

Evaluation of Yield Advantages, Competitiveness and Economic Benefits of Pigeonpea(*Cajanus cajan*L.) Based Intercropping Systems Under Different Date of Sowing.

Abstract

A field experiment was conducted to evaluate the yield advantage, competitiveness and economics of pigeonpea based intercropping system under different dates of sowing at Department of Agronomy farm, VNMKV., Parbhani during *kharif* 2016-2017 and 2017-2018. The soil of experimental plot was deep black (vertisol) with good drainage. The experiment was laid out in split plot design with two replications. In main plot treatment four sowing dates (D₁- sowing within a week period after regular commencement of monsoon, D₂- sowing 15 days after D₁, D₃- sowing 15 days after D₂ and D₄- sowing 15 days after D₃) and in sub plot treatments seven cropping system i.e. I₁-pigeonpea+soybean (2:3), I₂- pigeon pea+ pearl millet (2:1), I₃- pigeonpea+niger (2:3), I₄-sole pigeon pea, I₅- sole soybean, I₆- sole pearl millet and I₇- sole niger. The net plot size is 5.40 m x 4.80 m for each treatment. The results discover that D₁ date of sowing reported maximum pigeon pea equivalent yield and net monetary return over D₃ and D₄sowing dates but which was on par with D₂. Among seven cropping systems pigeonpea + soybean was marked highest pigeonpea equivalent yield over all other six cropping systems. During pooled result the system net monetary returns affirm that I₁-pigeonpea + soybean cropping system was found significantly superior over cropping systems I₂-pigeonpea + pearl millet, I₄-sole pigeonpea, I₅-sole soybean, I₆-sole pearl millet and I₇-sole niger, but which was on par with pigeonpea + niger (I₃). The component crops in intercropping system did not contend equally. The behaviour of niger crop in intercropping was found dominant over the pigeonpea based crop. Pearl millet and Soybean were the least competitive intercrops while niger crop appeared to be much competitive when grown as intercropping in association with pigeonpea based cropping system.

Key words: Competitiveness, Dates of sowing, economic, Evaluation, Pigeonpea, intercropping systems, Yield advantages

Climate is the most influential factor for crop production. The farmer selects a crop race that is adapted to their regional area where it will be grown. However, it is weather in the locality that will ultimately determine the crop growth, development and productivity. Unless the crop and cultivars are well adapted in particular area where they are grown, their cultivation in that locality is uneconomical. Knowledge of agrometeorology and crop physiology is necessary for crop production as it is concerned with interaction between meteorological, hydrological and crop phenophases/ physiological factor on one hand and crop production on the other. Indian agriculture, to a large extent, depends on the South- West monsoon shower and associated weather phenomenon. Average annual rainfall of the country is about $4 \times 10^3 \text{ km}^3$ (400 M ha m) out of global rainfall $5 \times 10^5 \text{ km}^3$ (Lal, 1994). India's share is only one per cent of global precipitation. The 74 % rainfall contribution from South West monsoon and remaining 10 per cent during North East monsoon. The average annual rainfall of the country is 1200 mm (400 M ha m). However distribution across the country varies from Western Rajasthan ($< 100 \text{ mm}$), in North Eastern states ($> 3600 \text{ mm}$) and 1000 mm from East Coast to 2500- 3000 mm in West Coast.

Dryland agriculture has prominent place in Indian farming, occupying around 67 % of cultivated area, containing to nearly 44 % of food basket and supporting 40 % of human and 60 % of livestock population. Most (80 to 90 %) of the pulses, oilseeds and millets are confined to dryland ecosystem. It is characterized by resource scare, small and marginal farmers, poor infrastructure and low investment in modern technology and proper inputs. The discrepancy between rainfall distribution and the water requirement is the major cause of instability of certain crops of dryland areas of India. Most dryland areas of India are either mono-cropped or intercropped. Traditional dryland cropping systems are not necessarily the most suitable ones to the agro-climatic conditions as they are mostly subsistence in nature. Crop production in arid and semiarid climate, with $< 750 \text{ mm}$ annual rainfall, is limited by moderate to severe soil moisture stress during sustainable period of crop growth season. In arid and semiarid tropics with 4-5 months crop growing season, predominant cropping system is intercropping with short season crops. If the cropping growing period is longer ($> 5-6$ months), as in areas of bimodal rainfall distribution, intercropping is mostly taken with long duration crop such as pigeonpea and cotton. Although, double cropping with sequential cropping of 3-4 months duration crop can be practiced, farmers prefer intercropping for a number of reasons. (Rao and Dart, 1987)

