**Effect of Intercropping and Sowing Time on Yield and Economics of Potato Production**

**Abstract**

Intercropping is a cost-effective cropping technique that increases productivity, maximizes land use, and enhances the income of farmers while minimizing risks from mono-cropping. The objective of this study was to determine the impact of intercropping on potato yield and potato economics in on-farm trials (OFTs). The trials compared various intercropping systems, such as potato with bottle gourd, cabbage, watermelon, and maize, against sole potato cropping. The findings indicated that intercropping greatly enhanced yield equivalence and benefit-cost (B:C) ratio over the sole potato cultivation practice followed by farmers. Treatment T4 (potato + maize) had the highest B:C ratio (4.3) in the year 2019 which was at par with Treatment T3 (potato + cabbage). In the year 2021, treatment T4 (potato + maize) had the highest B:C ratio (4.04) which was at par with Treatment T3 (potato + cabbage). These results indicate the potential of intercropping for enhancing land utilization efficiency, improving returns to the farmer, and ensuring sustainable agricultural practice.

**Keywords:** Intercropping, Potato, Yield Equivalence, Benefit-Cost Ratio, Vegetable Crops

**Introduction**

Potato (*Solanum tuberosum* L.) is the most significant cash and staple crop grown globally, playing a considerable role in ensuring food security as well as livelihoods in rural areas. Mono-cropping potato, however, tends to cause poor economic gains, higher risk exposure to pathogens and pests, and poor utilization of available resources. Mono-cropping production systems, which predominate in traditional potato production, tend to cause soil nutrient loss, enhanced susceptibility to climatic variations, and decreased aggregate land productivity.

Intercropping, or growing two or more crops in a single field, has been identified as a sustainable means of enhancing agricultural productivity. Intercropping increases the efficiency of resource use, decreases the frequency of disease and pests, and offers several harvests, hence guaranteeing higher economic stability for farmers. The proven benefits notwithstanding, intercropping is not fully exploited in potato-based farming systems, especially among countries where farmers depend on traditional mono-cropping production.

The intercropping of potato with suitable vegetable crops can potentially enhance land use and increase financial rewards. The most efficient intercropping patterns need to be identified to enhance yield and profitability while encouraging sustainable farming practices. The present study is intended to evaluate the effect of intercropping potato with vegetables on yield, land productivity, and economic benefits, offering important information for smallholder farmers and policymakers.

**Research Gap and Objective**

In India, intercropping is a common practice that increases land productivity and also reduces the risk of climatic variability, pests, and market price fluctuations. But with all its benefits, there has been limited research on the comparative yields of various vegetable-based intercropping systems with potato, especially in the agro-climatic conditions of Sheohar, Bihar. Current research is mainly concerned with cereal-based intercropping, and thus there is no research conducted on the efficiency and profitability of vegetable-based intercropping. In addition, small-scale farmers do not have region-specific recommendations for maximizing intercropping benefits. The aim of this research is to assess the effect of potato intercropping with chosen vegetables on yield, land use efficiency, and profitability, thus filling the gap in research and offering evidence-based recommendations for sustainable and economically competitive potato production.

**Materials and Methods**

The experiments were carried out at farmers' fields under on-farm trial (OFT) situations in the agro-climatic zone of Sheohar, Bihar. The RBD with four treatments per OFT and five replications per treatment was used for the experiment. Field experiments were conducted during rabi. Strict agronomic management and recommended cultural practices were followed. The treatments were:

**Year 2019:**

* T1: Sole potato (Farmers' Practice)
* T2: Potato + Bottle Gourd (4:1)
* T3: Potato + Cabbage (1:1)
* T4: Potato + Maize (1:1)

**Year 2021:**

* T1: Sole potato (Farmers' Practice)
* T2: Potato + Bottle Gourd (4:1)
* T3: Potato + Cabbage (1:1)
* T4: Potato + Maize (1:1)

The performance of every treatment was assessed on the basis of tuber yield, yield equivalence, cost of cultivation, gross return, net return, and B:C ratio. Data were analyzed through routine statistical analysis using analysis of variance (ANOVA) for the significance of treatment differences. Yield equivalence was computed to provide a comparison between intercropping and sole crop productivity. Moreover, economic determinants like gross and net return were evaluated for assessing the profitability of various combinations of intercropping. Statisical analysis are done with help of Panse VC, Sukhatme PV (1985).

