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Effect of intercropping on yield and economics of castor (*Ricinus communis* L.) under rainfed conditions of Coimbatore

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Abstract

A field research was carried out on castor-based intercropping under rainfed circumstances was conducted at Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu. During the *rabi* season of 2025. Castor was intercropped with pulse, vegetables and oilseeds like green gram, horse gram, chickpea, groundnut, sesame, soybean, lablab, bhendi and brinjal with the row ratio of 2:2. The results indicated that increased in both seed yield (911 kg/ha) and stalk yield (1881 kg/ha) of castor was obtained when castor was intercropped with pulses when compared to sole castor. To evaluate the benefits of pulse intercropping, various indicators such as the relative crowding coefficient (RCC), land equivalent ratio (LER), and castor equivalent yield (CEY) were computed. Higher CEY (1045 kg/ha), RCC (2.71), LER (1.64) was observed in castor – green gram (2:2) treatment. The higher B:C ratio (4.18) was obtained in castor and green gram in 2:2 ratio.

Keywords: Castor (*Ricinus communis* L.), intercropping, rainfed agriculture, green gram

1. Introduction

Castor (*Ricinus communis* L.) is a significant non-edible industrial oilseed crop that is extensively grown in arid and semi-arid areas because of its capacity to tolerate marginal soils and moisture stress. The main reasons for the crop's worth are its high oil content (40–55%) and the fact that ricinoleic acid that makes up around 85–90% of its fatty acid makeup. Castor oil is an essential raw ingredient for the production of lubricants, polymers, medications, cosmetics, and other industrial goods because of its unique chemical characteristics.

Castor's wide spacing, moderate initial development, deep root system, and unpredictable growth behaviour make it especially well-suited for intercropping. These features make it possible to introduce short-duration intercrops with enough room and time without negatively impacting the primary crop. Because of their short lifetime and capacity to fix atmospheric nitrogen, pulse crops including green gram, horse gram, and chickpea are frequently interplanted in castor-based systems.

Under rainfed circumstances, oilseed crops like Soybean, Sesame, and Groundnuts can be effectively combined with castor in addition to pulses. When planted at the right spacing, these crops effectively use the soil moisture that is available and produce more oil without substantially competing with the primary crop. In a similar way, short-duration vegetable crops like as Bhendi (okra), Lablab, and Brinjal can be planted in between castor rows, particularly in areas with good market access. According to Sharmili *et al.*, (2019)^[1], intercropping pulses into intercropping systems provides a strategic option to solve a variety of agricultural difficulties while increasing sustainability.

Increased gross returns and improved land use efficiency are possible with vegetable intercropping, especially in the early phases of castor development before canopy extension. Farmers may increase overall system productivity, diversify production, and lower the risks related to rainfall unpredictability by using pulses, vegetables, and oilseeds as intercrops. In rainfed ecosystems, such diverse intercropping systems boost profitability, stabilize yields, and

optimize resource consumption.

The current study was conducted, in order to evaluate the impact of intercropping with pulses, vegetables, and oilseeds on the economics and yield of castor (*Ricinus communis*) in Coimbatore's rainfed condition.

2. Materials and Methods

A field experiment was conducted during the *Rabi* season of 2025 to study the performance of castor-based intercropping systems under rainfed condition at the experimental farm of Karunya Institute of Technology and Sciences, Coimbatore district of Tamil Nadu. The soil of the experimental field was clay loam in texture, containing 25.70% clay, 18.00% silt and 34.16% coarse sand. The soil had available nitrogen of 499kg/ha, available phosphorus of 11 kg/ha and available potassium of 180 kg/ha.

The experiment was laid out in Randomized Block Design (RBD) with ten treatments and three replications. The treatments consisted of sole castor and castor based intercropping systems in 2:2 row ratio with different intercrops viz., T₁–Sole castor, T₂ – Castor + Green gram (2:2), T₃ – Castor + Horse gram (2:2), T₄ – Castor + Chickpea (2:2), T₅ – Castor + Groundnut (2:2), T₆ – Castor + Sesame (2:2), T₇ – Castor + Soybean(2:2), T₈ – Castor + Lablab (2:2), T₉ – Castor + Bhendi (2:2), T₁₀ – Castor + Brinjal (2:2). The varieties used in this experiment was castor (TMV 5), green gram, (VBN 6), horse gram (PAIYUR 2), chickpea (JG-11), groundnut (TMV 14), sesame (TMV 7), soybean (CO (Soy) 3), lablab (CO-2), bhendi (CO(GB)14), and brinjal (CO-2).