Intercropping includes strip cropping, alley cropping, contour cropping, paired row cropping, skip cropping, parallel cropping, companion cropping, multi-story cropping and synergetic cropping in additive and replacement series. Pigeonpea based intercropping systems with Cereals crops are more popular in India (Aiyer, 1949). Amount of rainfall determines the cereal crop associated with pigeonpea and rice with 1000 to 1500 mm, maize with 750 to 1000 mm, sorghum with 500 to 750 mm and millets with 400 to 600 mm rainfall. Most cereals, depending on their growth and development period, reduce the normal growth of pigeonpea and can be ranked for competitiveness: maize $>$ sorghum $>$ pearl millet $>$ setaria (Rao and Willey, 1980).

Paired row planting can adjust full population of base crop and leave adequate inter space to accommodate two or more row of intercrop. In this technique two adjacent rows of the base crop are paired by reducing the inter-row spacing in the pair, narrow enough to create some inter-space between pairs of base crop rows but wide enough to minimize competition among plants of the base crop. In the inter-space of 60-120 cm paired rows of pigeonpea, two or more rows of other short statured intercrop can be planted. In other words, two rows of base crop and three rows of intercrop can be accommodated in 120 cm (60-120 cm paired) space instead of two rows of base crop alone with usual planting method. This is often referred to as 60-120 cm paired row planting. In dryland agriculture, intercropping is practiced to minimize the risk of total crop failure due to vagaries in monsoon for yield and economic advantage over sole cropping. Studies in recent past however, indicated profitability of intercropping even under irrigation due to efficient use of natural resources as well as applied inputs. All India coordinated research project on cropping systems indicated productivity of several intercropping systems in different region of the country in the recent past (Hegde, 1992, Singh et al.,1994, Yadav and Prasad, 1997).

Pigeonpea is a highly drought resistant crop. It can successfully grown in areas receiving only 65 cm annual rainfall, as the crop matures fast and pest damage is low. It is mostly photoperiodic sensitive, indeterminate and short days result in reduced vegetative phase and onset of flowering. Pigeonpea can be cultivated on variety of soils from sand to heavy clay loams. However, well drained medium heavy loam soils are best suited. The inbuilt mechanism of biological nitrogen fixation enables pulse crops to meet 30 to 90 % of their nitrogen requirements, hence a small dose of 15- 25 kg N/ha applied at sowing is sufficient to meet the requirement of most of the pulse crops. (Karwasra and Kumar, 2007).Pigeonpea can be knitted into many cropping systems viz., intercropping, mixed cropping and sequential cropping etc. The initial slow growth, deep rooting pattern, ability to tolerate drought and low soil moisture has made it highly suitable crop for intercropping systems. It is intercropped with many short duration legumes, cereals and commercial crops. With the complementary effect of pigeonpea on soil fertility, improvement, nutrient recycling, smothering of weeds and efficient utilization of soil moisture under different cropping systems it occupies more area in cropping systems than as a sole crop.