**Table-1: Year 2019**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Result** |  | | | | | |
| **Treatments** | **Tuber Yield q/ha** | **Yield equivalence** | **Result: Cost of cultivation** | **Gross return (Rs./ha)** | **Net Return (Rs/ha)** | **BC Ratio** |
| T1 | 368.20 | 368.20 | 84000.00 | 368200.00 | 284200.00 | 3.38 |
| T2 | 329.80 | 410.80 | 87000.00 | 410800.00 | 323800.00 | 3.72 |
| T3 | 364.20 | **462.00** | 87500.00 | **449000.00** | 361500.00 | **4.13** |
| T4 | 388.75 | **459.00** | 87500.00 | **460000.00** | 372500.00 | **4.30** |
| **CD at 5%** | **13.73** | **8.97** |  |  |  |  |

**Table-2: Year 2021**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Tuber Yield q/ha** | **Yield equivalence** | **Result: Cost of cultivation** | **Gross return (Rs./ha)** | **Net Return (Rs/ha)** | **BC Ratio** |
| T1 | 305.20 | 305.20 | 90000.00 | 366000.00 | 276000.00 | 3.06 |
| T2 | 327.00 | 410.80 | 93000.00 | 392400.00 | 299400.00 | 3.22 |
| **T3** | **385.20** | **457.00** | **93500.00** | **425840.00** | **332340.00** | **3.55** |
| **T4** | **389.20** | **463.00** | **93500.00** | **472040.00** | **378540.00** | **4.04** |
| **CD at 5%** | **13.73** | **8.97** |  |  |  |  |

**Figure-1: Tuber Yield q/ha**

**Figure-2: Yield equivalence**

**Results and Discussion**

In Year 2019, intercropping was very much better than sole cropping in enhancing yield equivalence, economic benefits, and land use efficiency. Treatment T3 (potato + cabbage) had the best performance with highest yield equivalence of 462.00 q/ha and highest B:C ratio of 4.3 recorded in the treatment T4 and hence the most profitable combination. Treatment T4 (potato + maize) also exhibited very good improvement with yield equivalence of 459.00 q/ha. Conversely, sole potato cropping had the lowest B:C ratio (3.38), which reflects its relative inefficiency in maximizing land productivity and economic returns (Zhao et al., 2019). These results imply that intercropping, especially with maize and cabbage, can improve potato production profitability and sustainability to a large extent similar finding by Gitari et al., 2018 and Gitari et al., 2019).

In year 2021, intercropping potato with maize (Treatment T4) had the highest yield equivalence (463.00 q/ha) and B:C ratio (4.04), reflecting its highest economic viability. Intercropping with cabbage (Treatment T3) was also a profitable practice, with a yield equivalence of 457.00 q/ha and a B:C ratio of 3.55. The only potato cultivation system had the lowest B:C ratio (3.06), which reflects its relative inefficiency in economic returns (Zhang et al., 2021). These findings highlight the promise of intercropping, especially with maize and cabbage, to increase productivity and profitability in potato-based production systems closed result find by (Xie et al., 2021 and Anning et al., 2021).

**Conclusion**

The results of this research unequivocally show that intercropping potato with appropriate vegetable crops considerably increases yield, land-use efficiency, and economic returns. From among the intercropping systems examined, Potato + Maize (Year 2019 and 2021) proved to be the superior combinations with regard to B:C ratios and equal yields. Such findings present promising evidence for the use of intercropping as a sound competitor to sole cropping, as they guarantee both environmentally friendly and economical potato cultivation. In addition, the use of intercropping systems can improve soil health, farm income diversity, and lowering crop failure risks. More attention in future studies should be on improving crop density, nutrient balance, and water efficiency to optimize the advantages of intercropping in potato cultivation systems.

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