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# GROWTH DYNAMICS OF INTERCROPPING SYSTEM IN CASTOR (*RICINUS COMMUNIS* L.) UNDER IRRIGATED ECOSYSTEM

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ABSTRACT

A field experiment was conducted to select suitable method of planting and intercropping with castor. Paired row planting of castor (60 / 120 cm x 60 cm) significantly improved the growth parameters (plant height, DMA, CGR, NAR, LAI), yield attribute (branches plant$^{-1}$, length of primary spike, capsule plant$^{-1}$, seed weight plant$^{-1}$, 100 seed weight) and the yields (seed, stalk and biological). Significantly higher values of growth parameters (plant height at harvest, DMA at 70, 120 and 180 DAS, CGR between 40-70 DAS and 70-120 DAS, LAI and yield attributes were recorded under paired planting of castor with greengram followed by castor+blackgram and castor+clusterbean. Maximum total seed yield and also stalk and biological yields of castor were recorded under castor+greengram intercropping system which was significantly higher over castor+ sesame intercropping system. Significantly higher castor equivalent yield (49.55 q ha$^{-1}$) was realised under castor+greengram intercropping system over castor+ clusterbean and castor+sesame but found at par with castor+blackgram.

**Key words :** Planting method, intercropping, growth dynamics, DMA, LAI, CGR, NAR.

Castor (*Ricinus communis* L.) is an important non edible oil seed crop of India being cultivated in 6.15 lacs hectares with a production of 5.90 lacs tones (FAO, 2003). In Rajasthan castor occupies 0.26 lacs hectare areas with the production of 0.22 lac tonnes. Among the different production factors, important of planting methods is considered as a major factor on determining growth and yield of castor (Gauda Reddy *et al.*,1975)

Being a widely spaced crop long duration and initial slow growth in nature, castor offers good scope for intercropping. Advantage of intercropping in castor can be increased by reorienting crop geometry for better availability of solar energy (Willey, 1979) and putting suitable intercrops. Legume crops may be better choice owing to beneficial effect of fixing atmospheric nitrogen and thereby some extra nitrogen was perhaps made available to the castor to utilize more efficiently beyond 90 DAS to harvest of castor. Additional advantage of nitrogen might have resulted in overall development of the crop in terms of plant height, DMA, branches and leaves per plant. Ramanathachetty (1983) already stated that legume fix atmospheric N and buildup about 20 to 50 kg N ha$^{-1}$ soil N which can be utilized by companion crop of long duration nature. Looking to good proposal of castor in irrigated ecosystem of Southern Rajasthan this was conducted to realize higher net return.

## MATERIALS AND METHODS

A field experiment was conducted during rainy seasons of 2001-2002 and 2002-2002 at the Agronomy Farm, Rajasthan College of Agriculture, Udaipur. The soil was clay loam having bulk density 1.40 mg m$^{-3}$ with pH 8.0. The soil was medium in organic carbon (0.73%), available nitrogen (279.30 kg ha-1) and phosphorus (22.4 kg ha$^{-1}$) and high in available K (328.4 kg ha$^{-1}$). The experiment was laid out in randomized block design with four methods of castor planting i.e., uniform row planting at 90 cm x 60 cm, 120 cm x 45 cm and paired row planting at 60 / 120 cm x 60 cm and 80 / 160 cm x 45 cm and five intercropping systems i.e. sole castor, with greengram, blackgram, clusterbean and sesame. There were four additional treatments of sole crop greengram, blackgram, clusterbean and sesame with three replications. Castor var. GCH 4, greengram var. K-851, blackgram var. T-9, clusterbean var. RGC-936 and seasame var. RT-46 were sown on 18 and 19 July in 2001 and 2002, respectively. The recommended seed drate of casto (12 kg $ha^{-1}$), greengram and blackgram (15 kg $ha^{-1}$), clusterbean (20 kg $ha^{-1}$) and seasame (3 kg $ha^{-1}$) were used.

Recommended doses of fertilizer 80 kg N $ha^{-1}$ and 50 kg $P_2O_5$ $ha^{-1}$ were applied to the castor. Castor was weeded manually twice 20 and 40 DAS. During the crop season there was 362.7 mm rainfall in 2001-2002 and 2002-2003, respectively. In all these were 5 pickings 120, 150, 180, 210 and 240 days after sowing, respectively.

Different growth parameters i.e. DMA, CGR, NAR, LAI and the yields were recorded for treatment evaluation.

