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EVALUATION OF CASTOR (*RICINUS COMMUNIS* L.) BASED INTERCROPPING SYSTEMS IN SOUTH GUJARAT: IMPACT ON GROWTH, YIELD, RESOURCE UTILIZATION AND ECONOMIC VIABILITY

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ABSTRACT

A field experiment was carried out at College farm, N.M.College of Agriculture, Navsari Agricultural University, Navsari during *Rabi* 2023-24 to study the performance of castor (*Ricinus Communis* L.) based intercropping system in south gujarat condition. The soil of experimental plot was clayey (*Vertisols*) with low in available N (240.42 kg/ha), medium in P_2O_5 (39.58 kg/ha) and high in K_2O (338.28 kg/ha). The soil reaction (pH) was slightly alkaline (7.68). The experiment was arranged in a randomized block design (RBD) with nine treatments, which included: T_1 (sole castor), T_2 (sole green gram), T_3 (sole indianbean), T_4 (sole sorghum), T_5 (sole sweet corn), T_6 (castor + greengram (1:2), T_7 (castor + indianbean (1:2)), T_8 (castor + sorghum (1:2) and T_9 (castor + sweet corn (1:2). Result revealed that indices to check system productivity *viz*., castor equivalent yield (3043.20 kg ha^{-1}), Land equivalent ratio (1.5) and economical paramaters *viz*., gross realization (187747 ` ha$^{-1}$), net realization (140707 ` ha^{-1}) recorded significantly higher under castor + greengram (1:2) (T_6) and the B:C ratio was also obtained higher with castor + greengram (1:2) (T_6) along with least competition ratio, which is closely followed by castor + sweet corn (1:2) (T_9). That showed (T_6) castor + greengram (1:2) intercropping system proved to be superior, demonstrating higher system productivity, enhanced economic returns and efficient resource utilization compared to other treatments under South Gujarat conditions.

Key words : CEY, Economics, Indices, LER, Resource utilization.

Introduction

Castor (*Ricinus communis* L.), a crucial non-edible oilseed crop in India, is mainly grown in arid and semi-arid regions. Native to Ethiopia and belonging to the Euphorbiaceae family, castor is valued for its oil content (45-50%) and industrial significance due to ricinoleic acid. The oil is used in products like soaps, inks, lubricants and cosmetics, while the seed cake serves as organic manure, and the stalks are utilized for fuel, thatching, and paper pulp. Castor's versatility makes it an essential crop in India's agricultural landscape (Chakrabarty *et al*., 2021).

India, being the largest producer and consumer of castor, especially in states like Gujarat, Rajasthan, Maharashtra and Madhya Pradesh, plays a significant role in global castor production. Despite its dominance, castor productivity in rainfed conditions is limited by factors such as erratic rainfall, poor soil quality, and low adoption of modern practices. Intercropping, particularly with pulses, sorghum, and sweet corn, offers a promising solution to improve productivity by optimizing space utilization, controlling pests and enhancing soil health (Willey *et al*., 2012; Charles *et al*., 2013).

Intercropping is a time-tested practice in dryland farming, especially in regions with unpredictable rainfall. By introducing compatible intercrops like legumes or fast-growing crops, farmers can improve resource utilization, reduce competition, and increase overall yield per unit area. This practice not only enhances soil fertility through nitrogen fixation but also provides additional income from intercrops and serves as a safeguard against total crop failure. However, selecting the right intercrops and optimizing planting patterns to minimize competition between the main and intercrop species remain key challenges (Chetty and Rao, 1979; Kuniya *et al*., 2018).

To fully evaluate the benefits of intercropping systems, it is essential to calculate various agronomic and economic indices, such as Crop Equivalent Yield (CEY), Land Equivalent Ratio (LER), Benefit-Cost Ratio (BCR) and Net Realization. These indices provide critical insights into the performance of intercropping systems by quantifying land use efficiency, economic returns and overall productivity. CEY converts the yield of intercrops into an equivalent yield of the main crop, enabling an accurate assessment of combined productivity. LER indicates the relative advantage of intercropping over sole cropping, while BCR and Net Realization are vital economic indicators that reflect the profitability and financial sustainability of the system. Incorporating these parameters ensures a comprehensive evaluation of intercropping practices, aiding in the identification of sustainable and economically viable systems.

In light of these considerations, the present research, titled "Performance of Castor (*Ricinus communis* L.) Based Intercropping System in South Gujarat Condition" aims to explore suitable intercrop combinations for castor and assess their overall system productivity. The investigation focuses on identifying the most effective intercropping systems that can boost castor productivity, enhance soil health, and maximize economic returns for farmers. By evaluating the performance of castor-based intercropping systems through agronomic and economic indices, the study will provide valuable insights for improving castor yield and promoting sustainable agricultural practices in Gujarat and similar agro-climatic regions (Anonymous, 2020, 2021).

