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M Mallikarjun
Krishi Vigyan Kendra, Kalyandurg, ANGRAU, Andhra Pradesh, India

K Balaji Naik
Krishi Vigyan Kendra, Kalyandurg, ANGRAU, Andhra Pradesh, India

E Sireesha
Krishi Vigyan Kendra, Kalyandurg, ANGRAU, Andhra Pradesh, India

V Yugandhar
Krishi Vigyan Kendra, Kalyandurg, ANGRAU, Andhra Pradesh, India

M Harani
Krishi Vigyan Kendra, Kalyandurg, ANGRAU, Andhra Pradesh, India

E Chandrayudu
Krishi Vigyan Kendra, Kalyandurg, ANGRAU, Andhra Pradesh, India

Corresponding Author:
M Mallikarjun
Krishi Vigyan Kendra, Kalyandurg, ANGRAU, Andhra Pradesh, India

Effect of in-situ moisture conservation practices on growth and yield of castor

M Mallikarjun, K Balaji Naik, E Sireesha, V Yugandhar, M Harani and E Chandrayudu

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Abstract
Soil moisture stress is a limiting factor in crop productivity, particularly in arid and semi-arid environments as it impacts several physiological and biochemical processes in plants. Moisture stress is a reoccurring chronic problem in Ananthapur, where a large section of the land is in the arid and semi-arid tropics. Moisture stress of varying intensities can affect two-thirds of India's agricultural land and the likelihood of it happening is more than 35%. Rainfed crops' productivity was greatly impacted by intra-seasonal dry spells brought on by irregular rainfall distribution. To increase the soil moisture availability to the agricultural crops and to increase the infiltration and percolation of rain water into the root profile, the in-situ moisture conservation techniques are recommended. Taking this into account, a Front Line Demonstrations (FLDs) were conducted for two years from 2023-24 to 2024-25 at KVK operated mandals of Kalyandurg area of Ananthapur district in 2.0 ha area to assess the impact of in-situ soil moisture conservation practices on growth, yield attributes, yield and economics of castor on rainfed alfisols. The study revealed that demonstrated practice of Chiseling followed by *in-situ* moisture conservation furrow recorded higher spikes/plant, more capsules/spike, bean yield, gross return, net return and B:C ratio than farmers practice. The demonstration of soil moisture conservation practices resulted in 17.6% higher in 2023-24 and 15.5% higher in 2024-25 over farmer's practice. The enhanced yield in demonstrated soil moisture conservation practices can be attributed due to more spikes per plant and more capsules per spike. soil moisture conservation approaches also provided a greater economic advantage, and their adoption resulted in a better benefit-cost ratio (1.43) than farmers practice (1.39). From the findings It can be concluded that, under current circumstances, adopting Chiseling followed by *in-situ* moisture conservation furrow practices in castor cultivation could result in a higher economic benefit than farmers' practices, encouraging more farmers to adopt soil moisture conservation practices not only in castor but also in other major rainfed crops like Redgram, groundnut and pulses.

Keywords: In-situ, soil moisture conservation, front line demonstrations, rainfed

Introduction
Two thirds of cultivated area in India is under rainfed farming which is often influenced by aberrant weather conditions, by which the poor rainfed farmer suffers with low productivity and low net returns. The main aim of extension in dryland areas is to increase net returns of the dryland farmer by improving the economic returns and by reducing the cost of production with minimum risk of crop failures, besides sustaining natural resources (Reddy *et al* 2022) [7]. Castor (*Ricinus communis* L.) is most important non-edible oilseed crop of India because of very diversified uses of its oil and high export demand. The crop is more tolerant to water deficit, is frequently grown in marginal and sub marginal shallow soils under rainfed conditions with low inputs. Crop is often subjected to moisture stress at critical stages, resulting in yield reduction. In India, castor is grown under two contrasting environments *viz.*, irrigated intensive cultivation with high productivity in Gujarat and Rajasthan; and rainfed cultivation coupled with poor management and very low productivity in Andhra Pradesh, Karnataka, Tamil Nadu, Orissa, etc., which require location specific technologies (Naidu *et al* 2015) [4]. In 2020-21, World major producing countries are India (16.47 lakh tonnes), Mozambique (0.72 lakh tonnes), Brazil (0.35 lakh tonnes), China (0.21 lakh tonnes), Thailand (0.12 lakh tonnes) and Myanmar (0.12 lakh tonnes) (PJTSAU Crop Outlook 2024) [5]. India being the global leader in castor production,

