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Economics, equivalent yield and land equivalent ratio for maize with chickpea intercropping system under middle Gujarat condition

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Abstract

An agronomical experiment, maize with chickpea intercropping system conducted to work out the economic potential, equivalent yield and land equivalent ratio under middle Gujarat condition. The experiment was carried out at College Agronomy Farm, Anand Agricultural University, Anand (Gujarat) during *rabi* and summer season of 2019-20 and 2020-21 on loamy sand soils found low in organic carbon and available nitrogen, medium in available phosphorus and potassium with slightly alkaline in reaction. The treatment comprised of total six different intercropping treatments *viz.*, T₁ - Sole maize, T₂ - Sole chickpea, T₃ - maize + chickpea 1:1 (Additive series), T₄ - maize + chickpea 1:1 (Replacement series), T₅ - maize + chickpea 2:1 (Paired row) and T₆ - maize + chickpea 2:2 (Paired row) set up under randomized block design. The economics worked for intercropping and sole cropping situation differed significantly with regard to gross return and net profit per hectare. Treatment T₃ - maize + chickpea 1:1 Additive series recorded significantly the highest gross profit (₹1.929 lakh/ ha) followed by T₆ - maize + chickpea 2:2 Paired row (₹1.573 lakh/ ha) and in sole cropping treatment T₁ - Sole maize (₹1.271 lakh/ha). Similarly highest net profit was obtained by cultivating maize + chickpea 1:1 Additive series (₹1.633 lakh/ ha) followed by T₆ - maize + chickpea 2:2 Paired row (₹1.278 lakh/ ha) and in sole cropping treatment T₁ - Sole maize (₹1.005 lakh/ ha). Same trend observed in Maize equivalent yield and Land equivalent ratio were concerned, treatment with maize + chickpea 1:1 (Additive series) produced highest MEY (82.77 Qt/ha), covered highest LER (1.49) and fetched the highest BCR (6.51) value as compared to remaining intercropping treatments.

Keywords: *Rabi* maize, chickpea, intercropping, economics, land equivalent ratio

Introduction

Intercropping maize with leguminous crop like chickpea is an age-long practice. Maize (*Zea mays* L.) is one of the important staple food crops of the world and mainly grown for food to human consumption and as a feed for livestock. It is known as a "Queen of cereals" and Miracle crop because of its monoecious nature, higher carbon dioxide assimilation capacity, wider adaptability and high yielding potential. Intercropping, the agricultural practice as growing of two or more crops in the same space at the same time in a particular field, is an age old and commonly used cropping practice which aims at to match efficiently crop demands to the available growth resources and labour. In India, the intercropping systems comprising cereals and legumes are very common. The role of cereal + legume intercropping systems for improving the productivity and profitability and sustaining the soil health through improving physical, chemical and biological soil parameters is well established. However, proper identification of location-specific cereals and legumes and their arrangement is necessary to optimally use the available resources. Maize being one of the important staple food crops of the world and largely cultivated in India confining an area of 9.60 million ha with the production of 27.15 million tonnes, having average productivity of about 2.80 tones/ha (Anon, 2020) [2]. In Gujarat state, maize is having an area of 0.44 million ha with a production of 0.68 million tones and productivity of 1659 kg/ha (Anon., 2018) [1]. As maize crop is generally cultivated solely at wider row spacing provides an opportunity to cultivate legumes as an intercrop to utilize inter row space for higher profitably and returns. Among the pulses, chickpea is one of the most important and extensively cultivated pulse crops. However, Kheroar and Patra (2013) [7], reported that interfere of legumes intercrops with normal growth of maize crop. That's why, present investigation was undertaken to determine the benefits of such practice may include income generation, efficiency of land utilization.

