry matter by the plant. The highest plant height (Table 1) was recorded in T_{12} treatment at all the growth stages might be attributable to the spraying potato plants with organic compounds which can be readily absorbed by the leaves and not lost through fixation, decomposition or leaching as well as these bio-available organic fertilizers secreted microorganisms, which releases organic acids which are precursors of enzymes that help in the mineralization of vastly available NPK nutrients in soil thus encourage the capability of plants to produce vigorous vegetative growth characters by activating the photosynthesis process (Ahmed *et al*., 2002). This finding was in close conformity with the results of Najm *et al*. (2013) and Al-Hisnawy (2011) in potato.

Number of stems per plant is important because it influences the number and size of tubers at harvest. The results (Table 1) revealed that inorganic fertilizers and organic fertilizers had a ~~non significant~~non-significant effect on the number of main stems per plant at all growth stages of

Formatted: Superscript
Formatted: Superscript
Formatted: Indent: First line: 0"
Formatted: Indent: Left: 0", Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"
Formatted: Indent: First line: 0"
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight

potato it could be attributed to the inherent genetic variation in the number of eyes on seed tubers and also it depends upon the uptake of nutrients by the plant at early stages of crop growth (Ghiyal and Bhatia, 2018). Muleta and Aga (2019) reported that the absence of close relationships between mineral nutrition and the number of stems per plant, the yield difference due to nitrogen treatment was not attributed to its effect on stem density as the number of stems was not significantly influenced by nitrogen nutrition.

The highest leaf length and leaf width (Table 2 & T3) in T_{12} treatment at all the growth stages might be due to organic fertilizers integrated with inorganic fertilizers which play a major role in many physiological and biochemical processes such as cell division and elongation, enzyme activation, stabilization of the native conformation of enzymes and metabolism of carbohydrates and protein compounds led to increased leaf length and width (Medani *et al*., 2000). The obtained results are supported by those of Gunadi (2009) in potato.

Leaf area is required for maximum light interception which results in synthesizing photosynthetic and an increase in the weight of the tuber (Gangele, 2017). The data showed (Table 4 & 5) that T_{12} treatment was recorded significantly highest value of leaf area and leaf area index at all the growth stages could be attributed to the presence of balanced macro and micronutrients in INM could be sufficient at the beginning of growth season which has a synergistic effect in promoting cell division, cell growth and proliferation of leaves and ~~auxillary~~auxiliary branches which might be caused by the extension of the leaf surface and the increase of photosynthesis capacity resulting in higher leaf area index as reported by Abou-Hussain *et al*. (2003). Present results are in close conformity with Chopra *et al*. (2006) who stated that there was an increase in leaf area index with increasing fertilizer levels in potato.

Plant spreading indicates the size of the photosynthetic system and is therefore an indication of intercepted radiation. From the (Table 6) highest plant spreading was recorded in T_{12} treatment at could be attributed to higher nutrient availability induced by the maximum vegetative growth in terms of plant height, number of main stems, increased leaf length and leaf width led to more canopy development (Neogi and Das, 2022). This result is in accordance with the finding of Shubha *et al*. (2019) in potato. Stem diameter is one of the most important parameters for the transportation of water, nutrients and other internal fluids from the roots to the leaves and the flow of photosynthates from the source (leaves) to sink *i.e.*, tubers (Wien, 1997). The highest stem

Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight

diameter (Table 7) was recorded in T_{12} treatment might be due to the higher availability of nutrients, thus might ~~increased~~increase photosynthesis and consequently increased the manufacture of carbohydrates which helped in increased stem diameter (Marton, 2001 and Saha *et al*., 2001).

