**Original Research Article**

**Research on the rainfed condition of Coimbatore for castor (*Ricinus communis*) based pulse intercropping**

**ABSTRACT:**

During the *rabi* season of 2024, a field study was carried out at Karunya Institute of Technology and Sciences to study the castor-based pulse intercropping under rainfed conditions of Coimbatore, India. Castor was intercropped with pulse crops like cowpea, chickpea, greengram and horsegram were sown in replacement series row ratios of 1:2 and 2:2. The result showed that intercropping greengram and horsegram with castor in a 2:2 ratio increased both the seed yield (917 kg/ha) and stalk yield (900 kg/ha) of castor in comparison to sole castor. Intercropping indices including the castor equivalent yield (CEY), land equivalent ratio (LER) and relative crowding coefficient (RCC) were calculated to assess the advantage of pulse intercropping. The higher CEY (1004.06 kg/ha), LER (1.44), RCC
(53.94) observed in castor + green gram (1:2). The higher B:C ratio (4.16), as well as net return (Rs. 152489/ha), was exhibited in the castor + green gram (2:2) followed by castor + horsegram (2:2) intercropping system.

**Keyword**: Castor, Intercropping, Yield, CEY and Economics.

**INTRODUCTION**

In India rainfed agriculture occupies about 51 percent of country’s net sown area, rainfed agriculture is risky and intricate, but if it is properly managed these areas offer enormous potential for faster agricultural growth than irrigated areas (MoA&FW, 2022). When considering land productivity in places with limited rainfall, the yield benefit of intercropping under rainfed conditions is quite important (Ma *et al.,* 2024). Castor (*Ricinus communis*) is a non- edible oilseed crop that has been cultivated in arid and semi-arid regions of the world for a very long time. Castor seeds have an oil content ranging 40 to 55 percent, making them highest percentage of oil content among the oilseed crops. Castor oil is regarded as one of the most valuable and beneficial natural oilseeds crops globally. The most common usage of castor oil is in the production of a vast array of ever-growing industrial goods, including nylon fibres, hydraulic fluids, jet engine lubricants, cosmetics, and medications. The kernel of the castor plant holds an oil content of 64 to 71%, castor oil is distinctive because it contains ricinoleic acid (hydroxy fatty acid). Castor cake generates 22.37% protein and 45- 46 % carbohydrates, along it is highly concentrated organic manure that contains 4.5, 2.6, and 1.2 % nitrogen, phosphorus, and potash, respectively.

Castor is a drought-resistant and sturdy oilseed crop that has become an essential component of rainfed agriculture in semi-arid regions. It is usually grown as a monocrop, which may not always be

the most effective or economical method when it is rainfed condition. However, since castor is a long-term crop and has a relatively thin population of plants, it can be intercropped with oilseed, pulse, and food grain (cereal) crops that grow quickly and have a short duration in the right geometry to boost growth, yield, and economics per unit area.

Advantage of intercropping in castor can be increased by reorienting crop geometry for better availability of solar energy and growing suitable intercrops. In comparison to sole cropping, intercropping has been identified as a potentially advantageous in crop production strategy that can offer long-term yield advantages. These benefits are particularly significant because they are attained via the straightforward expediency of growing crops together rather than the use of expensive inputs.

Intercropping pulses into the intercropping systems offers a strategic solution to address various agricultural challenges while promoting sustainability (Sharmili *et al.* 2019). The benefits of legumes as an intercrop include improved root stratification, increased root and shoot growth, improved utilization of soil nutrients, and nitrogen fixation, which enables the legumes to become nitrogen-independent and releases some nitrogen for non-legume plants.

In this context, the present investigation was carried out to find out the suitable pulse intercrop for castor under rainfed conditions.

**MATERIALS AND METHODS:**

The field experiment was carried out during the *Rabi* season of 2024 to investigate castor-based pulse intercropping under rainfed condition at Karunya Institute of Techonology and Sciences, Coimbatore district of Tamil Nadu. The soil texture of the experimental field was a clay loam with 23.40% clay, 19.00% silt and 32.30% coarse sand. The soil contained available nitrogen of 295 kg/ha and available phosphorus of 18 kg/ha and available potassium of 283 kg/ha. The experiment was conducted in Randomized Block Design (RDB) with nine intercropping treatments *viz.,* T1- sole castor, T2 - castor + cowpea (1:2), T3 - castor + cowpea (2:2), T4 - castor + chickpea (1:2), T5 - castor + chickpea (2:2), T6 - castor + greengram (1:2), T7 - castor + greengram (2:2), T8 - castor + horsegram (1:2), T9 - castor + horsegram (2:2). The varieties tested in this experiment were castor (TMV5), cowpea (CO(CP)7), chickpea (CO 4), greengram (VBN 6), horsegram (Paiyur 2).