Materials and Methods

A field experiment was carried out at College farm, N.M.College of Agriculture, Navsari Agricultural University, Navsari during *Rabi* 2023-24 to study the performance of castor (*Ricinus communis* L.) based intercropping system in south gujarat condition. The soil of experimental plot was clayey (*Vertisols*) with low in available N (240.42 kg/ha), medium in P_2O_5 (39.58 kg/ha) and high in K_2O (338.28 kg/ha). The soil reaction (pH) was slightly alkaline (7.68). The experiment was arranged in a randomized block design (RBD) with nine treatments, which included: T_1 (sole castor), T_2 (sole green gram), T_3 (sole indianbean), T_4 (sole sorghum), T_5 (sole sweet corn), T_6 (castor + greengram (1:2)), T_7 (castor + indianbean (1:2)), T_8 (castor + sorghum (1:2)) and T_9 (castor + sweet corn (1:2)). The field preparation included ploughing, harrowing and planking to achieve a fine tilth suitable for sowing. The sowing was carried out on 25^{th} August, 2023 with the recommended seed rates for each crop and fertilizers were applied based on the respective treatment requirements. Castor was planted at a spacing of 135 x 90 cm, while intercrops were spaced at 45 x 10 cm. Irrigation was managed according to the critical growth stages of the crops. Observations were recorded at different growth stages including plant population, plant height at 30 and 60 DAS, number of branches per plant, spike length, number of spikes per plant, capsules per spike and seed yield (kg/ha). The crops were harvested in January and February 2024 and yield attributes such as stalk yield, harvest index and oil content were measured. The productivity of intercropping systems was assessed using various indices and economic parameters to evaluate their efficiency and viability. Castor Equivalent Yield (CEY) was used to standardize the yield of intercrops into castor yield, enabling direct comparisons across treatments. Land Equivalent Ratio (LER) quantified the efficiency of land use in intercropping compared to sole cropping, with values greater than one indicating a yield advantage of intercropping systems. Competition Ratio (CR) measured the degree of competition between the component crops, where lower values indicated reduced interspecific competition and better compatibility. Economic analysis involved calculating the gross realization (¹ /ha) based on the seed and stalk yields at prevailing market prices, while the cost of cultivation included all input and management expenses. The net profit was determined by subtracting the total cost of cultivation from the gross realization, and the benefit-cost ratio (BCR) was calculated to assess economic efficiency, with higher values reflecting greater profitability. These indices and parameters together provided a holistic evaluation of the productivity, resource use efficiency, and economic performance of intercropping systems. Statistical analysis was conducted using the method as described by (Panse and Sukhatme, 1985) and the significance of differences was tested using the 'F' test. The data were analyzed using standard ANOVA techniques to assess the performance of different treatments focusing on growth and yield parameters to determine the most effective intercropping system for castor in the region.

Results and Discussion

Indices

Castor Equivalent Yield

Introducing greengram as an intercrop with castor significantly enhanced castor equivalent yield (CEY). The treatment castor + greengram (1:2) (T_6) recorded the highest CEY (3043 kg ha^{-1}), statistically on par with castor + indianbean (1:2) (T$_7$) at 2776 kg ha^{-1} and closely followed by castor + sweet corn (1:2) (T$_9$). The lowest CEY was observed in sole sorghum (T$_4$) at 1168 kg ha^{-1}. The superior CEY in T$_6$ was attributed to the higher seed yields of both castor and greengram, coupled with the premium market price of greengram. These findings align with the reports of Mohsin *et al*. (2018) in castor intercropped with groundnut and greengram and Gangadhar *et al*. (2023) in castor intercropped with greengram, pearl millet and sesame.

Table 1 : Castor equivalent ratio (CEY) and Land equivalent ratio (LER) as influenced by sole and intercropping systems.

Treatments	CEY (kg ha^{-1})	LER
T$_1$: Sole castor	2250	1.0
T$_2$: Sole green gram	1572	1.0
T$_3$: Sole indianbean	1214	1.0
T$_4$: Sole sorghum	1168	1.0
T$_5$: Sole sweet corn	1446	1.0
T$_6$: Castor + greengram (1:2)	3043	1.5
T$_7$: Castor + indianbean (1:2)	2776	1.4
T$_8$: Castor + sorghum (1:2)	2404	1.1
T$_8$: Castor + sweet corn (1:2)	2476	1.4
SEm ±	92.58	-
CD at 5%	270.2	-
CV (%)	7.98	-