Materials and Methods

The field experiment was conducted at College Agronomy Farm, Anand Agricultural University, Anand (Gujarat) during *rabi* season of 2019-20 and 2020-21 to find out the feasibility of *rabi* maize (*Zea mays* L.) - chickpea (*Cicer arietinum* L.) intercropping system under middle Gujarat condition. Experimental field was loamy sand soils found low in organic carbon, nitrogen, medium in available phosphorus and potassium with slightly alkaline in reaction. The treatment was comprised of total six different intercropping planting patterns *viz.*, T₁- Sole maize, T₂- Sole chickpea, T₃- maize + chickpea 1:1 (Additive series), T₄ - maize + chickpea 1:1 (Replacement series), T₅ - maize + chickpea 2:1 (Paired row) and T₆ - maize + chickpea 2:2 (Paired row) set up under randomized block design. The maize variety GAYMH 3 (Gujarat Anand Yellow Maize Hybrid - 3) was taken as main crop which was intercropped with chickpea variety GJG 3 (Gujarat Junagadh Gram 3). The sole crop of maize and chickpea were drilled at 60 cm x 20 cm and 30 cm x 10 cm spacing, whereas, for intercropping system different planting patterns were: maize + chickpea in 1:1 ratio with additive and replacement series, maize + chickpea in paired row with 2:1 and 2:2 ratio, manifesting different plant populations. For paired row the spacing was 45-90-45 cm. The recommended doses of fertilizers *i.e.*, 150:60:00 NPK kg/ha was applied to maize crop only under sole and intercropping system, while 20:40:00 NPK kg /ha was applied only to sole chickpea. Maize as a main crop and chickpea as an intercrop were sown simultaneously.

Following characters were calculated from the formula given below:

Maize equivalent yield (MEY) (kg/ha)

Maize equivalent yield was worked out for all the experimental units by following formula.

$$\text{Yield of maize} + \frac{\text{Yield of chickpea} \times \text{Price of chickpea}}{\text{Price of maize}}$$

Land Equivalent Ratio (LER)

The Land Equivalent ratio (LER) of the area under sole cropping to the under intercropping needed to give equal amount of yield at the same management level.

$$\text{Land Equivalent Ratio} = \frac{\text{Sum of the fractions of the intercropped yield}}{\text{Sole crop yield}}$$

Results and Discussion

Economics of maize with chickpea intercropping system (Table 1) and Maize equivalent yield (MEY) and Land equivalent ratio (LER) (Table 2) are presented.

1. Economics

Main purpose of intercropping with different row arrangements is to increase the total production and income per unit area and time. An additional return from available piece of land is possible by different way of intercropping.

Data on total cost of cultivation, gross profit, net profit and B:C ratio (Table 1) revealed that different intercropping system manifested significant impact on all the above economic characters. Significantly highest gross profit (₹1.929 lakh/ ha) on pooled basis was recorded under the treatment T₃ (maize + chickpea 1:1 Additive series) and lowest gross profit was noticed under the treatment T₂ – Sole chickpea (₹1.092 lakh/ ha). Similar result obtained in net profit return. The treatment T₃ (maize + chickpea 1:1 Additive series) obtained highest net realization (₹1.633 lakh/ ha) with maximum BCR value of 6.51. The lowest net return (₹0.812 lakh/ ha) was noticed under the treatment T₂ (Sole chickpea) with lowest BCR value of 3.90. These results are in conformity with findings of Islam *et al.* (2020)^[5], Kaushik *et al.* (2018)^[6], Barik *et al.* (2016)^[4] and Kour *et al.* (2016)^[9].

2. Maize Equivalent Yield

The appraisal of mean data presented in Table 2 revealed that grain yield of maize was significantly influenced due to different intercropping systems during the year 2019-20, 2020-21 and in pooled analysis. Treatment T₃ (maize + chickpea 1:1 Additive series) recorded significantly the higher grain yield (55.91 Qt / ha) in pooled analysis. However, it was found statistically at par with treatment T₁ (sole maize). The percent increase in grain yield under the treatment T₃ was higher over the treatment T₄, T₅ and T₆ were 45%, 20% and 17% on pooled basis, respectively. Similarly the treatment T₃ (maize + chickpea 1:1 Additive series) out yielded all the treatments with significantly the highest maize equivalent yield (MEY) of 82.77 Qt/ha in pooled analysis. An increase reported under T₃ over the treatments T₁, T₂, T₄, T₅ and T₆ were to the tune of 51%, 74%, 55%, 37% and 23% on pooled basis, respectively (Table 2).

The significant impact of treatment T₃ (maize + chickpea 1:1 Additive series) on grain yield might be ascribed to its better performance through out to growth period and obtaining higher yield attributes *viz.*, higher cob length, cob girth, number of grains/cob under this treatment. The higher performance in maize - chickpea 1:1 (Additive series) intercropping system might be accrued to sufficient availability of solar radiation, soil moisture and nutrients. The increase in stover yield under treatment T₃ is mainly attributed to growth attributing parameter like plant height. These results are in conformity with findings of Baishya *et al.* (2021)^[3], Islam *et al.* (2020)^[5], Pandey *et al.* (2020)^[8], Vaghela *et al.* (2020), Parimaladevi *et al.* (2019)^[10], Patel *et al.* (2018), Barik *et al.* (2016)^[4] and Kour *et al.* (2016)^[9].

