# EVALUATION OF BOTANICAL AND CHEMICAL TREATMENTS ON GROWTH AND PRODUCTIVITY OF POTATO

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## ABSTRACT

*Potato (Solanum tuberosum L.) is one of the most significant Solanaceous vegetable crops throughout the world, and a food and cash crop in many parts of the world. A field experiment was carried out in Jorayal Rural Municipality- 2, Budar, Doti from late winter to early summer season. The objective of the study is to assess the impact of botanicals and chemicals on the growth and yield of potatoes in Budar-02, Doti, Nepal, with an emphasis on the need for environmentally sustainable farming practices. Five treatment comprising chemical fungicides, botanicals and a bio-control agents i.e. Mancozeb, Syzygium cumini L.(Jamun), Allium sativum L (Garlic), Eupatorium adenophorum Spring (Banmara) were arranged in a randomized block design and replicated six times. The result showed that botanical treatments positively influenced plant growth. It indicated a consistent increase in plant height throughout the crop growth period, with Mancozeb and Banmara treatments exhibiting the highest heights i.e 35 and 34.33 cm respectively. Compared to control, yield was also increased by 36.16% in Mancozeb and 30% in Jamun respectively. These findings imply that botanicals holds immense potential as a non-toxic, environmentally friendly and at the same time sustainable alternative to chemicals, contributing to agricultural productivity and environmental preservation.*

***Keywords:*** *alternatives, growth, non-toxic, productivity, sustainable*

## INTRODUCTION

In Nepal, potato (*Solanum tuberosum* L.) is one of the most significant vegetables, food and cash crop, which is mostly farmed and used as vegetable in the plains and mid-hills but one of the most important staple foods in the high-hills (Timsina et al., 2013). It is more well-liked by Nepal's rural, resource-poor and small-scale farmers due to its wider adaptability, high yield potential and high demand. It ranks fifth in terms of area coverage, second in total production, and first in productivity among food crops grown in Nepal (Maharjan et al., 2010). The share of potato to Gross Domestic Product (GDP) and Agriculture Domestic Product (AGDP) were 2.17 and 6.57%, respectively (Bajracharya & Sapkota, 2017). According to the report of MoALD, (2020/21) the area under potato cultivation is 198,788 ha and production is 3,325,231 mt. Despite the release of various high yielding superior varieties, low production remains a challenge due to several abiotic and biotic constraints. Conventional farming methods, often reliant on synthetic pesticides and fungicides, may contribute to soil degradation, environmental pollution, and unsustainable farming practices, therefore there is a pressing need to explore innovative and environmentally sustainable farming approaches that can enhance potato yields while minimizing environmental impact.

Botanicals offer a promising and environmentally sustainable solution to effectively address agricultural challenges while minimizing adverse impacts on the environment. Furthermore, botanicals entail the utilization of natural plant extracts, characterized by bioactive compounds that possess inherent qualities that have the potential to promote plant growth and protection. The botanical extracts from various plants have shown antifungal properties and can act as natural inhibitors against plant pathogens (Maharjan et al., 2010). The plants extracts can serve as natural inhibitors, effectively countering plant pathogens that contribute to diseases and hinder the optimal development of crops. By leveraging the natural defense mechanisms present in various plants, botanicals not only help in the promotion of growth of crops, but also act as a shield against potential threats posed by fungal pathogens.

The excessive and careless use of chemical fungicides has damaged our ecology and contributed to several human ailments, like cancer, renal problems, infertility, and neurological and psychiatric issues (Choudhary et al., 2018). As a result, the world is mostly in need of an alternate eco-friendly method of combating low yield issues in potato. Botanical extracts are a safer option than chemical among the many accessible substitute materials. There are various antimicrobial metabolites in botanical extracts that are less hazardous to people and the environment (Wedge & Smith, 2006). The use of such environmentally friendly technologies is consistent with current worldwide trends in sustainable agriculture and ecologically sound agricultural methods.