Table 1. Effect of integrated nutrient management on plant height (cm) and number of main stems of potato Cv. Kufri Chandramukhi

Table 1: Effect of integrated nutrient management on plant height (cm) and number of main stems of potato Cv. Kufri Chandramukhi

Treatments	Plant height (cm)							Number of main stems per plant	
	30 DAT			60 DAT			At harvest		
	2021-22 (*Rabi*)	2022-23 (*Rabi*)	Pooled	2021-22 (*Rabi*)	2022-23 (*Rabi*)	Pooled		2021-22 (*Rabi*)	2022-23 (*Rabi*)
T_1	44.59	47.50	46.04	62.06	66.19	64.12	Dried	7.07	7.07
T_2	43.54	46.89	45.22	61.30	65.46	63.38	Dried	6.87	7.27
T_3	37.79	38.35	38.07	54.09	54.93	54.51	Dried	6.20	7.47
T_4	39.38	41.56	40.47	56.15	57.71	56.93	Dried	6.20	6.50
T_5	39.78	41.79	40.79	57.69	60.23	58.96	Dried	6.53	6.83
sT_6	49.24	52.45	50.84	67.52	71.55	69.54	Dried	7.40	7.60
T_7	46.80	50.07	48.44	65.60	68.01	66.81	Dried	7.27	7.43
T_8	41.59	45.94	43.77	60.56	63.04	61.80	Dried	6.67	6.83
T_9	40.47	45.10	42.78	59.33	61.65	60.49	Dried	5.73	6.53
T_{10}	45.75	48.80	47.28	63.93	67.45	65.69	Dried	6.40	6.93
T_{11}	49.18	52.13	50.66	66.64	71.20	68.92	Dried	6.93	7.13
T_{12}	52.53	53.67	53.10	69.30	74.18	71.74	Dried	6.60	7.40
T_{13}	48.91	51.75	50.33	66.19	69.89	68.04	Dried	7.07	7.07
CD (P=0.05) for Treatments	3.81	4.10	2.73	5.35	5.54	3.75	-	NS	0.28
CD (P=0.05) for Years			1.07			1.47			
SEm ± for Treatments	1.31	1.40	0.96	1.83	1.90	1.32	-	0.73	0.10
SEm ± for Years			0.38			0.52			
CV	5.08	5.13	5.11	5.09	5.02	5.05	-		

Table 2: Effect of integrated nutrient management on leaf length (cm) at different growth stages of potato Cv. Kufri Chandramukhi

Formatted: Highlight

Formatted: Font: Bold

Formatted: Justified, Indent: Left: 0", Hanging: 0.63"

Formatted: Font: Bold

Formatted: Indent: First line: 0"

Formatted Table

Commented [SS6]: F

Table 3: Effect of integrated nutrient management on leaf width (cm) at different growth stages of potato Cv. Kufri Chandramukhi

Treatments	Leaf width (cm)							
	30 DAP			60 DAP			At harvest	
	2021-22 (*Rabi*)	2022-23 (*Rabi*)	Pooled	2021-22 (*Rabi*)	2022-23 (*Rabi*)	Pooled	2021-22 (*Rabi*)	2022-23 (*Rabi*)
T_1	12.20	14.19	13.20	16.75	18.65	17.70	Dried	Dried
T_2	12.02	13.88	12.95	16.41	18.28	17.35	Dried	Dried
T_3	9.43	11.16	10.30	13.01	15.85	14.43	Dried	Dried
T_4	10.07	12.09	11.08	13.98	16.34	15.16	Dried	Dried
T_5	10.28	12.24	11.26	14.95	16.81	15.88	Dried	Dried
T_6	14.16	16.11	15.14	19.50	21.37	20.43	Dried	Dried
T_7	13.53	15.12	14.32	17.61	20.02	18.81	Dried	Dried
T_8	11.80	13.40	12.60	15.88	17.86	16.87	Dried	Dried
T_9	10.98	12.85	11.92	15.56	17.48	16.52	Dried	Dried
T_{10}	12.84	14.81	13.82	17.43	19.69	18.56	Dried	Dried
T_{11}	14.09	15.94	15.01	19.03	20.93	19.98	Dried	Dried
T_{12}	15.47	17.12	16.29	20.10	21.95	21.03	Dried	Dried
T_{13}	13.99	15.93	14.96	18.89	20.86	19.88	Dried	Dried
CD (P=0.05) for Treatments	1.24	1.68	1.02	1.61	1.64	1.12	-	-
CD (P=0.05) for Years			0.40			0.44		
SEm ± for Treatments	0.43	0.57	0.36	0.55	0.56	0.39	-	-
SEm ± for Years			0.14			0.15		
CV	5.96	7.00	6.59	5.68	5.13	5.39	-	-

Commented [SS7]: Need to follow journal pattern and formatting of the manuscript which is very casual.