## RESULTS AND DISCUSSION

### *Growth parameters*

*Effect of planting methods*

Paired row planting of castor (60/120 cm x 60 cm) recorded significantly higher plant height, dry matter accumulation at successive growth stage (70, 120 and 180 DAS), CGR between 40-70 DAS and 70-120 DAS, NAR between 40-70 DAS over uniform row planting (90 cm x 60 cm, 120 cm x 45 cm) and paired row planting at 80/160 cm x 45 cm. LAI at all growth stage except 40 DAS were significantly higher over uniform row planting at 120 cm x 45 cm, however found at par with uniform row planting (90 cm x 60 cm). Paired row planting of castor could intercept more solar radiation and utilize it efficiently which is reflected by improvement in CGR and NAR and ultimately plant height and DMA at successive growth stage (Table 1 and Fig. 1). This finding is in line with that of Kantesh *et al.* (1997) in respect of plant height, DMA, LAI and CGR of sugarcane under paired row planting of 60/120 cm.

*Effect of intercropping*

Maximum plant height of castor (206.70 cm) was recorded in castor + greengram intercropping system which was significantly higher over no intercropping (11.0%) and castor + sesame (12.7%) per plant. Dry matter accumulation was observed higher 70 and 180 DAS under castor + greengram which was statistically superior over castor+ sesame. However, at 120 DAS growth stage castor + greengram intercropping exhibited significantly higher dry matter accumulation by 6.5 and 21.8 per cent over no intercropping and castor + sesame respectively. CGR was suppressed in castor + sesame intercropping system between 40-70 DAS and 70-120 DAS as compared to other intercropping system. Further NAR was not found to very significantly due to intercropping system. LAI of castor at 70, 120 and 180 DAS was significantly higher with sole castor and castor + legumes over castor + sesame (Table 1). This can be attributed to the that legume intercrops having comparatively short span of life were harvested 60-80 DAS and there was no competition for nutrients, moisture and solar radiation 60 DAS. The castor growth under competition free environment result to higher number of branches $plant^{-1}$ and consequently LAI. These result of LAI of pigeon pea + blackgram intercrop system are close conformity to those reported by Subramanian and Venkateswarlu (1989).

### *Yield attributes and yield*

*Effect of planting methods on castor*

Paired row planting of castor (60/120 cm x 60 cm) increased yield attributes i.e. branches $plant^{-1}$, length of primary spike, number of capsule $plant^{-1}$, seed weight $plant^{-1}$ and 100-seed weight significantly (Table 2). These increases in yield attributes could be ascribed to significant increases in growth parameters of the crop under paired planting of castor (60/120 cm). This system allows more interception of solar radiation by the crop canopy on account of higher inter paired row space. This might have enabled the crop to maintain higher net photosynthetic rate and resulted in greater dry matter production per unit area.

Paired row planting of castor (60/120 cm x 60 cm) registered maximum seed, stalk and biological yield (Fig. 2). It appears that higher value of NAR, CGR, LAI, DMA under this planting pattern reflected in enhanced vigour and

