Effect of integrated nutrient management on growth, yield and quality of potato (*Solanum tuberosum* L.)

Abstract

This study investigated the "Effect of integrated nutrient management on the growth and yield of potato (*Solanum tuberosum* L.)". Various parameters related to plant growth, tuber formation, and tuber weight and yield were examined across different treatment conditions. The results revealed that Treatment 5 (Vermicompost + Urea + FYM + Neemcake), representing an integrated nutrient management approach, consistently exhibited the highest plant weight at different growth stages, indicating a positive effect on plant growth. Additionally, Treatment 3 displayed superior performance regarding the number of tubers in different weight categories, suggesting enhanced tuber formation. However, the most significant outcome was the consistent superiority of Treatment 5 in terms of tuber weight and yield. Treatment 5 consistently produced the highest weight of tubers in all weight categories and achieved the highest tuber yield per plot. These findings underscore the positive impact of integrated nutrient management practices on tuber weight and overall crop productivity in potatoes. It is important to note that specific details regarding the nutrient management practices used were not provided, necessitating further research to identify the particular combination and types of nutrients employed in Treatment 5. Overall, this study emphasizes the importance of implementing integrated nutrient management strategies to enhance the growth and yield of potato crops, encouraging further investigation into the optimization of plant growth and tuber yield through nutrient management practices.

Keywords: Integrated nutrient management, treatment, growth parameters.

Introduction

Solanum tuberosum L., commonly known as Potato, is indigenous to South America and is the predominant vegetable crop globally, occupying the largest cultivation area. Currently, over 46% of the world's potato production originates from developing Asian countries. This surge underscores its escalating significance as a vital food source for burgeoning populations, contributing to rural employment and income generation. As the fourth most-consumed food crop worldwide, following rice, wheat, and maize, the Potato boasts high nutritional content (carbohydrates, proteins, dietary fibre, vitamins, minerals,

amino acids, etc.), easy digestibility, and substantial yield. Widely acknowledged as the "poor man's friend," the Potato consistently assures cost-effective energy and nutritional sustenance across diverse economic strata. India ranks second globally in potato production, with China leading the charts. In 2018-19, India cultivated potatoes on an average of over 2.18 million hectares, yielding 52.58 million tonnes, with a productivity of 24.07 tonnes/ha (https://agriwelfare.gov.in/en/Horticulturereports, 2020). Potato cultivation in India is primarily concentrated in the northern hills and plains, eastern hills, plateau regions, and southern hills, with Uttar Pradesh and West Bengal emerging as the leading states in potato cultivation. Other significant potato-producing states include Bihar, Madhya Pradesh, Assam, Gujarat, Punjab, Jharkhand, Karnataka, Haryana, and Chhattisgarh (https://agriwelfare.gov.in/en/Horticulturereports, 2020).

The versatility of potatoes finds expression in various forms for table consumption, including its role as a vegetable ingredient in cooked dishes and the production of potato flour for snacks, chips, slices, shredded potatoes, mashed potatoes, and French fries. Additionally, potatoes hold industrial value in the output of dextrin, alcohol, and starch, particularly farina, used in laundries and textiles. The nutrient demands of potatoes are high due to their relatively underdeveloped and shallow root system, resulting in a significant extraction of nutrients from the soil (Sarkar*et al*., 2011). To ensure sustainable productivity and maintain soil health, an integrated approach to nutrient supply using organic, inorganic, and bio-fertilizers is imperative (Jagadeesh *et al*., 1994). Farm Yard Manure (FYM) emerges as valuable organic manure, not only for its nutrient content but also for its contribution to soil improvement, aeration, water retention, and stimulation of microbial activity. Combining chemical fertilizers with organic manures, such as farm yard manure, compost, vermin-compost, bio-fertilizers, micronutrients, and other materials, is universally recognized for its beneficial effects (Alam *et al*., 2007 &Chettri*et al*., 2005). A balanced integration of organic and inorganic fertilizers and bio-fertilizers represents an ideal strategy to meet nutrient requirements for most vegetable crops (Yawalker*et al*., 1996). Adopting integrated nutrient management practices is essential for realizing higher yields, improved quality, and enhanced returns in vegetable crop cultivation.