Furthermore, assessing the influence of botanicals on the growth and productivity of potato plants in Nepal is crucial because the region's climatic condition, geographical conditions, and agricultural practices may influence the performance of these agents differently compared to other regions. Moreover, local farmers in Budar have limited access to conventional chemicals due to their cost and availability constraints, necessitating the exploration of economically feasible and accessible solutions. Thus, utilizing botanicals might be the most economical, effective and safe measure to enhance production of potato.

## MATERIALS AND METHOD

### Experimental site

The research was conducted at Jorayal RM-2, Budar, Doti, Nepal, during season (February to June 2023). Site located at Budar lies at a longitude of 80.56°E and latitude

29.09°N MASL with an elevation of 1358 meter above sea level (masl). The mean temperature ranges from $5^{o}C$ in winter to $31^{o}C$ in summer.

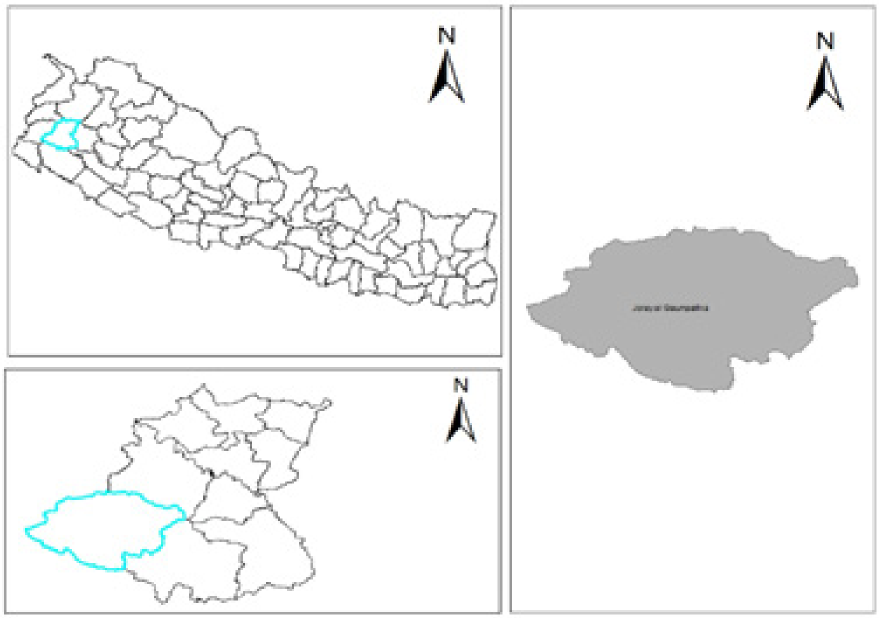



**Figure 1: Map of Nepal along with Doti district**

## Collection and preparation of botanicals

Studies and ethno botanical knowledge were considered during selection of botanicals. Plants were collected from nearby places. Plant parts of Banmara and Jamun were washed with running tap water two to three times and dried under shed for 2/3 weeks. Air dried leaves were grinded with the help of electric grinder to make fine powder. Garlic bulbs were cut into small pieces and blended by blender. The blended garlic and powdered Banmara and Jamun were preserved in safe container and used during treatment period.

## Experimental design and treatments

The experiment was conducted in a randomized complete block design (RCBD) with 5 treatments replicated six times. The individual plot size was 3 $m^2$ (2.5 m x 1.2 m) and the area of research field was 76.5 $m^2$. With a 25 cm plant-to-plant gap, there was 60 cm gap between rows. In each individual plot, there were two rows of 10 plants each. Each plot and block were separated by 50 cm distance. A predetermined amount of the chemical, botanicals were dissolved in a specific amount of plain water to make solutions. Potato Variety: Cardinal

**Table 1. Description of treatments**

| Treatments | | Concentration |
|---|---|---|
| T1 | *Syzyium cumini* (Jamun) | 2g/l |
| T2 | *Allium sativum* (Garlic extract) | 2g/l |
| T3 | *Eupatorium adenophorum*(Banmara) | 2g/l |
| T4 | Chemical (Mancozeb 75%) | 2g/l |
| T5 | Control (Spray with water) | - |

**Agronomic practices**

Land preparation was done by ploughing with harrow for two times, followed by planking. Farm yard manure @ 20 mt/ ha (6 kg per individual plot) was applied on the plot during land preparation. Sprouted potato seed tubers of approximately similar physiological age were planted on 2$^{nd}$ February, 2023 at 5-6 cm depth in ridges. After the initiation of potato sprouting, irrigation for the crop was given in furrow. As potato need consistent moisture during the growing period it was irrigated 3 times at 15 days interval.