**Table 1. Effect of planting methods and intercropping on growth dynamics of castor (pooled data of two years)**

| Treatments | Plant height (cm) | Dry matter accumulation (g plant$^{-1}$) | | | | Leaf area index | | | | CGR (gm$^{-2}$ day$^{-1}$) | | NAR (gm$^{-2}$ day$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 40 DAS | 70 DAS | 120 DAS | 180 DAS | 40 DAS | 70 DAS | 120 DAS | 180 DAS | between 40-70 DAS | between 70-120 DAS | between 40-70 DAS |
| Methods of castor planting | | | | | | | | | | | | |
| 90 X 60 | 191.1 | 23.2 | 73.5 | 191.5 | 381.0 | 0.238 | 0.494 | 1.218 | 1.821 | 3.10 | 4.37 | 8.97 |
| 120 X 45 | 187.2 | 22.5 | 68.6 | 173.8 | 341.3 | 0.236 | 0.467 | 1.137 | 1.705 | 2.85 | 3.90 | 8.56 |
| 60 / 120 X 60 | 205.5 | 24.9 | 81.8 | 208.9 | 408.7 | 0.242 | 0.509 | 1.226 | 1.854 | 3.52 | 4.71 | 9.91 |
| 80 / 160 X 45 | 202.0 | 23.8 | 76.5 | 193.3 | 386.4 | 0.240 | 0.503 | 1.221 | 1.840 | 3.25 | 4.33 | 9.29 |
| C.D. (P=0.05) | 8.52 | NS | 4.34 | 9.14 | 18.28 | NS | 0.0180 | 0.0370 | 0.0500 | 0.234 | 0.332 | 0.756 |
| Intercropping | | | | | | | | | | | | |
| None | 186.3 | 23.4 | 75.9 | 192.6 | 384.30 | 0.238 | 0.504 | 1.214 | 1.812 | 3.24 | 4.32 | 9.28 |
| Greengram | 206.7 | 25.1 | 79.2 | 205.2 | 398.99 | 0.242 | 0.510 | 1.233 | 1.845 | 3.34 | 4.66 | 9.44 |
| Blackgram | 203.8 | 24.0 | 78.2 | 198.5 | 392.70 | 0.241 | 0.500 | 1.216 | 1.832 | 3.34 | 4.46 | 9.56 |
| Clusterbean | 202.1 | 23.7 | 76.6 | 194.8 | 387.99 | 0.239 | 0.492 | 1.217 | 1.826 | 3.27 | 4.37 | 9.42 |
| Sesame | 183.4 | 21.8 | 65.6 | 168.4 | 332.74 | 0.235 | 0.460 | 1.123 | 1.710 | 2.71 | 3.81 | 8.21 |
| C.D. (P=0.05) | 9.53 | NS | 4.85 | 10.22 | 20.43 | NS | 0.0210 | 0.0410 | 0.0560 | 0.262 | 0.372 | NS |

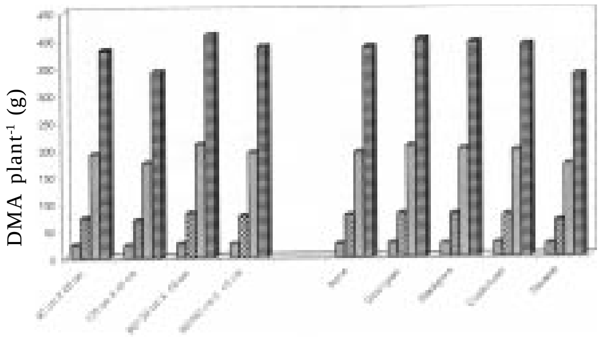


Fig. 1. Effect of planting methods and intercropping on dry matter accumulation by castor (Pooled)

Methods of castor planting Intercropping

Fig. 2. Effect of planting methods and intercropping on seed, stalk and biological yield of castor (Pooled)

Castor equivalent yield (q ha$^{-1}$)

Methods of castor planting Intercropping

Fig. 3. Effect of planting methods and intercropping on castor equivalent yield (q ha$^{-1}$) (Pooled)

yield attributes which might have contributed in significantly higher seed stalk and biological yield of the crop. Singh (2004) observed remarkable improvement in yield of soybean in paired row system over alternate row system an account of enhanced vigour and plant growth because of greater LAI which eventually led to eventually led to enhanced dry matter accumulation. Further study seed yield of castor showed positive correlation with growth and yield attributing characters.

The correlation between seed yield and DMA 70, 120 and 180 DAS, CGR between 70-120 DAS, number of branches plant-1, length of primary spike, no. of capsule plant$^{-1}$, seed weight plant$^{-1}$, and 100 seed weight with correlation coefficient of 0.819, 0.820, 0.788, 0.751, 0.798, 0.743, 0.886, 0.876 and 0.807, respectively were recorded. Similar increased the seed yield by 0.322, 0.138, 0.070, 5.978, 4.058, 0.861, 0.11, 0.073 and 0.917 qha$^{-1}$, respectively (Table 3).

*Effect of intercropping on castor*

Branches plant$^{-1}$, length of primary spike, and seed weight plant$^{-1}$ increased significantly under castor + greengram, castor+ blackgram and castor + clusterbean over no intercrop and castor + sesame. Further, castor+ sesame intercropping system reduced capsule plant$^{-1}$ and 100-seed weight significantly as compared to rest of the intercropping system. The castor + greengram system gave the maximum seed yield, stalk and biological yields which were recorded significantly higher over castor + sesame intercropping system. Enhanced yield attribute which contributed favorably to photosynthetic efficiency might be on account of higher nitrogen status of soil because of additional advantage of nitrogen fixation by legume root nodules. These results are in agreement with those of Sharma (2002) who has reported increased number of capsule spike$^{-1}$ in paired row, castor intercropped with greengram over sole castor.