produces 12.2 lakh tonnes from 7.62 lakh hectares, with an average yield of 1.6 tonnes per hectare (ICAR-IIOR 2020) [3]. Though the state of Andhra Pradesh stands second in area (1.86 l ha) and third in production (1.20 l t), the productivity levels of castor are very low (645 kg/ha) as compared to Gujarat (1,978 kg/ha), Haryana (1,600 kg/ha) and Rajasthan (1,417 kg/ha). The major reasons being growing castor under rainfed conditions in marginal and sub-marginal soils with low input management, occurrence of prolonged dry spell during mid/ terminal stages at flowering/capsule development stage during *kharif* season. Further, neither effective drought proofing mechanisms are available. Consequently, the realized productivity is only 25 to 30% of actual potential yield. Thus, castor cultivation during *kharif* season has become non-remunerative (Ramanjaneyulu *et al* 2016) [7]. However, in the recent past farmers are diversifying to castor crop from other rainfed crops *viz*., groundnut, pigeonpea and millets due to high remunerative prices to castor in the market for the last 3 years. Rainwater conservation is a critical factor in stabilizing and stepping up of crop yields in drylands. To increase the soil moisture availability to the agricultural crops and to increase the infiltration and percolation of rain water into the root profile, the in-situ moisture conservation techniques are recommended. As moisture is the key limiting factor in the rainfed farming and rainfall is the only source of water for this vast stretch of lands. It is necessary to harvest maximum rain water and to adopt methods to maximize the retention of the available moisture. Hence in rainfed areas, the in-situ rainwater harvesting through Deep ploughing and making conservation furrows assumes greater priority. Considering the above facts, attempt was made to study the effect of chisel ploughing and conservation furrows on the growth, yield and economics of castor under rainfed conditions.

Materials and Methods

Front Line Demonstrations (FLDs) were conducted for two years from 2023-24 to 2024-25 at KVK operated mandals of Kalyandurg area of Ananthapur district in 2.0 ha area to assess the impact of in-situ soil moisture conservation practices on growth, yield attributes, yield and economics of castor in rainfed alfisols. A high yielding castor hybrid ICH 66 was used for the demonstrations. Average rainfall during the crop growing period was 287.4mm and 584.8 mm during the year 2023-24 and 2024-25 respectively. The demonstration practice comprised of *in-situ* soil moisture conservation practices *viz*., Chisel ploughing and conservation furrow. Deep ploughing (40-55 cm) was done with Chisel plough which is used for breaking hard pans with less disturbance to the top layers. Its body is thin with replaceable cutting edge so as to have minimum disturbance to the top layers. It contains a replaceable share to shatter the lower layers. Conservation furrows are made with bullock drawn country plough near the row zone of castor leaving 20 cm apart on one side of the row. In case of farmers practice no such *in-situ* moisture conservation practices were followed. Sowing of castor was taken up in the month of June during both the years. Line sowing was done with a seed rate of 5 kg ha^{-1}. All other agronomic practices like fertilizer application and weed management was done uniformly in both demonstration and farmer's practice. Five randomly selected plants from all the farmers field were used for biometrical observations and yield data were recorded at the time of harvest in 5X5 m^2 plot.

Studies on the economics of castor production were conducted by keeping a record of operations performed, labour employed, power and inputs used. The authors calculated the costs of various cultural operations using fixed and variable costs. The costs of common cultural operations for all treatments, such as seeds, field preparation, fertilizer input costs, plant protection measures and irrigation are fixed, while those that vary with treatments, such as chisel ploughing and conservation furrow are variable. The cost of inputs on account of different treatments was added to the common cost of cultivation of castor crop to arrive at the total cost of cultivation. The gross return was computed using the selling price by farmers. Net return was estimated by subtracting total cultivation costs from gross return. The B:C ratio was thus, calculated by dividing gross return with total cost of cultivation.