Table 4: Effect of integrated nutrient management on leaf area (cm^2) at different growth stages of potato Cv. Kufri Chandramukhi

Treatments	Leaf area (cm^2)							
	30 DAP			60 DAP			At harvest	
	2021-22 (*Rabi*)	2022-23 (*Rabi*)	Pooled	2021-22 (*Rabi*)	2022-23 (*Rabi*)	Pooled	2021-22 (*Rabi*)	2022-23 (*Rabi*)
T_1	104.40	107.59	105.99	139.35	148.33	143.84	Dried	Dried
T_2	101.93	105.19	103.56	136.85	147.08	141.97	Dried	Dried
T_3	83.52	91.17	87.35	122.53	132.40	127.46	Dried	Dried
T_4	86.33	94.57	90.45	124.85	136.86	130.86	Dried	Dried
T_5	90.95	96.73	93.84	129.61	139.57	134.59	Dried	Dried
T_6	114.05	117.33	115.69	149.45	160.60	155.03	Dried	Dried
T_7	110.55	112.30	111.43	144.01	154.39	149.20	Dried	Dried
T_8	98.80	102.44	100.62	133.08	144.62	138.85	Dried	Dried
T_9	97.29	99.77	98.53	131.44	141.97	136.71	Dried	Dried
T_{10}	107.76	109.88	108.82	140.74	151.52	146.13	Dried	Dried
T_{11}	113.46	116.90	115.18	148.16	158.91	153.54	Dried	Dried
T_{12}	117.92	120.88	119.40	151.27	163.56	157.41	Dried	Dried
T_{13}	112.40	113.33	112.87	147.39	157.87	152.63	Dried	Dried
CD (P=0.05) for Treatments	8.79	9.04	6.14	11.71	13.07	8.55	-	-
CD (P=0.05) for Years			2.41			3.35		
SEm ± for Treatments	3.01	3.10	2.16	4.01	4.48	3.01	-	-
SEm ± for Years			0.85			1.18		
CV	5.06	5.02	5.04	5.02	5.20	5.12	-	-

Commented [SS8]: Follow journal pattern

Table 5: Effect of integrated nutrient management on Leaf Area Index (LAI) at different growth stages of potato Cv. Kufri Chandramukhi

Treatments	Leaf area index (LAI)							
	30 DAP			60 DAP			At harvest	
	2021-22 (*Rabi*)	2022-23 (*Rabi*)	Pooled	2021-22 (*Rabi*)	2022-23 (*Rabi*)	Pooled	2021-22 (*Rabi*)	2022-23 (*Rabi*)
T_1	0.116	0.120	0.118	0.155	0.165	0.160	Dried	Dried
T_2	0.113	0.117	0.115	0.152	0.163	0.158	Dried	Dried
T_3	0.093	0.101	0.097	0.136	0.147	0.142	Dried	Dried
T_4	0.096	0.105	0.101	0.139	0.152	0.146	Dried	Dried
T_5	0.101	0.108	0.104	0.144	0.155	0.150	Dried	Dried
T_6	0.127	0.130	0.129	0.166	0.178	0.172	Dried	Dried
T_7	0.123	0.125	0.124	0.160	0.171	0.166	Dried	Dried
T_8	0.110	0.114	0.112	0.148	0.160	0.154	Dried	Dried
T_9	0.108	0.111	0.110	0.146	0.158	0.152	Dried	Dried
T_{10}	0.120	0.122	0.121	0.156	0.168	0.162	Dried	Dried
T_{11}	0.126	0.130	0.128	0.164	0.177	0.171	Dried	Dried
T_{12}	0.131	0.134	0.133	0.168	0.182	0.175	Dried	Dried
T_{13}	0.125	0.126	0.126	0.164	0.175	0.170	Dried	Dried
CD (P=0.05) for Treatments	0.010	0.010	0.007	0.013	0.015	0.010	-	-
CD (P=0.05) for Years			0.003			0.004		
SEm ± for Treatments	0.003	0.004	0.002	0.005	0.005	0.003	-	-
SEm ± for Years			0.001			0.001		
CV	5.13	5.12	5.13	5.07	5.21	5.15	-	-

Commented [SS9]: Follow journal pattern

Table 6: Effect of integrated nutrient management on plant spreading (cm) at different growth stages of potato Cv. Kufri Chandramukhi

