Evaluation of Different Chick Pea Based Cropping Sequences in Rainfed Vertisols of Nandyal District of Andhra Pradesh

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Rainfed cropping is practiced on 1.13 billion hectares globally (Biradar et al., 2009) and meets about 60% of the food and nutritional needs of the world's population. In India, rainfed cropping is practiced on 72 million hectares, primarily in arid, semi-arid, and sub-humid climatic zones, accounting for about 51% of the net cultivated area. Low and erratic rainfall, degraded soils, and poor infrastructure are among the key constraints in India's rainfed areas. Therefore, intensive cropping of Vertisols requires careful management of soil temperature and moisture regimes (Srinivasarao et al., 2012). Residual soil moisture plays an important role in Rabi crops. Kar and Kumar (2009) reported that after the rainy season (Kharif), in areas where irrigation water is unavailable, residual moisture becomes critical for the second crop(Rabi)

Chickpea (*Cicer arietinum* L.) is the major Rabi pulse crop grown in the rainfed black soil tracts of India. Globally, India ranks first in chickpea production and consumption, accounting for nearly 75% of the world's cultivated area. Gram occupies about 37% of the total pulses area and contributes approximately 50% of total pulse production. Six statesi.e.,Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka, and Andhra Pradeshtogether account for 91% of chickpea production and 90% of the area under cultivation

In the Rayalaseema region, particularly in the districts of Prakasam, Kurnool, and Y.S.R., chickpea has emerged as a remunerative cash crop, covering an area of 3.97 lakh hectares by replacing traditional crops like cotton, sorghum, bajra, sugarcane, groundnut, and tobacco. Chickpea is grown as a Rabi crop, relying on residual soil moisture and cool temperatures under rainfed black soil farming conditions. However, due to frequent dry spells during critical crop growth stages, as well as dry root rot and gram pod borer infestations, chickpea yields have beenunsatisfactory for the past three years.

In contrast, when chickpea is grown as the sole Rabi crop after keeping the land fallow during the Kharif season, it often faces weed infestations due to the unavailability of sufficient moisture, nutrients, and space. To enhance cropping intensity and net returns under rainfed black soil farming conditions in the Rayalaseema region, Krishi Vigyan Kendra, Yagantipalli, conducted on-farm trials with three crop sequences—*Setaria*-chickpea, soybean-chickpea, and blackgram-chickpea. Setaria, Soybean and black gram were cultivated as preceding crops in Kharif followed by Rabi Bengal gram over three consecutive years (2018, 2019, and 2020).

Materials and Methods

Field experiments were conducted with different intercropping systems i.e.setaria-chickpea soybean-chickpea and Blackgram-chickpea during 2018-19 , 2019-20 and 2020-21 along with fallow – chickpea sequence in 60 KVK operational villages namely Koilakuntla, H.kottala, Satanakota villages of Nandyal district under rainfed black soil farming situation. Equivalent crop yield of chickpea was taken for considering the total yield of the system by following the formula below.

$$\text{Equivalent yield of crop} = \text{Yield of Crop 1 (kg)} + \frac{\text{Yield of Crop 2 (kg)} \times \text{Price of Crop 2 kg-1 (Rs.)}}{\text{Price of Crop 1 kg-1 (Rs.)}}$$

The mean seasonal rainfall distribution was 407 mm during the southwest monsoon (June-September), 151 mm during the northeast monsoon (October-December), 15 mm during winter (January-February), and 70 mm during summer (March-May). The percentage distribution of rainfall across seasons was 64.29% during the southwest monsoon, 23.85% during the northeast monsoon, 2.36% in winter, and 11.05% in summer. The annual rainfall received in 2018, 2019, and 2020 was 540.8 mm, 969.6 mm, and 584.4 mm, respectively, with deviations of -14.5%, +53.17%, and -7.67% compared to the average annual rainfall of 633 mm [Fig-1].

Climatic constraints in the villages were assessed based on long-term data, evaluation of natural resources, and identification of major farming situations, crop production constraints, climatic vulnerabilities, yield gaps, and opportunities for climate change adaptation. Based on this comprehensive analysis, field experiments were designed with appropriate cropping sequences to address climate vulnerabilities such as drought, in a participatory mode with the involvement of farmers.