Three manual weeding and earthing up were done throughout the potato growing period. First weeding was done at 40 days after planting, second at 65 DAP, and at 90 DAP followed by earthing up respectively. 110 DAP, the crop was harvested manually from the individual plot separately on May 23$^{rd}$ 2023, when the leaves turned yellowish and the tuber attained a desirable size. Yield/plot was taken by weighing the potato tubers using digital weighing balance.

**Assessment of agronomical characters**

**Plant height**

At 55 and 70 DAS, plant height (cm) was measured from soil surface (basal end of the main stem) to top of the plant (shoot apex) of 10 tagged plants.

**Number of main shoots**

The main shoots arising from the ground was counted at 55 and 70 DAS was observed.

**Measurement of number of branches per shoot**

Ten plants per plot used to collect the data on branches per plant was counted and averaged to give number of branches per shoot (NBPP).

**Statistical analysis**

Regarding the software programs, Microsoft word 2007 was used for word processing, MS Excel was used for data entry, tables and graphs. Treatment effects were analyzed using R-Studio software. After checking the compliance of the data with the assumptions of the statistical test, the data were subjected to analysis of variance (ANOVA) using RCBD design. A threshold P value of $<0.05$ was used to declare effects and interactions to be significant. When the effects were found to be significant ($P<0.05$), a LSD test ($\alpha = 0.05$) was used to study which means differed significantly and the comparison was made by employing Duncan multiple range test. In addition, the relationships among the studied parameters were assessed using Pearson's simple correlation analysis.

## RESULTS AND DISSCUSSION

**Plant height**

Throughout the growth period of the crop, a consistent increase in plant height was observed. Interestingly, the applied treatments did not show a significant difference in terms of plant height at 55 days after planting (DAP). Among the treatments, the plants treated with Mancozeb reached the highest height, averaging 31.83 cm. This was closely followed by the plants treated with Jamun, which had an average height of 30.30 cm. On the other hand, the control group, which did not receive any treatment, recorded the lowest plant height, with an average of 26.83 cm. Despite these differences in plant height, the statistical analysis suggested that the differences were not significant. This implies that the treatments did not have a substantial impact on the plant height at 55 DAP.

At 70 DAP of potato, there was no significant influence of treatment on the plant height. Mancozeb had the highest plant height (35 cm) followed by Banmara (34.33 cm) whereas lowest plant height was observed in Control (29.83 cm).