Material and methods

This research focuses on optimizing potato yield in the Horticulture field of DCAAS College Rampur, Dehradun, Uttarakhand, during the Rabi season of 2022-2023. The

experiment employs the *"Kufri Chandramukhi"* variety of potatoes and utilizes a Randomized Block Design (RBD) to investigate the impact of different treatments on crop performance. The study involves 20 plots with a spacing of 30cm x 30cm, organized into 5 treatments (T1 Control, T2 Vermi Compost, T3 Urea, T4 Urea+Neemcake, T5 vermicompost + Urea + FYM + Neemcake), each replicated thrice. The experiment commenced with the sowing of potatoes on November 1st, 2022. The aim is to contribute valuable insights into potato cultivation practices, enhancing agricultural productivity and sustainability. The experiment site is located km from Dehradun city at the elevation of North latitude of 29º.58' to 31º.2' and east longitude of 77º.34' to 78º.18' and 1467ft above the mean sea level. The climate of this area is sub-temperate to sub-tropical, with hot, desiccating summers and cold winters. The maximum temperature exceeds even 45 ℃ during the hot summers, and the minimum temperature occasionally plummets to 1℃ during winters. The data (2022-2023) on weather conditions that prevailed during crop season was recorded at the meteorological observatory located at the F.R.I. station. The weekly mean maximum and minimum temperature during the crop season ranges from 28.27 ℃ to 14.83℃ and 9.75℃ to 0.81℃, respectively. The weekly relative humidity ranged from 97% (max.) at 7:00 am to 43% (min.) at 2:00 pm. The total amount of rainfall received during crop season was 500mm, distributed up to February.

Result and Discussion

Effect of INM on growth parameters of potato

Plant growth parameters were meticulously evaluated in the potato cultivation of the Horticulture field at DCAAS College Rampur, U.K., during the Rabi season of 2022-2023. Measurements included plant height (cm), number of haulms per meter, number of leaves per meter, fresh weight of haulm, and dry weight of haulm. Plant height data, obtained at 30, 60, and 90 Days After Planting (DAP), revealed substantial differences among treatments across all growth stages. At 30 DAP, Treatment 5 exhibited the highest plant height (23.633 cm), followed sequentially by Treatments 4, 3, 2, and 1. This trend persisted at 60 DAP and 90 DAP, with Treatment 5 consistently surpassing other treatments. The analysis of haulm density (number of haulms demonstrated Treatment 4's predominance at 30 DAP (7.532), succeeded by Treatments 5, 1, 2, and 3. At 60 DAP, Treatment 5 displayed the highest haulm density (34.533), followed by Treatment 4, 2, 1, and 3. At 90 DAP (Hassan*et al*., 2017), Treatment 4 maintained superiority (34.613), followed by Treatments 2, 5, 3, and 1 (Choudhary*et al*., 2010). Concurrently, leaf counts (number of leaves were significantly

influenced by integrated nutrient management practices. At all observation stages, Treatment 5 consistently exhibited the highest leaf numbers. Lastly, fresh weight and dry weight of haulms at the dehaulming stage were significantly impacted by the applied nutrient management practices. Treatment 5 displayed superior fresh weight (370.14 gm) and dry weight (37.39 gm), maintaining a consistent trend across all observed parameters. These findings underscore the efficacy of Treatment 5 in promoting robust growth across multiple facets of potato cultivation.

Table 1: Effect of integrated nutrient management (INM) on growth parameters of potato

Treatments	Plant weight			No of haulms			No of leaves			Fresh weight haulm	Dry weight
	30 DAS	60DAS	90 DAS	30 DAS	60DAS	90 DAS	30 DAS	60DAS	90 DAS		
1	17.96	41.067	43.146	7.309	33.893	34.577	65.175	291.69	304.044	356.37	33.687
2	22.167	42.837	43.481	7.306	34.347	34.273	65.177	291.75	304.037	358.57	34.443
3	21.977	43.923	45.417	7.272	33.38	34.54	64.517	297.05	305.393	360.407	34.56
4	22.85	44.297	44.442	7.532	34.264	34.613	66.117	296.513	307.457	365.437	35.803
5	23.633	44.61	45.455	7.364	34.533	34.477	66.683	297.617	307.653	370.14	37.39
C.D.	1.582	1.28	0.57	0.061	0.33	0.31	1.536	1.417	2.233	1.572	0.989
SE(m)	0.478	0.387	0.172	0.019	0.1	0.193	0.464	0.428	0.674	0.475	0.299
SE(d)	0.675	0.547	0.244	0.026	0.141	0.273	0.656	0.605	0.953	0.671	0.422
C.V.	3.809	1.545	0.672	0.437	0.507	0.968	1.23	0.251	0.383	0.227	1.47