Land Equivalent Ratio

The study revealed that all intercropping treatments resulted in a higher Land Equivalent Ratio (LER) compared to sole cropping systems. Among the intercropping treatments, the highest LER (1.5) was observed in castor + greengram (1:2) (T$_6$), followed by castor + sweet corn (1:2) (T$_9$) and castor + Indian bean (1:2) (T$_7$), both recording an LER of 1.4. The superior LER values in intercropping systems can be attributed to the efficient utilization of available resources, including light, nutrients, and moisture, as well as the complementary nature of crop growth habits. Castor, being a long-duration crop, coexists effectively with short-duration intercrops that have deep root systems, resulting in minimal competition for resources. This harmonious interaction promotes better land utilization compared to sole cropping systems.These findings align with the results of Gangadhar *et al*. (2023), who reported similar benefits of intercropping castor with greengram, pearl millet, and sesame.

Economics

The economic analysis of various castor-based intercropping systems revealed that the treatment castor + greengram (1:2) (T$_6$) achieved the highest net realization of ` 140,707 ha$^{-1}$, followed by castor + sweet corn (1:2) (T$_9$) at ` 131,414 ha^{-1}, castor + Indian bean (1:2) (T$_7$) at ` 125,313 ha$^{-1}$ and castor + sorghum (1:2) (T$_8$) at ` 110,446 ha^{-1}. These intercropping treatments significantly outperformed sole cropping systems, where net realizations ranged from ` 33,800 ha$^{-1}$ (T$_3$ sole greengram) to ` 99,428 ha^{-1} (T$_1$ sole castor). In terms of the benefit-cost (B:C) ratio, castor + greengram (1:2) (T$_6$) recorded the highest value of 3.9 followed by castor + sweet corn (1:2) (T$_9$) with a B:C ratio of 3.8. Among sole cropping systems, sole castor (T$_1$) achieved the maximum B:C ratio of 3.4. The superior net realization and B:C ratios in intercropping systems are attributed to the complementary effects between the component crops leading to higher biological yields and additional economic returns. This synergy results from efficient resource utilization and reduced competition allowing both crops to thrive.These findings align with the results of Gangadhar *et al*. (2023), who reported similar benefits in intercropping castor with greengram, pearl millet and sesame and Mohsin *et al*. (2018), who observed comparable outcomes in castor intercropped with groundnut and greengram.

Table 2 : Gross realization, Cost of cultivation, Net realization and B: C ratio as influenced by sole and intercropping systems.

Treatments	Gross realization (` ha^{-1})	Cost of Cultivation (` ha^{-1})	Net Realization (` ha^{-1})	B:C ratio
T$_1$: Sole castor	140143	40715	99428	3.4
T$_2$: Sole greengram	94480	38824	55656	2.5
T$_3$: Sole indianbean	74184	40384	33800	1.9
T$_4$: Sole sorghum	81739	38718	43021	2.2
T$_5$: Sole sweet corn	120336	44195	76141	2.7
T$_6$: Castor + greengram (1:2)	187747	47040	140707	3.9
T$_7$: Castor + indianbean (1:2)	172754	47441	125313	3.6
T$_8$: Castor + sorghum (1:2)	153672	43226	110446	3.5
T$_9$: Castor + sweet corn (1:2)	177683	46269	131414	3.8

Conclusion

Based on a one-year field experiment conducted to evaluate the performance of a castor (*Ricinus communis* L.)-based intercropping system in South Gujarat, it was concluded that sole castor (T_1) recorded the highest plant height, seed yield (2250 kg/ha) and stalk yield (4977 kg/ha). However, intercropping systems, particularly castor + greengram (T_6), demonstrated superior overall performance in terms of economic and land-use efficiency. Treatment T_6 achieved the highest Castor Equivalent Yield (CEY) of 3043 kg/ha, Land Equivalent Ratio (LER) of 1.5, Net Realization of ` 140707/ha, and a Benefit-Cost Ratio (BCR) of 3.9. Other intercropping treatments, such as castor + sweet corn (T_9) and castor + indianbean (T_7), also exhibited significantly higher economic returns and resource-use efficiency compared to sole treatments. These results suggest that while sole cropping ensures higher yields for specific parameters, intercropping maximizes land-use efficiency, mitigates risks, and improves overall profitability due to the complementary effects of component crops. This aligns with findings from Gangadhar *et al*. (2023) and Mohsin *et al*. (2018), which emphasize the potential of intercropping in enhancing system productivity without significantly compromising castor's harvest index or oil content. Thus, castor-based intercropping systems, particularly with greengram or sweet corn represent a sustainable and economically viable strategy for rainfed conditions in South Gujarat offering both ecological and financial advantages for farmers.

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