Materials and methods

The field experiment was conducted during the *kharif* season 2016 and 2017 at Agronomy research Farm, College of Agriculture, Parbhani (Maharashtra). The soil was clayey in texture with pH 7.80. The soil was low in organic carbon (0.5 %), low in available nitrogen (198 kg/ha), phosphorus (14 kg/ha) and high in potash (492 kg/ha). The experiment consisted of twenty eight treatment combinations i.e. 4 dates of sowing (D₁- sowing within a week period after regular commencement of monsoon, D₂- sowing 15 days after D₁, D₃- sowing 15 days after D₂ and D₄- sowing 15 days after D₃) and 7 cropping systems i.e. I₁-pigeonpea+soybean (2:3), I₂- pigeon pea+ pearl millet (2:1), I₃-pigeonpea+niger (2:3), I₄-sole pigeon pea, I₅- sole soybean, I₆- sole pearl millet and I₇- sole niger in sub-plot. Experiment was laid out in split-plot design and

replicated twice. The gross (6.60 m x 6.00 m) and net plot size (5.40 m x 4.80 m) was taken. Pigeonpea variety 'BDN 711', soybean 'MAUS 71', pearl millet 'ABPC 4-3' and niger variety 'PNS 6' were sown on 27 June 2016 and 24 June 2017 as first sowing date (D₁) and D₂, D₃ and D₄ sowing was done after 15 days interval between each sowing date in both the years respectively. The seeds were sown in 60 cm x 20 cm spacing for sole pigeonpea, 30 cm x 15 cm for sole soybean and sole niger and 60 cm x 15 cm for sole pearl millet. In intercrop situation, pigeonpea was sown in paired rows at 60 cm keeping 120 cm distance between 2 pair to adjust 3 rows of intercrop for soybean and niger (2:3) and 1 row (2:1) for pearl millet (60/120 cm). The plant-to-plant distance of 20 cm in pigeonpea and 15 cm in intercrops was maintained. The recommended seed rates of 12-15 kg ha⁻¹, 60-65 kg ha⁻¹, 4-5 kg ha⁻¹ and 3-4 kg ha⁻¹ of pigeonpea, soybean, pearl millet and niger for sole and intercrops, respectively, were used in the experiment. The recommended dose of 25 kg N/ha through urea and 50 kg P₂O₅/ha through single superphosphate was applied to sole pigeonpea as well as in intercrops. Also the recommended dose of 30:60:30 NPK kg ha⁻¹ for soybean, RDF 60:30:30 NPK kg ha⁻¹ for pearl millet and RDF 20:20:0 NPK kg ha⁻¹ for niger crop through urea, SSP and MOP were drilled before sowing as a basal application. To maintain healthy and good crop stand follow the all recommended package of practices like thinning, weeding and plant protection measures as and when required.

The yield advantages of different intercropping systems over sole pigeonpea were determined in terms of pigeonpea crop equivalent (CEY), land equivalent ratio (LER) area time equivalent ratio (ATER), Aggressivity, Relative crowding coefficient (RCC), Competition Index (CI), Competition ratio (CR) and Competition coefficient (CC).

Pigeonpea Crop Equivalent Yield (CEY)

On the basis of Govt. minimum support prices (MSP) of pigeonpea, soybean, pearl millet and niger seed they yield of each treatment for both component crops converted into crop equivalent yield of pigeonpea crop (Anjeneyula et al., 1982). The pigeonpea equivalent yield (PEY) (kg ha⁻¹) is calculated as follows:

$$PEY = \sum_{i=0}^n Y_i e_i$$

Where,

Y_i is the yield of ith component

e_i is equivalent factor of ith component of price ith crop

or

$$PEY = P_{ab} + \frac{N_{ab} \times N_{mp}}{P_{mp}}$$

Where,

PEY = Pigeonpea equivalent yield (kg ha⁻¹)

P_{ab} = Yield of pigeonpea in intercropping system (kg ha⁻¹)

N_{ab} = Yield of soybean, pearl millet and niger in intercropping system (kg ha^{-1})

N_{mp} = Soybean, pearl millet and Niger market price (kg ha^{-1})

P_m = Pigeon pea market price (kg ha^{-1})

Land Equivalent Ratio (LER)

Land equivalent ratio is defined as the relative land area under sole crop that is required to produce the equal amount of yield from intercropping system under same management level. The LER was worked out by using the formula of Willey (1979).

For studying the best utilization of land, the land equivalent ratio for various treatments was calculated by using the given formula.

$$LER = \sum_{i=1}^m \frac{Y_j}{Y_{ij}}$$

Where,

Y_i is the yield of i^{th} component from a unit area grown as intercrop

Y_{ij} is the yield of i^{th} component grown as sole crop over the same area.