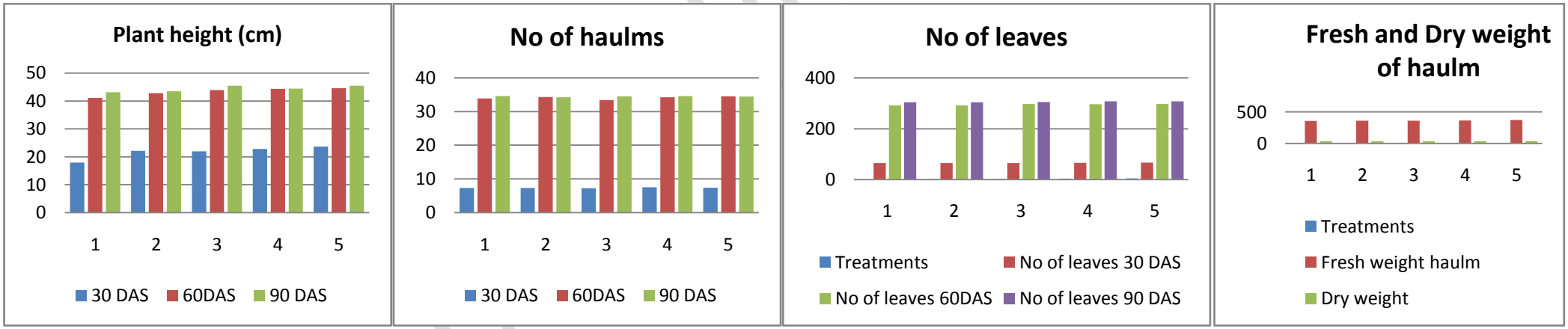

Figure 1: Effect of integrated nutrient management (INM) on growth parameters of potato

Effect of INM on yield parameters of potato

In exploring yield and its parameters under the influence of integrated nutrient management practices, data on the number of tubers per hill at harvest were meticulously recorded and detailed in the research findings. The weight categories encompassed 0-25g, 25-50g, 50-75g, and >75g. Treatment 3 consistently demonstrated superior performance, exhibiting the highest tuber counts across all weight categories. Specifically, Treatment 3 showcased pre-eminence in the 0-25g, 25-50g, and >75g weight classifications.

Similarly, the evaluation of tuber weight at harvest, documented in the research, unfolded insights into the impacts of varied treatments. Categorized into weight ranges of 0-25g, 25-50g, 50-75g, and >75g, Treatment 5 consistently manifested superior tuber weights, ranking Treatment 5 > Treatment 4 > Treatment 3 > Treatment 2 > Treatment 1. Treatment 5 asserted dominance in the >75g category, similar result reported by Barman *et al*., 2014 & 2018, while Treatment 1 registered comparatively lower tuber weights across all categories (Nongmaithem*et al*., 2011). Crucial to potato crop assessment, tuber yield, recorded at harvest, was detailed in the research findings. The diverse treatments significantly influenced tuber yield in weight categories (0-25g, 25-50g, 50-75g, and >75g). Treatment 5 consistently exhibited the highest tuber weights across all categories, with Treatment 5 > Treatment 4 > Treatment 3 > Treatment 2 > Treatment 1 (Bongkyon*et al*., 2004). Furthermore, Treatment 5 recorded the highest tuber yield at 9.243q/ha, followed by Treatments 4, 3, 2, and 1 (Jaipaul*et al*., 2011 &Khurana*et al*., 2005). These scientific findings highlight the considerable impact of Treatment 5 on tuber development and overall potato yield, providing valuable insights for optimizing agricultural practices in scientific research.