Treatments	Plant spreading (cm)												
	30 DAP						60 DAP						At harvest
	2021-22 (*Rabi*)		2022-23 (*Rabi*)		Pooled		2021-22 (*Rabi*)		2022-23 (*Rabi*)		Pooled		
	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	Dried
T_1	39.00	39.00	44.00	43.00	41.50	41.00	57.00	57.00	61.09	62.00	59.05	59.50	Dried
T_2	38.60	38.60	42.00	42.00	40.30	40.30	56.34	56.03	59.23	61.00	57.78	58.51	Dried
T_3	30.00	30.00	35.50	35.00	32.75	32.50	49.62	49.00	51.02	50.00	50.32	49.50	Dried
T_4	32.00	32.00	37.00	37.53	34.50	34.77	52.00	51.00	54.12	53.00	53.06	52.00	Dried
T_5	34.00	34.00	38.00	39.00	36.00	36.50	54.00	51.89	56.09	54.93	55.05	53.41	Dried
T_6	46.70	43.28	50.22	52.00	48.46	47.64	66.00	64.00	69.00	70.00	67.50	67.00	Dried
T_7	41.60	40.00	45.00	46.53	43.30	43.26	59.00	60.00	65.00	65.00	62.00	62.50	Dried
T_8	36.45	36.45	39.50	40.21	37.97	38.33	55.00	52.00	57.00	57.04	56.00	54.52	Dried
T_9	37.00	37.00	39.99	41.00	38.50	39.00	55.69	55.21	58.03	59.01	56.85	57.11	Dried
T_{10}	40.00	40.00	44.60	45.67	42.30	42.84	59.50	59.86	62.89	63.00	61.19	61.43	Dried
T_{11}	45.00	42.00	48.47	51.00	46.73	46.50	62.00	63.21	68.00	68.03	65.00	65.62	Dried
T_{12}	48.00	45.70	56.00	54.00	52.00	49.85	68.00	66.00	70.00	71.00	69.00	68.50	Dried
T_{13}	42.00	41.00	46.00	49.00	44.00	45.00	60.00	62.00	67.23	67.00	63.62	64.50	-
CD (P=0.05) for Treatments	3.47	3.45	3.94	3.90	2.56	2.54	5.35	5.22	5.28	5.25	3.66	3.61	
CD (P=0.05) for Years					1.00	1.00					1.44	1.41	-
SEm ± for Treatments	1.19	1.18	1.35	1.34	0.90	0.89	1.83	1.79	1.81	1.80	1.29	1.27	
SEm ± for Years					0.35	0.35					0.51	0.50	-
CV	5.25	5.34	5.37	5.23	5.32	5.29	5.47	5.39	5.10	5.05	5.28	5.22	

Commented [SS10]: Follow journal pattern

Table 7: Effect of integrated nutrient management on stem diameter (cm) at different growth stages of potato Cv. Kufri Chandramukhi

Treatments	Stem diameter (cm)						
	30 DAP			60 DAP			At harvest
	2021-22 (*Rabi*)	2022-23 (*Rabi*)	Pooled	2021-22 (*Rabi*)	2022-23 (*Rabi*)	Pooled	2021-22 (*Rabi*)
T_1	0.44	0.55	0.49	0.86	1.09	0.98	Dried
T_2	0.42	0.54	0.48	0.85	1.06	0.95	Dried
T_3	0.31	0.39	0.35	0.70	0.83	0.76	Dried
T_4	0.33	0.41	0.37	0.72	0.85	0.79	Dried
T_5	0.37	0.46	0.42	0.78	0.90	0.84	Dried
T_6	0.51	0.63	0.57	0.97	1.27	1.12	Dried
T_7	0.46	0.58	0.52	0.93	1.18	1.05	Dried
T_8	0.40	0.50	0.45	0.83	0.98	0.91	Dried
T_9	0.39	0.48	0.43	0.81	0.95	0.88	Dried
T_{10}	0.45	0.57	0.51	0.91	1.14	1.02	Dried
T_{11}	0.50	0.61	0.56	0.96	1.24	1.10	Dried
T_{12}	0.55	0.65	0.60	1.02	1.28	1.15	Dried
T_{13}	0.47	0.60	0.53	0.95	1.23	1.09	Dried
CD (P=0.05) for Treatments	0.05	0.07	0.04	0.10	0.12	0.08	-
CD (P=0.05) for Years			0.02			0.03	
SEm ± for Treatments	0.02	0.02	0.02	0.04	0.04	0.03	-
SEm ± for Years			0.01			0.01	