The treatments were sowed in replacement series and replicated three times. In order to calculate indices pertaining to biological efficiency of the four intercrops – cowpea, chickpea, greengram, horsegram was grown independently next to the treatment plots. The growth parameters were measured periodically. The fertilizer application was done as per recommended dosage (45:15:15 kg/ha) only to castor. The statistical analysis of the data of various characters was assessed by ANOVA. The critical difference for comparing the treatment means were worked out at 5 percent level of significance.

The yield of several crop is converted to one unit using grain equivalent yield (GEY). For a reliable comparison like GEY, Lal and Ray (1976) suggested crop economics by converting grain in term of gross return. The following formula was used to determine the intercropping system’s castor equivalent yield expressed in kg/ha.

$$Castor Equivalent Yield (CEY kg/ha) =\frac{Yield of intercrop \left(Yi\right)×priceof intercrop (Pi)}{price of base crop(Pp)}$$

Yi – Yield of intercrop (kg/ha)

Pi – Price of intercrop (₹/ha)

P(p) – Price of base crop (₹/ha)

The total land area needed for sole cropping in order to produce the yield in the intercrop mixture is known as the land equivalent ratio (LER). In actuality, it is the proportionate land area needed for pure stand of crop species to generate the same amount of produce as an intercropping at the same level of management. The formula used to determine the LER is

$$LER =\frac{Yab}{Yaa}+\frac{Yba}{Ybb}$$

Yab = Yield of “a” crop grown in association with “b” crop

Yaa = Yield of “a” crop grown in pure stand

Yba = Yield of “b” crop grown in pure stand

Ybb = Yield of “b” crop grown in association with “a” crop

The concept of Relative Crowding Coefficient (RCC) was proposed by De-Wit (1960). It shows whether a crop cultivated in a mixed population has yielded more or less than what would have been predicted in a pure stand.

$$RCC =\frac{Yab ×Zab}{(Yaa -Yab)×Zab}$$

Yab – Yield of ‘a’ intercropped with ‘b’

Yaa – Pure crop yield of ‘a’

Zab – Sown proportion of ‘a’ in combination with ‘b’

Zba – Sown proportion of ‘b’ in combination with ‘a’

**Results and discussion:**

The plant height of castor was significantly influenced due to different intercropping systems at harvest. Sole castor recorded significantly higher plant height (155 cm) followed by castor + greengram (152 cm) at 2:2 ratio, and castor intercropped with horsegram (150 cm) in the same ratio (Table 1). It might be due to favourable environment available to plants which is evident from higher dry matter accumulation under this system. Similar results were also obtained by Ghilotia *et al* (2019) in castor and mung bean intercropping cropping system.

The total dry matter production of castor was also significantly influenced due to different intercropping systems at harvest stage (Table 1). The higher dry weight was recorded in castor + greengram and castor + horse gram (2:2 ratios) compared to other intercropping systems. The notable rise in dry matter buildup at each crop growth stage appears to be caused by development of more leaves per plant, which may have increased the amount of radiant energy absorbed and used, which in turn increased the amount of photosynthates and ultimately, the amount of dry matter per plant, this has close conformity with Yadav and Jat Prajapat *et al*. (2005).

The mean seed yield and stalk yield of sole castor (934 kg/ha and 1843 kg/ha, respectively) was higher than that in the rest of the intercropping system (Table 1). Next best treatment for castor seed yield was castor + greengram (2:2) followed by castor + horsegram (2:2). The greater yield of seeds and stalks has resulted from increased photosynthetic translocation caused by more leaves, which increases metabolic activity. Similar trends were observed when castor intercropped with groundnut (Ganvir *et al*., 2004), and when castor intercropped with mungbean (Porwal *et al*., 2006).

**Intercrop association:**

The castor equivalent yield was significantly affected due to intercropping and maximum was recorded with castor + greengram (2:2) compared to other intercropping systems (Table 2). The higher castor equivalent yield with greengram intercropping was due to higher additional grain yield and market price of greengram. These results are in agreement with the findings of Thanunathan *et al*. (2006). The lower castor equivalent yield with other intercrops might be due to the severe competition for resources between castor and intercrops.