Table 2: Effect of integrated nutrient management (INM) on yield parameters of potato

Treatment	No of tubers				Weight of tubers				Weight of tuber kg per plot			tuber yield (q/ha)
	0-25g	25-50g	50-75g	>75g	0-25g	25-50g	50-75g	>75g	25-50g	50-75g	>75g	
1	3.147	2.49	1.87	2	10.157	46.64	57.077	77.857	1.35	6.677	7.817	5.66
2	3.37	2.177	2.003	2.07	15.473	71.007	93.273	121.54	1.797	10.22	10.743	8.247
3	3.543	2.213	2.033	2.323	16.473	73.27	97.37	123.697	1.88	10.747	10.85	8.557
4	3.35	2.263	2.337	2.36	17.253	81.243	98.26	127.453	1.917	10.95	11.213	8.793
5	3.323	2.29	2.37	2.42	18.347	83.3	98.713	129.2	1.943	11.2	11.27	9.243
C.D.	0.21	0.19	0.05	0.07	0.547	0.623	0.521	0.2	0.158	0.054	0.177	0.051
SE(m)	0.092	0.1	0.015	0.111	0.165	0.188	0.157	0.06	0.048	0.016	0.053	0.015
SE(d)	0.13	0.141	0.021	0.158	0.234	0.266	0.222	0.085	0.067	0.023	0.075	0.022
C.V.	4.773	7.573	1.226	8.64	1.841	0.459	0.306	0.09	4.646	0.284	0.89	0.326

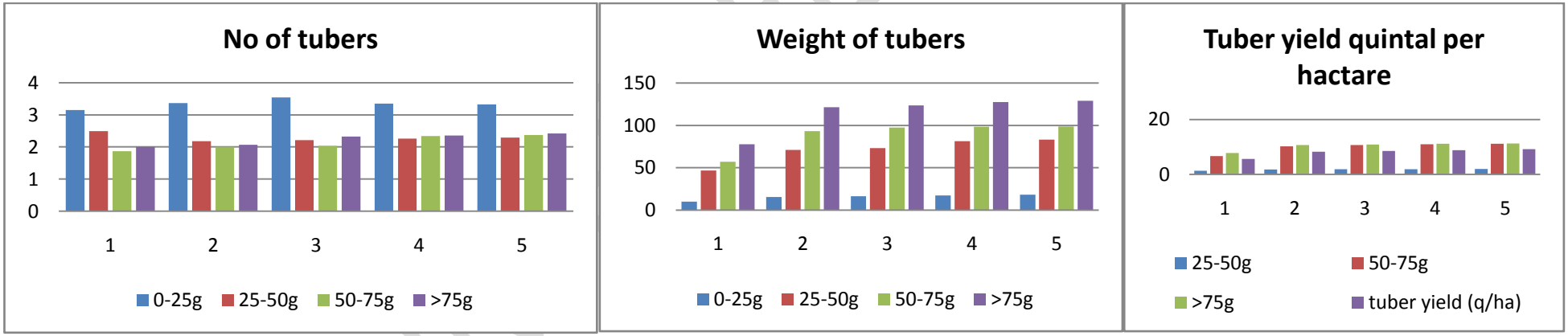

Figure 2: Effect of integrated nutrient management (INM) on yield parameters of potato

Conclusion

Our comprehensive investigation into integrated nutrient management practices in potato cultivation, conducted at the Horticulture field of DCAAS College Rampur, U.K., during the Rabi season of 2022-2023, has provided valuable insights into the intricate dynamics of growth and yield for the *"Kufri Chandramukhi"* potato variety. Employing a Randomized Block Design (RBD) with five treatments and three replications, Treatment 5 consistently exhibited superiority in plant height, haulm density, and leaf numbers throughout the observation period, indicating its positive impact on overall plant development. The robust performance of Treatment 5, characterized by higher plant weights and enhanced physiological attributes, positions it as a promising and effective nutrient management strategy for potato cultivation. In yield studies, Treatment 3 consistently demonstrated high performance regarding tuber counts and weights across size categories. Treatment 5 emerged as a dominant force, displaying the highest tuber weights and yield. This underscores the intricate interplay between nutrient management practices and the physiological processes governing potato growth. Treatment 5's pronounced positive influence suggests its potential as a critical approach for optimizing potato cultivation practices in the U.K.'s horticultural context. The empirical data generated from this research contributes significantly to understanding nutrient management strategies, offering valuable insights for future endeavours aimed at refining potato cultivation practices with a focus on sustainability and productivity.

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