Commented [SS11]: Follow journal pattern

4. CONCLUSION

It could be concluded that application of 75 % Recommended dose of NPK+ Organic NPK with micronutrients + Organic NPK + Organic based micronutrients + Organic phosphorus + Organic potash recorded significantly highest growth in terms of plant height, leaf area, leaf area index, plant spreading and stem diameter.

REFERENCES

1. Abad, M., Noguera, P., Puchades, R., Maquieira, A. and Noguera, V. (2002). Physico-chemical properties of some coconut dusts for use as a peat substitute for containerized ornamental plants. *Bioresource Technology*, 82(3): 241-245.
2. Abdeldagir, A. H., Errebhi, M.A., Sarhan, H. M. A. and Ibrahim, M. (2003). The effect of different levels of additional potassium on yield and industrial qualities of potato (*Solanum tuberosum* L.) in an irrigated arid region. *American Journal of Potato Research*, 80: 219-222.
3. Abou-Hussain, S. D., El-Shorbagy, T., Abou-Hadid, A. F. and El-Behairy, U. (2003). Effect of cattle and chicken manure with or without mineral fertilizers on tuber quality and yield of potato crops. *ISHS Acta Horticulturea*, 608: 95-100.
4. Al-Hisnawy E. A. K. (2011). The effect of spraying organic fertilizer (liquid humus) on the growth and yield of three cultivars of potato plant (*Solanum tuberosum* L.) M.Sc. Thesis. College of Agriculture. University of Kufa, Iraq.
5. Chopra, S., Kanwar, J. S. and Samnotra, R. K. (2006). Effect of different levels of nitrogen and potassium on growth, yield and biochemical composition of potatoes variety Kufri Jawahar. *Environment and Ecology*, 24(2): 268-271.
6. Gangele, P. (2017). Effect of different level of potassium with and without vermicompost in potato variety Kufri Chipsona-. Doctoral dissertation, RVSKVV, Gwalior, Madhya Pradesh. *Journal of Potassium*, 1(4): 89-92.

Formatted: Font: (Default) Times New Roman, 12 pt, Bold

Formatted: List Paragraph, Indent: Left: 0", Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"

Formatted: Indent: First line: 0"

Commented [SS12]: Follow journal pattern

Formatted: Font: (Default) Times New Roman, 12 pt

Formatted: List Paragraph, Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"

Formatted: Font: 11 pt

Formatted: Font: (Default) Times New Roman, 12 pt

7. Ghiyal, V. and Bhatia, A. K. (2018). Effect of nitrogen levels and fertigation frequency on the growth parameters and yield of potato tuber (*Solanum tuberosum* L.) Cv. Kufri Bahar. *Journal of Pharmacognosy and Phytochemistry*, 7(4): 2064-2067.
8. Gray, D. and Hughes, J. C (1978). Tuber quality in: The potato crop. The scientific basis for improvement, (ed Harris P.M) Chapman and Wall. London , 504-544.
9. Gunadi, N. (2009). Response of potato to potassium sources and application methods in andonsisols of Wes Java. *Indonesian Journal Agricultural Science*, 10 (2): 62-72.
10. Hawkes, J. G. (1990). The Potato: Evolution, biodiversity and genetic resources. Belhaven press, London.
11. Karam, F., Rouphac, Y., Lahoud, R., Breidi, J. and Coll, G. (2009). Influence of genotypes and potassium application rates on yield and potassium use efficiency of potato. *Journal of Agronomy*, 8(1): 27- 32.
12. Khurana, S. M. P. (1978). Higher to less values of international son potato souvenir central potato station, Jullunder, India.
13. Khurana, S. M. P. and Naik, P. S. (2003). The potato: An overview. In: The potato: Production and utilization in sub-tropics, eds. Mehta Publishers, New Delhi, 1–14.
14. Kumar, B. P., Gouthami, B., Joseph, B., Reddy, A. R., Reddy, N. S., Prathiksha, G., Lavanya, N., Ramohan, N. and Sparjanbabu, D. S. (2022). Performance of gluconate and lactate based formulations on plant growth and yield attributes in maize (*Zea mays* L.). *International Journal of Environment and Climate Change*, 12(11): 676-684.
15. Kumar, B. P., Vineetha, M., Reddy, S. N., Krishna, M. and Sparjanbabu, D. S. (2021). A Basic approach to organic farming through gluconate and lactate technology. Weser Books, No. 79737. ISBN: 978-3-96492-280-9.
16. Marton, L. (2001). Potassium effects on potatoes (*Solanum tuberosum* L.) yield.
17. Medani, R. A., Mohamed, S. A., El-Yazal, M. A. and Mahfouz, S. A. (2000). Growth, yield and chemical composition of sugar beat as affected by specific isolated biofertilizers in relation on nitrogen application. *Annals Agricultural Science*, 38(4): 20119-2038.
18. Muleta, H. D. and Aga, M. C. (2019). Role of nitrogen on potato production: A Review. *Journal of Plant Sciences*, 7(2): 36-42.