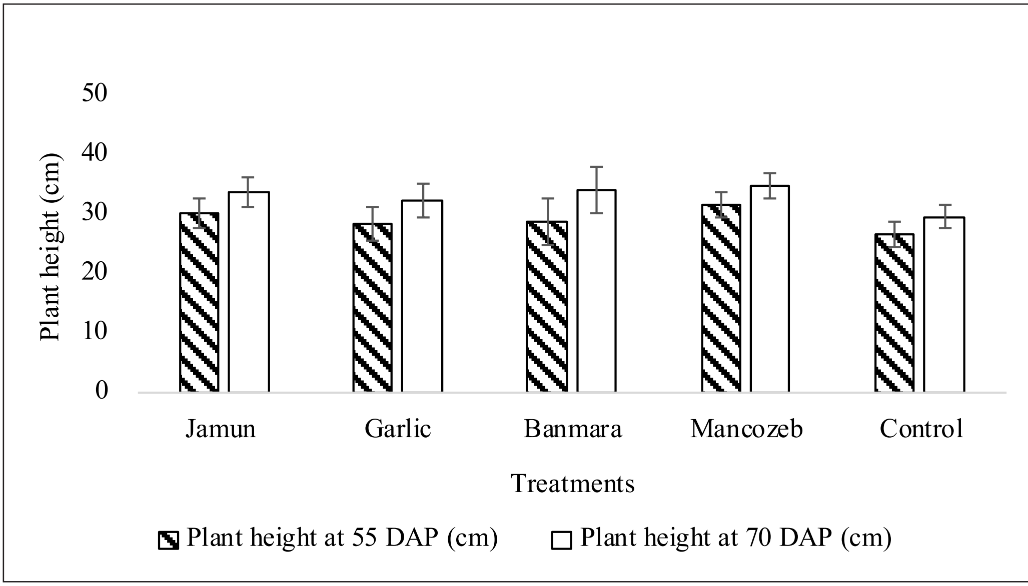



**Figure 2. Plant height at 55 and 70 DAP in bar-diagram**

**Number of main shoots**

The data collected on the number of main shoots at 55 days after planting (DAP) indicated that there was no significant statistical difference among the treatments. The plots treated with Mancozeb, a fungicide, exhibited the highest number of main shoots, averaging 5.20 stems per plant. This was closely followed by the plots treated with Garlic, which had an average of 5.03 stems per plant. On the other hand, the plots treated with Banmara, a common weed, had the lowest number of shoots, with an average of 4.77 stems per plant. Despite the differences in the average number of stems, the statistical analysis suggested that these differences were not significant enough to conclude that one treatment was superior to the others in terms of promoting the growth of main shoots in potato plants at 55 DAP.

Analysis of variance showed that there was no significance difference observed between the applied treatments in number of main shoots at 70 DAP. The highest number of main shoots was recorded with the application of Mancozeb (5.47 stems) followed by Jamun (5.10 stems) respectively. Control recorded the lowest number of main shoots (4.83 stems).

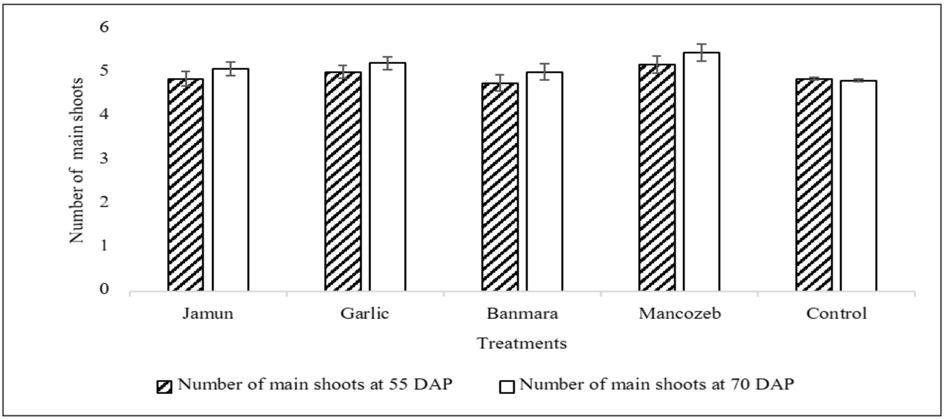



**Figure 3. Number of main shoots at 55 and 70 DAP**

**Number of branches per shoot (NBPP)**

At 55 DAP, maximum number of branches per shoot was observed in garlic (1.10) followed by Jamun (1), Control, Mancozeb and Banmara respectively.

The observation of the number of branches per shoot at 70 days after planting (DAP) showed a statistical similarity to the number of branches per shoot observed at 55 DAP. This suggests that the growth rate of the branches did not significantly change during this period. Among the different treatments, the plants treated with Jamun and Banmara exhibited the highest number of branches per shoot, with an average of 2.10 and 1.97 branches respectively. This indicates that these treatments may have promoted branching. On the other hand, the control group, which did not receive any treatment, showed the least number of branches per shoot, with an average of 1.45. This could suggest that the treatments may have had an effect on promoting branch growth compared to the untreated plants.

