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Effects of Different Fertilizers on the Yield and Yield Attributing Parameters of Sweet Potato (*Ipomoea Batatas* L.) in the Eastern Midhill of Nepal

Komal Rijal[1]*, Arjun Dahal[1], Bienam Dahal[1], Puspa Poudel[1], Saurabh Joshi Newar[1], Ranjit Kumar Bishwakarma Darnal[1] and Parashuram Bhantana[2]*

[1]*Agriculture and Forestry University, Rampur, Chitwan, Nepal*

[2]*Agricultural Research Station, Nepal Agricultural Research Council, Pakhribas, Dhankuta, Nepal*

***Corresponding author:** Komal Rijal, Agriculture and Forestry University, Rampur, Chitwan, Nepal

Parashuram Bhantana, Agricultural Research Station, Nepal Agricultural Research Council, Pakhribas, Dhankuta, Nepal

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ABSTRACT

Sweet potato is one of the major root crops contributing to food security in Nepal. However, its production may vary based on our different fertilizer sources. A field experiment was conducted in Pakhribas, Dhankuta, Nepal, from July to November 2021 to study the effect of organic and inorganic fertilizers on the yield and yield-attributing parameters of the sweet potato. The experiment was set up in a Randomized Complete Block Design (RCBD) with five treatments and four replications. The treatments were named T1: NPK, T2: Ash, T3: Titepati, T4: Vermicompost, and T5: Mycorrhiza respectively. One-month-old, uniform, and healthy vines of about 10 cm in length with three nodes of local landrace (white-colored) were selected as the planting material with a spacing of 60 X 30 cm^2. The number of vines per plant, vine length, number of leaves, leaf chlorophyll content, and yield were studied at different times after planting. Data analysis was done using Microsoft Excel and R-Studio. Results of the study showed that the number of vines at both 30 and 60 days after planting (DAP) was highest in the application of NPK at 30:30:50 Kg/ha, whereas the length of the vine was highest in the vermicompost-applied plots. Similarly, the leaf number was highest in the Titepati-treated plots. Also, the yield was highest in chemical fertilizer-treated plants. Likewise, the maximum plant-leaf chlorophyll content was recorded in ash-treated plants. Our result indicates that the judicious application of chemical fertilizers and organic manures boosts sweet potato production in the eastern mid-hills of Nepal.

Keywords: Sweet Potato; Mycorrhiza; Titepati; Vermicompost; Ash; SPAD

Introduction

The sweet potato (*Ipomoea batatas* L.) is one of the world's most significant root crops, contributing to reducing poverty and increasing food security (El Sheikha & Ray [1]). It is a future smart root crop that can thrive well in degraded land with minimum inputs, is climatically resilient, and has nutraceutical importance (Li & Siddique [2]). In Nepal, it is a neglected and underutilized crop species that can thrive well in the terai and mid-hills (Joshi, et al. [3]). The presence of endophytic bacteria is responsible for fixing nitrogen in sweet potatoes (Ueda & Yano [4]). It can give a good yield even in marginal land most probably due to its ability to fix atmospheric nitrogen. It is a dicotyledonous creeping plant belonging to the family Convolvulaceae. All sweet potato parts can be used for human consumption, animal feed, and industrial use (Esan, et al. [5]). This crop is rich in dietary fiber and can be further developed as a sustainable crop having diverse nutritionally enhanced and value-added products (Wang, et al. [6]). It is rich in vitamins A and C (Padmaja [7]). This is a root crop used widely during Haribodhani Ekadashi and Makar Sankranti (Hindu festivals) and has religious and cultural importance (Panta,

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et al. [8]). It contains high levels of anthocyanin and beta-carotene, making it a healthier alternative to synthetic coloring agents in food systems (Bovell-Benjamin [9]). The presence of beta-carotene can play an important role in combating long-term vitamin A deficiency in the world (Hotz, et al. [10]). Compared to major stable food crops, this crop has wider adaptability, a short duration cycle, and a high yield potential (Truong, et al. [11]). It is a functional food, and the consumption of sweet potatoes reduces the incidence of nutrition-related, non-communicable diseases like Type 2 Diabetes (Amagloh, et al. [12]). It is a starchy root crop with several qualities that are found in cereals, fruits, and vegetables (Padmaja [7]). This crop's production area, production, and productivity are not included in statistical information on Nepalese agriculture, which signifies that it is not a prioritized crop in Nepal (MoALD [13]). This crop is not commercialized in Nepal due to a lack of nutrient-rich, high-yielding varieties, efficient production technology, a lack of characterization and conservation of germplasms, the unstable yield of the local varieties, and research constraints (Bhattarai [14]).