In brief, LER is the summation of ratios of yields of intercrop to the yields of sole crop.

Or

$$LER = \frac{Y_{ab}}{Y_{aa}} + \frac{Y_{ba}}{Y_{bb}}$$

Where,

Y_{ab} = Yield of 'a' component intercropped with 'b'

Y_{aa} = Yield of 'a' component in sole planting

Y_{ba} = Yield of 'b' component intercropped with 'a'

Y_{bb} = Yield of 'b' component in sole planting

Area time equivalent ratio

The LER method was modified by Hielsch and McCollum (1987) to include the duration of the crop present on the land from planting to harvest. This method is known as the area time equivalent ratio (ATER).

$$ATER = \frac{Y_p D_p + Y_n D_n}{T_d}$$

Where,

Y_p = Yield of pigeon pea (kg ha^{-1})

- Y_n = Yield of soybean, pearl millet and niger (kg ha^{-1})
 D_p = Duration of pigeon pea
 D_n = Duration of soybean, pearl millet and niger
 T_d = Total duration of crop

Or

Area time equivalent ratio was calculated by using following formula suggested by Mendheet *al.* (2007).

$$\text{ATER} = \frac{1}{t_i} = \frac{n}{1} \left(\frac{d - Y_i}{Y_m} \right)$$

Where,

- d = Growth period of crops in days
 t = Time in days for which the field remained occupied (i.e. the growth period of the longest duration crop)
 Y_i = Yields of component crops in the inter cropping system
 Y_m = Yield of component crops in monoculture cropping system
 n = Number of crops involved

Aggressivity

This method was proposed by Mc Gilchrist (1965). It is the mixture of how much the relative yield increase in component a crop is greater than that for component b crop.

$$A_{ab} = \frac{Y_{ab}}{Y_{aa} \times Z_{ab}} - \frac{Y_{ba}}{Y_{bb} \times Z_{ba}}$$

Where,

- Y_{ab} = Yield of 'a' component intercropped with 'b'
 Y_{aa} = Yield of 'a' component in sole planting
 Y_{ba} = Yield of 'b' component intercropped with 'a'
 Z_{ab} = Row proportion of 'a' component intercropped in 'b'
 Z_{ba} = Row proportion of 'b' component intercropped in 'a'
 Y_{bb} = Yield of 'b' component in sole planting
 A_{ab} = Negative means get dominated
 A_{ab} = Bigger value either positive or negative means bigger difference in competitive abilities
 $A_{ab} = 0$ (component crops are equally competitive)
 $A_{ab} < 0$ (component a crop dominated)
 $A_{ab} > 0$ (component a crop dominant)

UNDER PEER REVIEW

Relative crowding coefficient (RCC):

It was proposed by Dewit (1960). It is used in replacement series of intercropping. It indicates whether a species or crops, when grown in mixed population, has produced more or less yield than expected in pure stand.

In 50:50 mixture

$$K_{ab} \text{ (RCC)} = \frac{\text{Mix. Yield of a}}{\text{Pure stand yield of a} \times \text{Mix. Yield of a}}$$

$$K_{ab} = \frac{Y_{ab}}{Y_{aa} \times Y_{ab}} \times Y_{ab} \times z_{ba}$$

$$\text{For all mixture : } K_{ab} = \frac{Y_{ab}}{(Y_{aa} - Y_{ab}) Z_{ab}}$$

Where

Y_{ab} = mix. yield of a crop grown with b

Y_{aa} = yield of pure stand crop a

Z_{ab} = proportion of sown spp. a in mix. With b

Z_{ba} = proportion of sown spp. b in mix. With a

$K > 1$ Yield advantage

$K = 1$ No difference

$K < 1$ Yield disadvantage

Competition Index (CI):

It is a measure to find out the yield of various crops when grown together as well as separately. It was proposed by Donald (1963)

$$CI = \frac{(Y_{aa} - Y_{ab}) \times (Y_{bb} - Y_{ba})}{Y_{aa} \times Y_{bb}}$$

Competition ratio (CR)