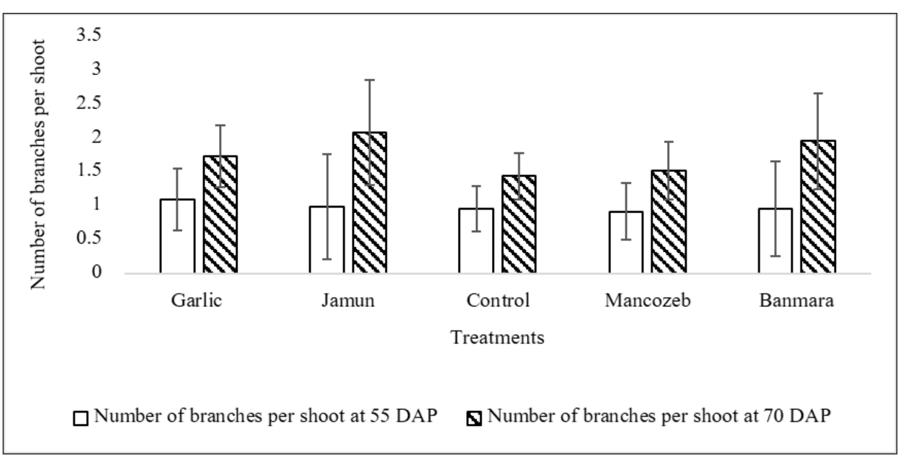



**Figure 4. Number of branches per shoot at 55 and 70 DAP in bar-diagram**

**Yield**

The highest yield was observed in mancozeb which was significantly different with control but at par with rest of the treatments. Compared to the control treatment, yield increased by 36.16% in Mancozeb and 30% in Jamun respectively. (Islam et al., 2021) and (Mekonen & Tadesse, 2018) also reported that use of Mancozeb and Jamun are not only effective against late blight but also increases the yield. Our results are in agreement with the work of the above researchers.

**Table 2. Effect of treatment on yield**

| Treatments | Yield (t/ha) |
|---|---|
| Mancozeb | 18.25[a] |
| Jamun | 16.84[ab] |
| Garlic | 12.6[ab] |
| Banmara | 12.33[ab] |
| Control | 11.65[b] |
| SEM (±) | 1.85 |
| LSD (0.05) | 6.03 |
| F- test | NS |
| CV | 22.25 |

*NS: Non -Significant difference, SEM (±): Standard Error Mean, CV: Coefficient of Variation, LSD: Least Significant Difference, treatment means followed by common letter (s) are not significantly different among each other based on LSD at 5% level of significance.*

**Correlation analysis**

Pearson's correlation coefficient analysis revealed a positive correlation between yield, plant height, number of main shoots, and number of branches per shoot.

**Table 3. Correlation between plant heights, number of main shoots, number of branches per shoot and yield**

| | Yield | Number of main shoots at 70 DAP | Number of branches per shoot at 70 DAP | Plant height |
|---|---|---|---|---|
| Yield | 1 | | | |
| Number of main shoots at 70 DAP | 0.395547 | 1 | | |
| Number of branches per shoot at 70 DAP | 0.202369 | 0.031774 | 1 | |
| Plant height | -0.01171 | 0.34242 | 0.283268 | 1 |

**Regression analysis**

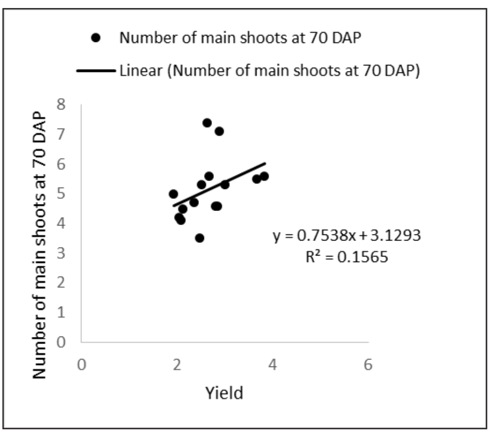
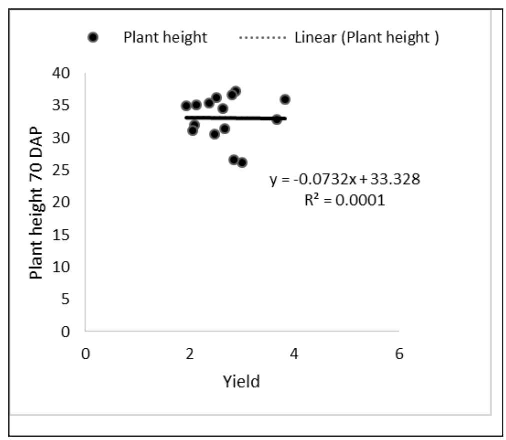