Results and Discussion

Yield attributes and Yield

Two years pooled analysis data in Table 1 reveals that chiseling and *in-situ* moisture conservation furrow was responsible for significantly increase in various growth and yield characters of castor. Chiseling followed by *in-situ* moisture conservation furrow produced higher primary spike length, more number of spikes per plant, more capsules in primary spike and yield/ha. Demonstrated practice of chiseling and *in-situ* moisture conservation furrow had higher spike length (41.9 cm) and more number of spikes/plant (4.71 spikes/plant) over the framers practice (Table 1). The average number of capsules/spikes is one of the important yield contributing parameters of castor which ultimately determines the total yield of the crop. As per the pooled data, demonstrated practices recorded (58 capsules/spike) 9.4% more capsules/spike than farmers practice (53 capsules/spike). The castor bean yield recorded under demonstrated practice was 634 kg/ha in 2023-24, 986 kg/ha in 2024-25 and 810 kg/ha when pooled over the years. This was about 17.6% higher in 2023-24 and 15.5% higher in 2024-25 over farmer's practice. The increase in yield is attributable to more spikes per plant and more capsules per spike. From the pooled data demonstrated practice of Chiseling followed by *in-situ* moisture conservation furrow produced 16.52% additional yield as compared to farmers practice of conventional tillage (Table 1). The results clearly showed the need of Chiseling and in-*situ* moisture conservation practice for higher yield attributing characters that ultimately helped in increasing the castor productivity. The results were in good agreement with those of Prihar *et al* (2000) [6], Biradar *et al.* (2020) [2] and Vivek *et al* (2023) [10].

Economics

Economic indicators like cost of cultivation, gross returns, net returns and Benefit: Cost (B:C) ratio of demonstrated moisture conservation practices are presented in Table 2. The cost of cultivation was higher in demonstrated practice when compared with the farmer practice in both years. From the Table (2), Farmers adopting Chiseling and in-*situ* moisture conservation practice (Rs. 32,185/-) recorded 13.7% additional cost than farmers practice over the pooled data (Rs.28,295/-). Year-to-year variability in cultivation costs can be explained by differences in the local social and economic conditions. The higher cost of production in demonstrated practice was due to deep ploughing and making of conservation furrows. The study demonstrated that demonstrated practices registered higher gross returns during the second year as compared to first year. This might be attributed to high yield during second year of study. The average gross returns from the pooled data recorded was Rs. 46,029/ha as compared to Rs. 39,469 in farmer's practice. Thus, demonstrated practice registered an increase of 16.6% gross returns over farmer's practice. The pooled data on net returns also showed the superiority of demo practices over farmer's practice. It was also noticed that net returns recorded under Chiseling followed by *in-situ* moisture conservation furrow (Rs.13,844/-) was 23.8% higher than farmers practice (Rs.11,174/-). The cumulative effect of technological interventions over two years, revealed an average benefit cost ratio of 1.43 in demonstration plots compared to 1.39 in control plots. Similar outcomes of increased economic benefit by adopting in-situ moisture conservation practices were also reported by Arora *et al* (2006) [1] and Shekhawat *et al.* (2015) [9].

Table 1: Yield attributes of castor as influenced by soil moisture conservation practices.

Parameters	2023-24		2024-25		Mean	
	I.P	F.P	I.P	F.P	I.P	F.P
Primary Spike length (cm)	38.6	37.8	45.2	44	41.9	40.9
Spikes per plant (No)	3.82	3.65	5.6	5.15	4.71	4.4
Maturity period for the first picking (days)	92	90	86	82	89	86
Capsules in primary spike (No)	54	50	62	56	58	53
Bean Yield (kg/ha)	634	539	986	853	810	696
% Yield Increase	17.6		15.5		16.5	
C.D (P=0.05) for bean yield	32.64		46.22		38.95	

IP-Improved Practice, FP-Farmers Practice

Table 2: Economics of castor production as influenced by soil moisture conservation practices.

Economic Parameters	2023-24		2024-25		Mean	
	I.P	F.P	I.P	F.P	I.P	F.P
Cost of cultivation (Rs/ha)	31570	27570	32800	29020	32185	28295
Gross Returns (Rs/ha)	34870	29464	57188	49474	46029	39469
Net Returns (Rs/ha)	3300	2075	24388	20454	13844	11174
B:C Ratio	1.11	1.08	1.74	1.7	1.43	1.39

IP-Improved Practice, FP-Farmers Practice

Conclusion

Real time contingency crop planning for aberrant rainfall plays a crucial role in dryland agriculture for sustaining the productivity and livelihood security of farmers. Inclusion of chiseling operation before conventional or rotary tillage along with *in-situ* moisture conservation furrow in castor enhanced the productivity, rain water use efficiency and economic benefits to the dryland farmers in *Alfisols* of scarce rainfall area of Ananthapur district in Andhra Pradesh.

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