Competition ratio is measure of intercrop competition, to indicate number of times by which the component crop is more competitive with than the other. The CR values for different replacement treatments were calculated by the equation given by Willey and Rao, 1980.

$$C_{ra} = \frac{Y_{ab}}{Y_{aa} \times Z_{ab}} \div \frac{Y_{ba}}{Y_{bb} \times Z_{ba}}$$

C_{ra} = Competition ratio for component 'a'

Z_{ab} = Row proportion of 'a' component intercropped in 'b'

Zba = Row proportion of 'b' component intercropped in 'a'

Statistical analysis and interpretation of data

The experimental data obtained on various selected variables were analyzed by the standard method of statistical analysis (Panse and Sukhatme, 1967) for split plot design. The mean values of different treatments were then worked out along with corresponding standard error of mean (SEM). The critical difference at 5 per cent level of significance was computed by the formula.

$$CD = SEM \times \sqrt{2} \times t \text{ value at respective d.f.}$$

Results obtained have been presented in the form of summary tables, providing SEM in each case and CD at 5 per cent level wherever significant. The values of CD have been taken into account for drawing conclusions.

Results and discussion

The data regarding the assessment of yield advantage of intercropping system viz. pigeonpea equivalent yield (PEY), land equivalent ratio (LER), Aggressivity, Area time equivalent ratio (ATER), relative crowding coefficient (RCC), competition index (CI) competition ratio (CR) and net monetary return (NMR) of pigeonpea influenced by sowing dates and different cropping systems treatments were presented in Table 1.

Sowing dates

Sowing date (D₁) found significantly superior for system pigeonpea equivalent yield (1661 kg ha⁻¹) than other sowing dates (D₃ and D₄) during both the years and it was at par with D₂ (1508 kg ha⁻¹) in pooled analysis.

The land equivalent ratio was significantly influenced due to sowing dates during both the years. Third sowing date (D₃) in pigeonpea recorded higher land equivalent ratio (1.19) as compared D₁, D₂ and D₄ sowing date, during first year. In second year fourth sowing date (D₄) recorded higher LER (1.33) than other sowing dates. These results are in conformity with those reported by Pramila Rani and Raji Reddy, (2010), Hari Ram *et al.*, (2011) and Channabasavanna *et al.*, (2015).

ATER during year 2016-17 was observed higher in sowing dates D₃ (1.05). In next year it was found in sowing dates D₄ (1.13) but less difference were seen between all sowing dates. ATER is the ratio of sum of yield of main crops and yield of component crop multiplied with duration of both crops to the total duration (days) of intercropping system. Delayed sowing reduces their crop duration also utilize time effectively as compared to early sowing dates.

Aggressivity of sowing date D₄ found higher (0.55) during first year. In next year it was seen in sowing dates D₃ (0.51). Aggressivity (Aab) was greater than (> 0) means all the sowing dates had difference in competitive ability. This might be due to delayed sowing increases the competition for soil moisture, nutrients, space and PAR within plant to plant and between two intercrops. (Patil, 2003, Dandayuthapani and Kuzhanthaivel, 2015)

Relative crowding coefficient of sowing date D₂ (1.51) was confirmed higher during 2016-17 and it was found higher in sowing date D₁ (2.28) during 2017-18. As RCC i.e. K value was greater than one (> 1) means more yield advantages than other sowing dates. As it depends upon the row proportion of crops and yield of both the crops.

Competition index and Competition ratio during both the year of experimentation were observed in sowing dates D_4 i.e. 0.46, 2.03 and 0.40, 1.80 respectively except CR was seen higher in sowing dates D_3 (1.80) during next year. CI measures the yield of various crops when grown together as well as separately. Here CR was the ratio of individuals LER'S of the two component crops, corrected by multiplying with their sowing proportion.