**Figure 5. Estimated linear relationship between Number of main shoots at 70 DAP and Yield of different treatments**




**Figures 6. Estimated linear relationship Plant height at 70 DAP and Yield of diff treatment**

## CONCLUSION

This research study concludes that plant extracts demonstrated positive impact on both plant growth and yield. Botanicals exhibited favorable results in case of plant growth, and yield. Inspite of having the effectiveness of Mancozeb, a chemical treatment, the study emphasizes the associated environmental and health hazards, underscoring the importance of exploring environmentally friendly alternatives. The use of botanicals aligns with the global shift towards sustainable agriculture, which aims to increase agricultural productivity while minimizing environmental impact. By reducing the reliance on chemical fungicides, we can decrease the amount of harmful residues in our food and the environment. Furthermore, the use of botanicals can contribute to biodiversity conservation, as many of these plants can be sourced locally and sustainably. This research not only represents a significant step forward in exploring the potential of botanicals as sustainable substitutes for conventional chemical fungicides, but also highlights the dual benefits of botanicals - enhancing agricultural productivity and preserving the environment. Consequently, the research represents a significant stride in investigating an environmentally friendly botanicals and bio-control agents, such as *Syzygium cumini*, as sustainable substitutes for conventional and potentially harmful chemical fungicides in contributing to both agricultural productivity and environmental preservation and opens up new avenues for further research into the development of safe, effective, and environmentally friendly disease management strategies.

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## REFERENCES

Choudhary, P., Goswami, S., Singh, V., & Chakdar, H. (2018). Harmful effects of fungicides: Current status. *Journal of Agriculture and Environment*, *12*(3), 45-58.

Islam, S., Azad, M. A. K., Islam, M. R., Sultana, M. S., Khatun, J. A., & Islam, M. H. (2021). Efficacy of some botanical extracts on the control of late blight disease in experimental potato field. *Advances in Bioscience and Biotechnology*, *12*(12), 426-435. https://doi.org/10.4236/abb.2021.1212027

Maharjan, B. L., Shreshta, K., & Basnyat, S. (2010). Botanical control of late blight of potato. *Nepal Journal of Science and Technology*, *11,*34-40. https://doi.org/10.3126/njst.v11i0.4087

Mahima Bajracharya, & Sapkota, M. (2017). Profitability and productivity of potato (Solanum tuberosum) in Baglung district, Nepal. *Agriculture & Food Security*, *6*(1), 47. https://doi.org/10.1186/s40066-017-0125-5

Mekonen, S., & Tadesse, T. (2018). Effect of varieties and fungicides on potato late blight (*Phytophthora infestans*, (Mont.) de Bary) management. *Agrotechnology*, *7*(2), 1-4. https://doi.org/10.4172/2168-9881.1000182

MoALD. (2022). *Statistical Information on Nepalese Agriculture 2021/22*. Government of Nepal, Ministry of Agriculture and Livestock Development, Planning and development Co-operation Co-ordination Division, Statistics and Analysis Section, Singha durbar, Kathmandu, Nepal.

Timsina, K., Kafle, K., & Sapkota, S. (2013). Economics of potato (*Solanum tuberosum* L) production in Taplejung district of Nepal. *Agronomy Journal of Nepal*, *2*, 173-181. https://doi.org/10.3126/ajn.v2i0.7533

Wedge, D. E., & Smith, B. J. (2006). Discovery and evaluation of natural product-based fungicides for disease control of small fruits. In inderjit & k. G. Mukerji (eds.), *Allelochemicals: Biological Control of Plant Pathogens and Diseases* (pp. 1-14). Springer Netherlands. https://doi.org/10.1007/1-4020-4447-X_1