The yields from different cropping sequences and the fallow-chickpea system were recorded. Economic analysis of input-output relationships and chickpea equivalent yields were recorded to quantify the benefits of the three cropping sequences over the last three years.

Table 1. Mean Grain yield (kg ha^{-1}), Bengalgram Equivalent Yield (kg/ha and Economics of Benagalgram based cropping sequences

Treatments	Yield (kg/ha)*		Chickpea Equivalent Yield(kg/ha)	Net Returns (Rs/ha)	BC ratio
	Preceding crop	Bengalgram			
Foxtail millet-Bengalgram	1827	1755	2635	74037	2.12
Fallow- Bengal gram		2050	2050	58150	2.0
Black gram- Bengal gram	1040	1786	3355	94356	2.39
Fallow- Bengal gram		2050	2050	58150	2.0
Soybean- Bengal gram	1682	1845	3431	102198	2.28
Fallow- Bengal gram		2050	2050	58150	2.0

Results

Three cropping sequences with Fox tail millet-chickpea, soybean-chickpea and blackgram-chickpea during 2018-19, 2019-20 and 2020-21 along with fallow – chickpea were taken up under rain fed condition. Yield and economics of different crops as well as chickpea equivalent, net return and B:C ratio are presented in Table1. The data of three years showed that during kharif Setaria(SIA-3088) recorded highest yield (1827kg/ha) followed by Soybean (1682 kg/ha) and black gram (1040 kg/ha). Among the chickpea based cropping sequences, in rabi season the highest seed yield of chickpea was recorded in soybean-chickpea sequence (1845kg/ha) followed by blackgram-chickpea (kabuli) (1786 kg/ha), while the lowest seed yield was recorded in setaria-chickpea (1755kg/ha) .

The data revealed that significantly higher CEY (3431 kg/ha) was recorded with soybean - chickpea sequence cropping with highest total net return of Rs. 102198/ha and B: C ratio of 2.28 followed by black gram-chickpea (CEY 3355 kg/ha net return Rs. 94356/ha and B: C ratio of 2.39). Setaria- chickpeaCEY (2635 kg/ha, net return Rs. 74037/ha and B: C ratio 2.12)and lowest with Fallow- chickpea (2050 kg/ha, netreturns Rs. 58150/ha and B: C ratio 2.0).

Conclusion

The average additional net returns of Rs. 32047/- per ha was recorded by the adoption of chickpea based cropping sequence than sole rabi chickpea production system . Rainfall pattern and cropping sequence of kharif season is the deciding factor for residual soil moisture availability which ultimately affects the production and productivity of the cropping system. The above cropping sequences ensured higher net income and livelihood security to the farmers and fodder security to their cattle.

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Evaluation of Drought Tolerance Potential of Elite Genotypes of Sugarcane (*Saccharum Officinarum*)

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Sugarcane is one of the important cash crop of Andhra Pradesh. Drought is one of the most important environmental stress factors limiting sugarcane production worldwide. Due to the erratic nature of rainfall, sugarcane production rely heavily on irrigation to meet production goals. Major part of cane area in marginal soils, rainfed conditions and moisture stress during formative phase, non adoption of recommended package of practices in plant and ratoon crops are some of the major constraints of cane production. Drought severely depress cane yield to the tune of 30-50% whereas the sucrose formation and sucrose recovery up to 5%. Severe drought causes the complete failure of crop and sucrose recovery.(Venkataramana,2003).A number of technologies like soaking setts in lime water and potash application etc., for managing drought situation but they are impractical and farmers are reluctant to use those technologies. The most efficient way of managing drought in water deficit areas is the use of proper drought resistant/ tolerant Varieties, their morpho-physiological studies besides agronomic management (Hemaprabha *et al* 2004).In sugarcane, four distinct growth stages have been characterized, namely germination, .tillering, grand growth and maturity. The tillering and grand growth stages, known as the sugarcane formative phase, have been identified as the critical water demand period, mainly because this is