The Land Equivalent Ratio (LER) among all the intercropping treatments was greater than sole thereby indicating that intercropping of castor with pulses was found superior as compared to than sole crop stand. Castor + greengram in 1:2 row ratio showed maximum LER (1.44) and the lowest LER was found in the 1:2 row ratio of castor + chickpea intercropping system (1.00) (Table 2). This result is similar to the findings of Gangadhar *et al*. (2023).

Relative crowding coefficient value of all intercropping systems is more than one indicating that all the pulse intercropping systems are advantage in castor. All intercrops had less crowding coefficient than main crop (castor) which indicated that castor produced more yield than expected in the intercropping systems. Total crowding coefficient had greater than unity indicates yield advantage. The higher value of total crowding coefficient was noticed in castor + greengram (53.94) in 2:2 row ratio and the least in castor + chickpea intercropping system (1.00) with row ratio of 1:2 (Table 2). This result is also in accordance with the findings of Gangadhar *et al*. (2023).

**Economics of intercropping:**

The data indicated that, castor + greengram intercropping system in 2:2 row proportions was more remunerative with a net return of Rs. 1,52,489 followed by castor + horsegram (Rs. 1,52,033/ha) in 2:2 row proportions compared to sole crop of castor (Rs. 1,39,227/ha) and other intercropping systems (Table 1). This result was mainly due to the high yield of green gram and the relatively minor reduction in castor economic yield of within this intercropping arrangement. Similar findings were observed by Mohsin *et al*. (2018) and Gangadhar *et al*. (2024).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment**  | **Plant height** **(cm)** | **Dry matter production (kg/ha)** | **Castor (kg/ha)** | **Net income** **(Rs. /ha)** |
| **Grain**  | **stalk** |
| T1  Castor sole crop | 155 | 113.8 | 934 | 1943 | 139227 |
| T2  Castor + cowpea (1:2) | 143 | 104.3 | 758 | 1508 | 114075 |
| T3  Castor + cowpea (2:2) | 146 | 106.3 | 834 | 1643 | 125537 |
| T4  Castor + chickpea (1:2) | 139 | 101.3 | 655 | 1351 | 88435 |
| T5  Castor + chickpea (2:2) | 147 | 107.8 | 861 | 1711 | 134582 |
| T6  Castor + greengram(1:2) | 144 | 106.2 | 819 | 1612 | 127653 |
| T7  Castor + greengram (2:2) | 152 | 112.3 | 917 | 1843 | 152489 |
| T8  Castor + horsegram (1:2) | 143 | 105.9 | 782 | 1548 | 124134 |
| T9  Castor + horsegram (2:2) | 150 | 112.1 | 900 | 1827 | 152033 |
| **SE(d)** |  5.60 |  0.88 | 33.06 | 63.20 |  |
| **CD (P=0.05)** | 16.26 | 2.55 |   95.92 | 207.78 |  |

**Table 1. Effect of intercropping on growth, yield and economics**

**Table 2. Effect of intercropping on various competitive assessments**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatment** | **Castor Equivalent Yield (kg ha-1)** | **Land Equivalent Ratio** | **Relative Crowding Coefficient**  |
| T1  Castor sole crop | 819.74 | 1.28 | 8.61 |
| T2  Castor + cowpea (1:2) | 874.80 | 1.20 | 8.34 |
| T3  Castor + cowpea (2:2) | 696.79 | 1.00 | 4.70 |
| T4  Castor + chickpea (1:2) | 923.93 | 1.36 | 11.79 |
| T5  Castor + chickpea (2:2) | 880.68 | 1.20 | 14.24 |
| T6  Castor + greengram(1:2) | 1004.06 | 1.44 | 53.94 |
| T7  Castor + greengram (2:2) | 864.20 | 1.20 | 10.29 |
| T8  Castor + horsegram (1:2) | 1002.78 | 1.41 | 26.47 |
| T9  Castor + horsegram (2:2) | 819.74 | 1.28 | 8.61 |
| **SE(d)** | 874.80 |  |  |
| **CD (P=0.05)** | 696.79 |  |  |

**Fig 1. Effect of intercropping in plant height (cm), dry matter production (kg/ha), castor yield (kg/ha) and yield intercrops (kg/ha).**

**Fig 2. Effect of castor intercropping in intercropping assessment**

**CONCLUSION**

Based on the results, it could be concluded that, in comparison to other intercropping system, growing castor and greengram at 2:2 ratio increased productivity and net income per unit area, hence this intercropping system can be recommended to the farmers in rainfed conditions. As an alternative, a 2:2 castor + horsegram intercropping can be recommended. While it offers numerous advantages, there are constraints such as competition for light, water and nutrients that may impact the productivity of intercrops.

**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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