The quality of sweet potato planting material is determined by the length, health, and age of the cuttings. However, very little research has been done on how these factors, notably the age of the cuttings, affect the yields of tubers. Malaysian Agricultural and Research Development Institute (MARDI) released three varieties of purple-fleshed sweet potatoes in 2017: Anggun 1, Anggun 2, and Anggun 3. For these 3 varieties, the best timing to take cuttings from the mother plant in order to get high-yielding planting material was still a mystery. However, research showed that cuttings taken from Anggun 3 at the time of 3-3.5 months after planting (MAP) gave a higher yield (Nurul Atilia Shafienaz, et al. [15]). Though inorganic fertilizers help to enhance the vegetative and storage parameters of sweet potatoes, they are not readily available or may be too expensive to use by the poor farmer. Apart from this, in Nepal, mixed type of farming system is prevalent, where livestock raising is an integral part of crop production. Hence, the readily available organic fertilizer source can obtain a similar yield as the inorganic fertilizer (Esan, et al. [16]). In this research, the effect of locally available organic fertilizer sources, mycorrhiza, and inorganic fertilizer source is studied in regard to their effects on the yield and yield-attributing parameters.

Materials and Methods

Location and Climate of the Research Site

Field experiments were conducted in Pakhribas Municipality Ward-4, Dhankuta District, Koshi Province, Nepal (Figure 1), with latitude and longitude of 27˚04" N and 87˚27" E, respectively. The crop period was of five months, from July to November 2021. The study site was at an altitude of 1,714 meters above sea level with warm temperate climatic conditions. The soil was slightly acidic with a pH of 6.5, and had a silty loam texture. The average rainfall was 1500 ml. The highest rainfall recorded was in the month of July with a total rainfall of 573.9 ml, and the lowest was in the month of November with a total rainfall of zero. The highest Relative Humidity (RH) was recorded in the month of August with RH % of 92.2. The highest temperature was recorded in the month of September with an average temperature of 24.62˚C, and the lowest in the month of November with an average temperature of 12.06˚C.

Figure 1: Map of the research area.

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Field Experiment Design, Nutrient Sources and Planting Material

The design of the experiment was Randomized Complete Block Design (RCBD) with five treatments and four replications. The treatments were named T1: NPK (30:30:50 kg/ha), T2: Ash (10 ton/ha), T3: Titepati (*Artemisia vulgaris*) (10 ton/ha), T4: Vermicompost (10 ton/ha), and T5: Mycorrhiza (30kg/ha) respectively. Ash and Titepati were collected locally, whereas NPK, Vermicompost, and Mycorrhiza were purchased from the local Agri-enterprise shop. All of them were applied at the time of land preparation, except Nitrogen. Nitrogen was applied in two split doses, half dose at the time of land preparation and the other half after 30 days of planting. Farm Yard Manure (FYM) was applied at the rate of 10 ton/ha in the entire field at the time of field preparation. The main plot size was 106.47 m^2 with the individual plot size 3.24m^2. One-month-old, uniform, and healthy vines of about 10cm length with three nodes of local landrace (white-colored) were selected as the planting material. This particular landrace was chosen as it was the most popular cultivar among the farmers at the experiment site. A spacing of 60 cm X 30 cm was maintained between row to row and plant to plant, accommodating 18 plants per plot. The vines were planted on June 19, 2021. Among the transplanted vines, 10.55% of them got rot, and gap filling was done after 17 days of planting. Two hand weeding were done, the first after 25 days of transplanting and the second after 45 days of transplanting.