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Black

Formatted: Font: (Default) Times New Roman, 12 pt

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Black

Formatted: Font: (Default) Times New Roman, 12 pt

19. Najm, A. A., Hadi, M. R. H. S., Darzi, T. M. and Fazeli, F. (2013). Influence of nitrogen fertilizer and cattle manure on the vegetative growth and tuber production of potato. *International Journal of Agriculture and Crop Sciences*, 5(2): 147-154.
20. Neogi, S. and Das, S. K. (2022). Effect of nitrogen and zinc in nano forms on growth and productivity of potato (*Solanum tuberosum* L.) in inceptisols. *Journal of Crop and Weed*, 18(1): 32-38.
21. Perrenoud, S. (1983). Fertilization for high yield potato. IPI Bulletin 8, 2nd Edition, International potash institute, Basel, Switzerland, 58-71.s
22. Reddy, R. U. and Reddy, M. S. (2011). Influence of integrated nutrient management on dehydrogenase activity of soil in tomato-onion cropping system. *Journal of Reseacrh ANGRAU*, 40(2):75-76.
23. Saha, R.sand Das, ss. (2001). Effect of potassium with and without sulphur containing fertilizers on growth and yield of potato (*Solanum tuberosum* L.). *Environment and Ecology*, 19(1): 202-205.
24. Shubha, A. S., Srinivasa, V., Devaraju., Shivaprasad, M., Nandish, M. S., Lavanya, K. S., Yogaraju, M. and Shanwaz, A. (2019). Effect of integrated nutrient management on growth, yield and economics of potato (*Solanum tuberosum* L.) under hill zone of Karnataka. *The Pharma Innovation Journal*, 8(5): 714-718.
25. Wien, H. C. (1997). The physiology of vegetable crops. CAB. International, New York, USA, 662.s
26. Sarvade S, Mishra HS, Kaushal R, Chaturvedi S, Tewari S, Jadhav A. Performance of wheat (Triticum aestivumL.) crop under different spacings of trees and fertility levels. African Journal of Agricultural Research. 2014a;9(9):866–873.
27. Shrivastava AK, Upadhyay VB, Gautam DS, Sarvade S, Sahu RK. Effect of integrated nutrient management on growth and productivity of *Withania somnifera* (L.) Dunal in Kymore Plateau and Satpura hills of Madhya Pradesh, India. Archives of Agriculture and Environmental Science. 2018;3(2):202-208.
28. Thakur RK, Bisen NK, Shrivastava AK, Rai SK, Sarvade S. Impact of integrated nutrient management on crop productivity and soil fertility under rice (*Oryza sativa*) – Chickpea (*Cicer arietinum*) cropping system in Chhattisgarh Plain Agro-Climatic Zone. Indian Journal of Agronomy. 2023;68(1):9-13.

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Font: Italic

29. Thakur U, Dutt B, Sarvade S, Sharma KR. Effect of FYM doses and plant spacing on the production of *Oenothera biennis* L. Indian Journal of Ecology. 2015;42(2):359-362.

Formatted: Font: Italic

Formatted: Font: (Default) Times New Roman, 12 pt