3. Land Equivalent Ratio

It is evident from the data (Table 2) that all intercropping systems gave land equivalent yield (LER) greater than 1.0. The difference in LER due to different treatments was found significantly the highest under treatment T₃ (maize + chickpea 1:1 Additive series) *i.e.*, 1.49 in pooled analysis, indicating 49% more area would be required for producing the same quantity of grain yield for solitary cropping system compared to intercropping. These results are in conformity with findings of Kaushik *et al.* (2018)^[6] and Kour *et al.* (2016)^[9].

Table 1: Economics of maize + chickpea intercropping system (On pooled basis)

Treatments	Maize yield (Qt/ha)		Chickpea yield (Qt/ha)		Maize income (₹ in lakh /ha)		Chickpea income (₹ in lakh /ha)		Gross profit (₹ in lakh /ha)	Total cost of cultivation (₹ in lakh /ha)	Net profit (₹ in lakh /ha)	BCR
	Grain	Stover	Seed	Haulm	Grain	Stover	Seed	Haulm				
T ₁ – Sole Maize	54.65	68.67	--	--	1.202	0.687	--	--	1.271	0.266	1.005	4.77
T ₂ – Sole Chickpea	--	--	17.40	24.18	--	--	1.044	0.048	1.092	0.280	0.812	3.90
T ₃ – Maize + chickpea (1:1) Additive series	55.91	71.75	9.85	18.33	1.230	0.718	0.591	0.037	1.929	0.296	1.633	6.51
T ₄ – Maize + chickpea (1:1) Replacement series	38.62	59.06	5.37	11.82	0.850	0.591	0.322	0.024	1.254	0.268	0.986	4.67
T ₅ – Maize + chickpea (2:1) Paired row	46.55	56.20	5.00	10.61	1.024	0.562	0.300	0.021	1.405	0.281	1.120	4.99
T ₆ – Maize + chickpea (2:2) Paired row	47.99	64.71	7.05	15.20	1.056	0.647	0.423	0.030	1.573	0.296	1.278	5.31
S.Em. ±	1.713	0.326	2.24	5.612	-	-	-	-	0.039	-	0.072	0.16
C.D. at 5%	5.012	0.954	6.55	1.643	-	-	-	-	0.123	-	0.264	0.51
C.V. %	9.94	10.27	9.90	9.93	-	-	-	-	18.63	-	15.04	5.32

Selling price: Seed = 1. Maize – ₹2200 /Qt, 2. Chickpea – ₹6000 /Qt, 3. Stover - ₹ 100 /Qt & 4. Haulm – ₹200 /Qt

Table 2: Grain/Seed and Stover/ Haulm yield of maize and chickpea as influenced by different intercropping systems (On pooled basis)

Treatments	Maize yield (Qt/ha)		Chickpea yield (Qt/ha)		Maize Equivalent Yield (Qt / ha) (MEY)	Land Equivalent Ratio (LER)
	Grain	Stover	Seed	Haulm		
T ₁ – Sole Maize	54.65	68.67	--	--	54.65	1.00
T ₂ – Sole Chickpea	--	--	17.40	24.18	47.46	1.00
T ₃ – Maize + chickpea (1:1) Additive series	55.91	71.75	9.85	18.33	82.77	1.49
T ₄ – Maize + chickpea (1:1) Replacement series	38.62	59.06	5.37	11.82	53.27	1.38
T ₅ – Maize + chickpea (2:1) Paired row	46.55	56.20	5.00	10.61	60.18	1.30
T ₆ – Maize + chickpea (2:2) Paired row	47.99	64.71	7.05	15.20	67.21	1.40
S.Em. ±	1.713	0.326	2.24	5.612	1.80	0.02
C.D. at 5%	5.012	0.954	6.55	1.643	5.19	0.05
C.V. %	9.94	10.27	9.90	9.93	8.34	4.03

Conclusion

The current finding shows that legumes like chickpea crop contributed to the maximum yield of maize. So, it could be conclude that intercropping system with maize -chickpea with 1:1 (Additive series) produced higher maize equivalent yield, covering highest land equivalent ratio and fetching highest net realization and benefit cost ratio (BCR) under middle Gujarat condition.

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