Data Collection and Analysis

The number of vines per plant, vine length, and number of leaves per plant were recorded on the 30^{th} and 60^{th} days after transplanting. A stainless-steel ruler (12 inches or 30 cm) was used to measure the length of the vines. Leaf chlorophyll content was measured using Soil Plant Analysis Development (SPAD) readings. Data were analyzed using R-Studio and Microsoft Excel.

Results and Discussion

Effect of different organic and inorganic fertilizers on vine number per plant is shown in Table 1. The number of vines per plant was not significantly affected by the treatment of organic and inorganic fertilizers. However, the effects were seen in the order of NPK >Ash>-Titepati>Vermicompost>Mycorrhiza. (Singh, et al. [17]) reported that the application of 50% RDF (Recommended dose of fertilizer) + 50% vermicompost significantly increased the number of branches per vine at 45 DAP (Days after planting) as compared to Control, 100% RDF, 100% FYM, 50% RDF + 50% FYM, 100% vermicompost, and 100% poultry manure. The effect of various organic and inorganic fertilizers on the length of sweet potato vine per plant is shown in Table 2. The length of the vine was not significantly affected under observation at 30 DAP and 60 DAP as well. However, longer vine length was found in NPK treated plot which is in agreement with (Sijuwola, et al. [16]). This increase in vine length is due to the fast release of the nutrients. Statistically, the effect of all treatments on the length of the vine was found to be similar. They were non-significantly different, which is in agreement with (Mukhtar, et al. [18-20]).

Table 1: Effect of different treatments on vine number per plant.

Treatments	Number of Vines	
	30DAP	60DAP
NPK	1.77	1.56
Ash	1.08	1.19
Titepati	1.69	1.56
Vermicompost	1.33	2.38
Mycorrhiza	1.44	1.25
LSD	Ns	Ns
SEM (±)	-	-
F-probability	< 0.001	
CV %	-	-
Grand Mean	-	-

Note: ns: non-significant, LSD: Least significant difference, SEM: Standard Error of Mean, CV: Coefficient of Variance.

Table 2: Effect of different treatments on vine length per plant.

Treatments	Length of Vines (m)	
	30DAP	60DAP
NPK	0.29	1.36
Ash	0.23	1.74
Titepati	0.15	1.25
Vermicompost	0.25	1.65
Mycorrhiza	0.14	1.07
LSD	Ns	Ns
SEM (±)	-	-
F-probability	< 0.001	
CV %	-	-
Grand Mean	-	-

Note: ns: non- significant, LSD: Least significant difference, SEM: Standard Error of Mean, CV: Coefficient of Variance.

The effect of various organic and inorganic fertilizers on the number of leaves per plant is shown in Table 3. The data at 30 DAP shows that the plants fertilized with Titepati have the highest number of leaves i.e., 35, followed by treatment with NPK (30:30:100), and the lowest was observed in Mycorrhiza (30kg/ha), i.e., 15. As shown by the data at 60 DAP, the number of leaves grew to be the highest in the case of NPK, which was 301.88, whereas in case of Titepati, the number of leaves averaged 149.25. Similar to above, the lowest number of leaves per plant was seen in Mycorrhiza (30kg/ha), i.e., 91.44. The effect of various organic and inorganic fertilizers on the yield of sweet potato is shown, in Table 4. The total yield above the ground, i.e., shoot yield, was observed as the greatest in the case of NPK (30:30:50) at 7.76 kg/plot, which was significantly higher. The treatment with Titepati and Ash followed behind with a yield of 6.99 and 5.53 kg/plot respec-

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tively. The significantly lowest yield was found with the treatment of Vermicompost i.e., 4.68kg/plot. Similarly, in case of fresh tuber yield, the greatest yield was found in the case of NPK (30:30:50) (9.67 kg/plot), which was numerically higher. This data is in par with (Sidiky, et al. [16]). Similar to the shoot yield, the tuber yield of plot treated with Titepati (10t/ha) and ash (10t/ha) were 8.87 kg/plot and 9.12 kg/plot respectively, lower than that of NPK treated plot. The lowest tuber yield was observed with the treatment of Mycorrhiza, which was 7.21 kg/plot.

Table 3: Effect of different treatments on leaf number per plant.