*Castor equivalent seed yield*

Maximum castor equivalent seed yield under row planting (60/120 x 60 cm) could be ascribed to additive effects of seed yield of castor and intercrops (Table 2). The results are in

**Table 2. Effect of planting methods and intercropping on yield attributes and yield of castor (pooled data of two years)**

| Treatments | Branches plant$^{-1}$ | Length of primary spike (cm) | Capsule plant$^{-1}$ | Seed weight plant$^{-1}$ | 100 Seed weight plant$^{-1}$ | Yield (q ha$^{-1}$) | | | Castor seed equivalent yield (q ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Seed | Stalk | Biological | |
| Methods of castor planting | | | | | | | | | |
| 90 X 60 | 7.70 | 36.98 | 267.77 | 251.35 | 30.31 | 41.56 | 86.40 | 127.96 | 46.23 |
| 120 X 45 | 7.08 | 34.53 | 242.31 | 216.30 | 27.96 | 37.83 | 80.30 | 118.14 | 42.20 |
| 60 / 120 X 60 | 8.18 | 39.80 | 289.89 | 270.48 | 32.18 | 41.84 | 88.29 | 131.14 | 47.50 |
| 80 / 160 X 45 | 7.88 | 39.16 | 276.25 | 254.78 | 31.05 | 41.37 | 88.09 | 129.46 | 46.12 |
| C.D. (P=0.05) | 0.36 | 1.45 | 9.94 | 16.03 | 1.38 | 1.33 | 4.13 | 5.08 | 1.45 |
| Intercropping | | | | | | | | | |
| None | 7.62 | 37.33 | 270.57 | 248.63 | 30.34 | 40.89 | 86.33 | 127.22 | 40.89 |
| Greengram | 8.09 | 39.33 | 278.80 | 270.95 | 31.66 | 42.45 | 88.56 | 131.01 | 49.55 |
| Blackgram | 7.97 | 38.55 | 273.89 | 261.50 | 31.34 | 41.62 | 87.98 | 129.60 | 48.36 |
| Clusterbean | 7.95 | 38.21 | 272.93 | 257.93 | 257.55 | 30.86 | 41.21 | 87.12 | 128.33 |
| Sesame | 6.90 | 34.67 | 241.56 | 202.51 | 27.69 | 37.10 | 78.86 | 115.96 | 40.94 |
| C.D. (P=0.05) | 0.40 | 1.62 | 11.11 | 17.92 | 1.54 | 1.48 | 4.62 | 5.68 | 1.62 |

**Table 3. Effect of planting methods and intercropping on yield attributes and yield of castor (pooled data of two years)**

| S. No | Dependent variable | Independent variable | Correlation coefficient | Regression equation |
|---|---|---|---|---|
| 1. | Seed yield (q $ha^{-1}$) | DMA (g $plant^{-1}$) 70 DAS | 0.819** | Y=16.473 + 0.322 X |
| 2. | Seed yield (q $ha^{-1}$) | DMA (g $plant^{-1}$) 120 DAS | 0.820** | Y=14.048 + 0.138 X |
| 3. | Seed yield (q $ha^{-1}$) | DMA (g $plant^{-1}$) 180 DAS | 0.788** | Y=13.960 + 0.070 X |
| 4. | Seed yield (q $ha^{-1}$) | CGR (g $m^{-2}$ $day^{-1}$) between 70-120 DAS | 0.751** | Y=16.873 + 5.978 X |
| 5. | Seed yield (q $ha^{-1}$) | No. of branches $plant^{-1}$ | 0.798** | Y=9.377 + 4.058 X |
| 6. | Seed yield (q $ha^{-1}$) | Length of primary spike (cm) | 0.743** | Y=8.253 + 0.861 X |
| 7. | Seed yield (q $ha^{-1}$) | No. of capsule $palnt^{-1}$ | 0.886** | Y=10.284 + 0.113 X |
| 8. | Seed yield (q $ha^{-1}$) | Seed weight $plant^{-1}$ | 0.876** | Y=22.555 + 0.073 X |
| 9. | Seed yield (q $ha^{-1}$) | 100-seed weight (g) | 0.807** | Y=12.793 + 0.917 X |

** Significant at 1 per cent level of probability

agreement with the findings of Sharma (2002). Higher castor equivalent seed yield under castor + legume intercropping system over sole castor and castor + seasame (Table 2 and Fig. 3). These results area in conformity with the findings of Gupta and Rathore (1993).

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