Three replications of each treatment were raised in replacement series. The nine intercrops green gram, horse gram, chickpea, groundnut, sesame, soybean, lablab, bhendi and brinjal were planted separately next to the treatment plots in order to determine indices related to biological efficiency. Growth parameters were recorded at regular intervals throughout the study. Fertilizers were applied only to the castor crop according to the recommended dose of 45:15:15 kg/ha. The collected data on different traits were analysed using analysis of variance (ANOVA). The critical difference (CD) at the 5% level of significance was calculated to compare the treatment means.

Grain equivalent yield (GEY) is used to convert the yield of many crops into a single unit. Lal and Ray (1976) [2] proposed agricultural economics by translating grain in terms of gross return for a trustworthy comparison such as GEY. The castor equivalent yield of the intercropping system, given in kg/ha, was calculated using the following formula.

$$CEY = \frac{\sum Y_i \times P}{P(b)}$$

Were,

Y_i – Yield of intercrop (kg/ha)

P_i – price of intercrop (₹/kg)

P(b) – Price of base crop (₹/kg)

The land equivalent ratio (LER) is the total land area required for solo cropping in order to generate the yield in the intercrop combination. It is really the proportionate quantity of land required for a pure stand of a certain crop species to yield the same amount of product as an intercropping at the same management level. The LER is calculated using the following formula:

$$LER = LER_a + LER_b$$

$$LER_a = \frac{Y_{ab}}{Y_{aa}}$$

$$LER_b = \frac{Y_{ba}}{Y_{bb}}$$

Were,

L_a – Land equivalent ratio of main crop.

L_b – land equivalent ratio of intercrop.

Y_{aa} – yield of main crop in pure stand.

Y_{ab} – yield of main crop in intercrop.

Y_{bb} – yield of intercrop in sole cropping condition.

Y_{ba} – yield of intercrop in intercropping

DeWit (1960) [3] introduced the idea of the Relative Crowding Coefficient (RCC). It indicates if a crop grown in a mixed population has produced more or less than what would have been expected in a pure stand.

$$RCC = \frac{Y_{ab} \times Z_{ba}}{(Y_{aa} - Y_{ab}) \times Z_{ab}}$$

Where,

Z_{ab} – Sown proportion of 'a' in combination with 'b'

Z_{ba} – Sown proportion of 'b' in combination with 'a'

3. Results and Discussion

The plant height of castor at harvest was significantly affected by the different intercropping systems. The tallest plants were observed in sole castor (158.77 cm), followed by castor intercropped with green gram (155.68 cm) in a 2:2 ratio, while castor grown with horse gram in the same ratio recorded a slightly lower height (153.87 cm) (Table 1). This could be because the plants had better growing conditions, which helped them produce more dry matter. Similar results were also reported by Tephilla *et al.*, (2014) [4] in a castor and pulse intercropping system with different intercropping ratios. The total dry matter production of castor at harvest was significantly affected by the different intercropping systems (Table 1). Higher dry weight was observed when castor was intercropped green gram and horse gram) in a 2:2 ratio compared to the other intercropping combinations.

Castor + green gram (2:2) and castor + horse gram (2:2) had the greatest seed production among the intercropping treatments. The improved movement of photosynthates throughout the plant, which is supported by more leaves and increases total metabolic activity, may be the cause of the greater seed yields. Castor intercropped with mungbean (Porwal *et al.*, 2006) [5] and groundnut (Ganvir *et al.*, 2004) [6] showed similar outcomes.

3.1 Intercrop Association

The intercropping systems also had a significant impact on the castor equivalent yield with a maximum castor + green gram (2:2) yield compared to the other combinations (Table 2). This system could perform better because of the increased grain yield and market price of green gram. Conversely, other intercropping systems may have lower castor equivalent yield because of increased competition between castor and the intercrops over nutrients, water, and light.

