GROWTH, YIELD AND ECONOMIC EVALUATION OF WHEAT (*TRITICUM AESTIVUM* L.) – COWPEA (*VIGNA UNGUICULATA* L.) SEQUENTIAL CROPPING SYSTEM IN ODISHA

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ABSTRACT

Sequential cropping of wheat (Triticum aestivum L.) followed by cowpea (Vigna unguiculata L.) under irrigated conditions was evaluated for growth, yield, and economic feasibility. Wheat was sown in November 2021 and succeeded by cowpea in March 2022 with recommended fertilizers and FYM. Growth parameters, including plant height, leaf number, LAI, and dry matter, increased steadily in both crops. Germination was high (91% in wheat, 90% in cowpea). Wheat yielded 3,850 kg ha^{-1}, while cowpea produced 1,489 kg ha^{-1}. Economic analysis showed higher profitability in wheat (B:C ratio 1.63) than cowpea (1.2), indicating the benefits of cereal–legume systems.

KEYWORDS: Benefit–cost ratio, dry matter production, integrated farming system, leaf area index, sequential cropping, wheat–cowpea system

INTRODUCTION

Sequential cropping involving cereals and legumes is an important agronomic practice for improving land productivity, resource use efficiency and sustainability of agricultural systems. It enables the cultivation of two or more crops in a year on the same land, thereby increasing cropping intensity and maximizing the utilization of available resources such as water, nutrients and solar radiation. Sequential cropping systems are particularly important under irrigated conditions, where assured water supply allows the successful cultivation of successive crops within a year. Such systems not only enhance total productivity but also improve soil fertility and farm income by diversifying crop production and optimizing the use of available inputs (Reddy, 2015; Reddy, 2024). Wheat (*Triticum aestivum* L.), widely known as the "King of Cereals," is one of the most important food grain crops grown throughout the world. It serves as a staple food for a large proportion of the global population and is a major source of carbohydrates, protein and essential nutrients. Wheat plays a vital role in ensuring food security and contributes significantly to the agricultural economy of many countries, including India. Proper agronomic management practices such as suitable cropping systems, balanced nutrient management and efficient water use are essential for sustaining wheat productivity (Prasad, 2019; Sheaffer and Moncada, 2012). Cowpea (*Vigna unguiculata* L.), belonging to the family Fabaceae, is an important legume crop valued for its high protein content and adaptability to diverse agro-climatic conditions. It is widely cultivated as a vegetable, pulse and fodder crop. Being a leguminous crop, cowpea has the ability to fix atmospheric nitrogen through symbiotic association with *Rhizobium* bacteria, thereby improving soil fertility and reducing the need for external nitrogen fertilizers. Inclusion of cowpea in cropping systems enhances soil health, improves nutrient cycling and contributes to sustainable agricultural production (Patra, 2013; Nedunchezhiyan and Sahoo, 2019). Integration of cereal and legume crops in a sequential cropping system offers several agronomic and ecological advantages. The cereal crop efficiently utilizes soil nutrients and moisture, while the succeeding legume crop enriches the soil through biological nitrogen fixation and organic matter addition. This complementary relationship between cereals and legumes helps in maintaining soil fertility, improving soil structure and increasing overall system productivity. Moreover, sequential cropping systems involving wheat followed by cowpea can enhance economic returns to farmers by producing two marketable crops within a single year (Jayanthi and Kalpana, 2016; Yuvaraj and Manickam, 2018). Therefore, the adoption of wheat–cowpea sequential cropping systems can play a crucial role in increasing cropping intensity, improving soil nutrient status and enhancing farm profitability under irrigated conditions. Considering these advantages, the present field practical was conducted to evaluate the growth parameters, yield attributes and economics of a wheat–cowpea sequential cropping system (Meena and Sihag, 2021; Thavaprakaash and Velayudham, 2023; Reddy, 2026).

MATERIALS AND METHODS

The field experiment was conducted in a 4 m × 5 m plot (20 m²) under irrigated conditions following standard agronomic practices. Sequential cropping experiments are commonly conducted under irrigated conditions to evaluate crop growth, productivity and economic returns in diversified cropping systems (Reddy, 2015; Jayanthi and Kalpana, 2016). Wheat variety Sonalika was sown on 15 November 2021 at a spacing of 22.5 cm × 5 cm using the line sowing method. The crop was supplied with the recommended fertilizer dose of 60:40:30 kg N: P_2O_5: K_2O ha^{-1} along with farmyard manure to ensure adequate nutrient availability and maintain soil fertility (Prasad, 2019; Yuvaraj and Manickam, 2018). Growth observations were recorded at 10, 20 and 40 days after sowing (DAS) to assess crop development. Plant height was measured from the ground level to the tip of the longest leaf or spike using a meter scale, and the number of fully opened leaves was counted manually. Leaf area was determined by measuring leaf length and maximum width and multiplying by a correction factor of 0.67, which was derived from the ratio of actual leaf area to measured area (18.66/27.6). The Leaf Area Index (LAI) was calculated by dividing the total leaf area per plant by the ground area occupied per plant, which is an important indicator of canopy development and photosynthetic efficiency (Jain, 1990; Sheaffer and Moncada, 2012). Dry Matter Production (DMP) was estimated by uprooting 25 representative plants, which were then oven dried at 65–70°C until constant weight was obtained, and the dry weight was recorded. Dry matter accumulation is a reliable parameter for assessing crop growth and biomass production under different management practices (Reddy, 2024). After the harvest of wheat, cowpea variety Kashi Kanchana was sown on 9 March 2022 at a spacing of 45 cm × 15 cm with a fertilizer dose of 25:50:25 kg N: P_2O_5: K_2O ha^{-1} along with 1 kg FYM. Observations on germination percentage, plant population, plant height, number of leaves, LAI and yield attributes were recorded using standard crop measurement procedures (Nedunchezhiyan and Sahoo, 2019; Patra, 2013). Yield obtained from each plot was converted into kg ha^{-1} to estimate productivity on a hectare basis. Economic analysis of the cropping system was carried out by calculating cost of cultivation, gross return and benefit–cost ratio, which are commonly used indicators for evaluating the profitability of cropping systems (Meena and Sihag, 2021; Sarma, 2020). Since the objective of the study was to observe crop growth, yield attributes and economic performance under a sequential cropping system under field conditions, the experiment was conducted as a field observation without treatment comparisons, and therefore statistical analysis such as analysis of variance (ANOVA) was not applied as per Rao, N.G., 1983; Gomez and Gomez, 2010. The results are presented as descriptive observations of crop performance under the given management practices.