Treatments	Number of Leaves	
	30DAP	60DAP
NPK	27.5[ab]	301.88[a]
Ash	19.75[bc]	133.75[a]
Titepati	35.00[a]	149.25[a]
Vermicompost	21.625[bc]	128.25[a]
Mycorrhiza	15.00[c]	91.44[a]
LSD	10.01*	212.68
SEM (±)	1.50	31.88
F-probability	< 0.001	
CV, %	28.23	88.61
Grand Mean	23.78	160.88

Note: Mean followed by common letter(s) within columns are non-significantly different based on DMRT P=0.05, ns: non- significant, *Significant at 0.1 P level, LSD: least significant difference SEM: Standard Error of Mean, CV: Coefficient of Variance.

Table 4: Effect on yield of different treatments on Kg per plot.

Treatments	Yield (kg)	
	Shoot	Root
NPK	7.76[a]	9.67[a]
Ash	5.53[ab]	9.12[a]
Titepati	6.99[ab]	8.87[a]
Vermicompost	4.68[b]	7.33[a]
Mycorrhiza	4.74[b]	7.21[a]
LSD	2.79*	2.98*
SEM (±)	0.38	0.45
F-probability	< 0.001	
CV %	31.42	23.44
Grand Mean	5.94	8.53

Note: Mean followed by common letter(s) within columns are non-significantly different based on DMRT P=0.05, ns: non- significant, *Significant at 0.1 P level, LSD: Least Significant Difference, SEM: Standard Error of Mean, CV: Coefficient of Variance.

Various organic and inorganic fertilizers significantly affected the chlorophyll content on the leaves of sweet potato plant, as shown in Table 5. The highest chlorophyll content was found to be with the treatment of Ash (10t/ha), with a SPAD value 43.09, which was followed by Titepati (10t/ha), which had a SPAD value of 42.16. The significantly lowest chlorophyll content was found to be with the treatment of Mycorrhiza (30kg/ha) with a SPAD value of 39.24. This finding is in agreement with (Pepo [13]), where strong correlation was observed among SPAD readings in regard to total yield and marketable yield of sweet potato tubers (Figure 2).

Table 5: Effect of different treatments on chlorophyll contain of leaves.

Treatments	Chlorophyll
NPK	41.34[abc]
Ash	43.09[a]
Titepati	42.16[ab]
Vermicompost	40.18[bc]
Mycorrhiza	39.24[c]
LSD	4.6*
SEM (±)	0.7
CV %	7.6
Grand Mean	40.5

Note: Mean followed by common letter(s) within columns are non-significantly different based on DMRT P=0.05, ns: Non- significant, Significant at 0.1 P level SEM: Standard Error of Mean, CV: Coefficient of Variance.

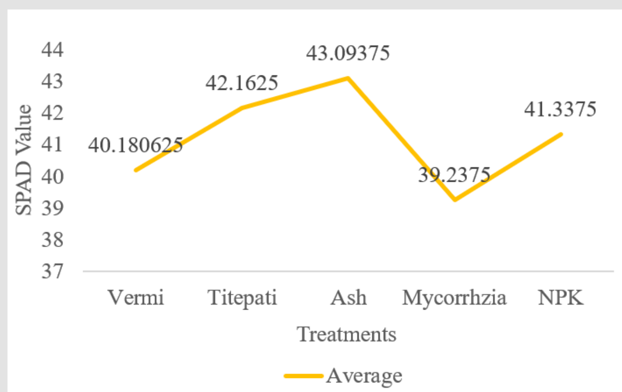

Figure 2: Soil plant analysis development chlorophyll meter readings.

Conclusion

In conclusion, the research conducted in Pakhribas municipality, Dhankuta from July to November 2021, investigated the effects of different fertilizer sources on the yield and yield attributing characters of sweet potato. The results revealed that the application of chemical fertilizer resulted in the highest yield and number of vines. Titepati treatment showed the highest leaf number; Vermicompost treatment resulted into longest vine length; whereas ash treatment showed the maximum SPAD value. Chemical fertilizers are either unavailable or too expensive for Nepalese subsistence farming, even though fertilizer applications have been shown to boost yield. Hence, careful blending of organic and inorganic fertilizer sources can increase the yield of sweet potato in the eastern mid-hills of Nepal.

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