The Land Equivalent Ratio (LER) of all the intercropping treatments was higher than the sole thereby denoting that intercropping castor with pulses was better as compared to the sole crop. Castor + green gram in 2:2 row ratio recorded highest

LER (1.64) and lowest LER was recorded in the 2:2 row ratio of castor + soybean intercropping system (1.20) (Table 2).

Relative crowding coefficient value of all intercropping systems is greater than 1 suggesting that all the pulse intercropping systems are beneficial in castor. The coefficient of less crowding was lower in all the intercrops than the main crop (castor) this showed that castor yielded higher than anticipated in the intercropping systems. Complete crowding coefficient had greater than unity shows yield advantage. The castor + green gram (2.71) in 2:2 row ratio was observed to have the higher value of the total crowding coefficient and the least in castor + sesame intercropping system (1.09) with the same ratio (Table

2). This finding also conforms to the results of Gangadhar *et al.*, (2023)^[7].

3.2 Economics of Intercropping

The data shows that the intercrop with castor – green gram (2:2) with a net return of Rs.1,59,004 profit compared to the sole castor Rs. 1,39,300 and castor-oilseed intercrop and castor-vegetable intercrops (Table 1). The high yield of pulse intercrop with castor-green gram and the very little decrease in the economic yield of castor within this intercropping configuration were the primary causes of this outcome. Mohsin *et al.*, (2018)^[8] and Gangadhar *et al.*, (2024)^[9] reported similar results.

Table 1: Effect of intercropping on growth, yield and economics of Castor

Treatments	Plant Height (cm)	Dry matter production (kg/ha)	Castor seed yield (kg/ha)	Castor stalk yield (kg/ha)	Net income (Rs. /ha)	B:C Ratio	Intercrop Association		
							Castor equivalent yield (CEY) (kg/ha)	Land equivalent ratio (LER)	Relative Crowding Coefficient (RCC)
T ₁ - Sole castor	158.77	114.3	926	1918	139300	3.93	926	1.00	1.00
T ₂ Castor + Green gram (2:2)	155.68	112.7	911	1881	159004	4.18	1045	1.64	2.71
T ₃ Castor + Horse gram (2:2)	153.87	110.3	886	1852	140698	3.84	933	1.30	1.32
T ₄ Castor + Chick pea (2:2)	151.77	109.5	857	1830	138131	3.80	954	1.35	1.41
T ₅ Castor + Groundnut (2:2)	143.10	100.8	680	1384	102990	2.71	1016	1.27	1.58
T ₆ Castor + Sesame (2:2)	141.35	102.6	704	1489	117737	4.06	781	1.41	1.09
T ₇ Castor + Soybean (2:2)	138.00	101.6	713	1466	112728	3.44	795	1.20	1.25
T ₈ Castor + Lablab (2:2)	149.32	107.5	827	1687	124846	3.56	868	1.30	1.36
T ₉ Castor + Bhendi (2:2)	147.84	106.5	784	1664	120981	3.44	852	1.39	1.55
T ₁₀ Castor + Brinjal (2:2)	145.69	103.5	769	1599	115455	3.37	820	1.38	1.52

4. Conclusion

Growing castor intercrop with pulse castor-green gram (2:2) net return of Rs.1,59,004, castor-horse gram (2:2) with net return of Rs. 1,40,698 followed by castor-chickpea (2:2) Rs. 1,38,131, ratio increased productivity and net income per unit area compared to other intercropping systems, according to the results. As a result, this intercropping system can be suggested to farmers in rainfed conditions. As an alternative intercropping, castor with vegetables like castor-lablab (2:2), castor-bhendi (2:2) and castor-brinjal (2:2) are more effective intercropping. Compared to the both castor-pulse and castor- vegetables, intercropping the castor-oilseed intercropping the plants struggle to survive because of the pest incidence which attack the same family plants. Even though it has many benefits, intercrop production may be impacted by factors such competition for light, water, and nutrients.

Competing Interests

Authors have declared that no competing interests exist.

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