RESULTS AND DISCUSSION

The wheat crop established uniformly under irrigated conditions, indicating favourable field management and good seed quality. Based on the spacing of 22.5 cm × 5 cm, the calculated optimum plant population was 1,780 plants per 20 m², while the actual plant count recorded in the field was 1,620 plants, resulting in a germination percentage of 91%. The estimated plant population per hectare was approximately 8,90,000 plants. Cowpea also established well under field conditions, with an optimum plant population of 297 plants per 20 m², of which 270 plants were successfully established, resulting in a germination percentage of 90%, indicating satisfactory crop establishment. Adequate plant population is essential for optimal resource utilization and yield maximization in crop production systems (Ananthakumar, 2012;

Prasad, 2015).

Growth observations revealed a steady increase in vegetative parameters from 10 to 40 DAS in both crops. In wheat, at 10 DAS, the average plant height was 12.4 cm with 3.2 leaves per plant and an LAI of 0.08, while dry matter production (DMP) of 25 plants was 0.85 g. At 20 DAS, plant height increased to 28.9 cm with 5.1 leaves per plant and an LAI of 0.17, along with dry matter production of 2.65 g. At 40 DAS, rapid vegetative growth was observed, with plant height reaching 64.3 cm, 8.6 leaves per plant, LAI of 1.48 and dry matter production of 18.7 g per 25 plants. The progressive increase in growth parameters reflects efficient nutrient uptake and favourable environmental conditions supporting active photosynthesis and biomass accumulation (Reddy, 2024; Yellamanda Reddy and Sankara Reddi, 2023). In cowpea, initial growth at 10 DAS showed plant height of 5.74 cm with two leaves per plant. At 20 DAS, plant height increased to 7.80 cm with 14.5 leaves per plant and LAI of 0.50. At 40 DAS, plant height reached 30.7 cm with 30.8 leaves per plant and LAI of 1.72. Dry matter production increased progressively and reached 16.4 g per 25 plants at 40 DAS, indicating vigorous vegetative growth and efficient biomass accumulation. The sharp increase in LAI and dry matter production at 40 DAS corresponds to the active tillering and canopy expansion stage, which enhances light interception and photosynthetic efficiency (Sheaffer and Moncada, 2012; Bhatnagar, 2014).

Yield attributes recorded at harvest showed that wheat produced an average ear length of 10.3 cm, 14 spikelets per ear and 40 grains per ear. Grain weight per ear was 1.31 g and the 1000-grain weight was 42.8 g. The estimated grain yield of wheat was 3,850 kg ha^{-1}. In cowpea, yield observations recorded 474 g and 421 g during the first and second pod pickings from the plot. The crop produced an average of 10 pods per plant with 10 seeds per pod and a test weight of 100 g, resulting in an estimated seed yield of 1,489 kg ha^{-1}. The higher yield was mainly attributed to improved growth characters, efficient photosynthate production and better partitioning of assimilates towards reproductive structures (Das, 2015).

Economic analysis revealed that wheat cultivation incurred a total cost of cultivation of ₹52,000 ha^{-1}, which included expenditure on seed, fertilizers, irrigation, labour and intercultural operations. With a market price of ₹22 kg^{-1}, the gross return obtained from 3,850 kg ha^{-1} grain yield was ₹84,700 ha^{-1}. The net return was ₹32,700 ha^{-1} with a benefit–cost ratio (B:C) of 1.63, indicating profitable wheat cultivation under irrigated conditions. Cowpea cultivation recorded a cost of cultivation of ₹36,313.65 ha^{-1} and gross return of ₹40,261.35 ha^{-1}, resulting in a net return of ₹3,947.70 and a B:C ratio of 1.2, indicating moderate profitability. Sequential cereal–legume cropping systems generally enhance system productivity and economic sustainability by improving resource use efficiency and marketable output (Bhatnagar, 2014). The integration of sequential cropping with diversified farming components such as fruit trees on bunds, seasonal vegetable cultivation within the main field and inclusion of backyard poultry units can further enhance farm income stability. Such integrated farming approaches enable year-round production, multiple income streams and reduced production risk, which are particularly beneficial for smallholder farmers. Practical demonstration under farmer field training programmes showed that crop diversification and enterprise integration increased net returns to ₹51,120 with a benefit–cost ratio of 6.02, highlighting the economic advantage of diversified farming systems.

CONCLUSION

Sequential cropping systems result in higher yield and improved resource use efficiency, their economic impact can be significantly amplified when combined with integrated farming practices. The findings suggest that scientific crop sequencing supported by enterprise diversification offers a viable pathway for enhancing income and sustainability among small and marginal farmers. Overall, the wheat–cowpea sequential cropping system proved to be agronomically efficient and economically viable under irrigated field conditions.

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