The system net monetary returns were significantly influenced due to sowing dates during pooled analysis. First sowing date (D_1) in pigeonpea observed significantly higher net monetary returns (Rs. 43275 ha^{-1}) as compared D_2 , D_3 and D_4 sowing date, during pooled analysis. A lowest system net monetary return was seen in sowing date D_4 (Rs.1817 ha^{-1}).Islam *et al.* (2008) also obtained higher net returns in early sown crop of pigeonpea.

Cropping systems

The different cropping systems markedly influenced the indices of intercropping system viz. pigeonpea equivalent yield (PEY), land equivalent ratio (LER), Aggressivity, Area time equivalent ratio (ATER), relative crowding coefficient (RCC), competition index (CI) competition ratio (CR) and net monetary return (NMR) of pigeonpeawere depicted in Table 1.

Total pigeonpea equivalent yield (PEY) is the best tool to determine the overall productivity potential of an intercropping system. The data presented in Table 1reflected that Systempigeonpea equivalent yield of pigeonpea + soybean (I_1) found superior i.e.1958 $kg\ ha^{-1}$ over pigeonpea + pearlmillet (I_2), pigeonpea + niger (I_3), Sole soybean(I_5), sole pearlmillet (I_6) and sole niger (I_7), but it was on par with sole pigeonpea (I_4) during pooled analysis.Pigeonpea equivalent yield (PEY) of intercropping system was recorded significantly higher except pigeonpea + pearlmillet (I_2), pigeonpea + niger (I_3) than sole pigeonpea system because of higher yield of both crops and more or less remunerative prices of intercrop than sole cropping system. The differential behavior in PEY was on account of productivity of crops in intercropping system and their relative market prices (Rathod *et al.*,2004a).

The land equivalent ratio (LER) is the relative area of a sole crop required to produce the yield achieved in intercropping. If LER value is equal to one, it means that there is no yield advantage but when LER is more than one, then there is yield advantage. The data on LER of different intercropping systems indicated thatLER of cropping system pigeonpea + pearlmillet (I_2) (1.28 and 1.39) recorded maximum during 2016-17 and 2017-18 as compared to all other cropping systems. It means 28 % and 39 % more area or yield required to sole crops to obtain similar yield when grown in intercropping. Lowest LER obtained in all sole cropping systems.(Gare *et al.*,2004 and Yenebala, 2017)

As the LER not take into account the time for which land is occupied by the component crops of an intercropping system, area-time equivalent ratio (ATER) was also calculated. The ATER provides a more realistic comparison of the yield advantage of intercropping over that of the sole cropping that the LER as it considers variation in time taken by the component crops of different intercropping systems. The ATER values shown in Table 1 revealed that ATER in all the intercropping systems was smaller thanLER values

indicating the over estimation of resource utilization in the latter. Hence contrary to LER, the ATER is free from the prediction of over estimation of resources utilization. Based on two year data, ATER value of pigeonpea + pearl millet (I_2) (1.15 and 1.25) cropping system was found higher during both the year of research investigation. It confirmed that pigeonpea + pearl millet (I_2) cropping system utilize area very efficiently as well as time also as compared to other systems. Lowest ATER was seen in pigeonpea + niger (I_3) (0.84 and 0.81) cropping system. Higher ATER values in the above mentioned intercropped treatments were due to higher combined seed yield per plant of both the crops per unit area and longer duration of the crop present on the land from planting to harvest. (Dandayuthapani and Kuzhanthaivel, 2015, Yenebala, 2017)

Competition functions

Competitive behavior of the component crops across different intercropping systems was determined in terms of aggressivity, relative crowding coefficient, competition index and Competition ratio.

Aggressivity is an important competition function to determine the competitive ability of a crop when grown in association with another crop. An aggressivity value of zero indicated that component crops are equally competitive. For another situation, both crops will have the same numerical value but the sign of the dominant species will be 'positive' and that of dominated 'negative'. The greater the numerical value, the higher is the difference in competitive abilities and the higher the differences between actual and expected yields. The data shown in Table 1 revealed that aggressivity of pigeonpea + niger (I_3) cropping system (-0.50) was recorded negative value during first year. It means component crop show dominant effect on main crop. During second year pigeonpea + niger (I_3) was recorded not negative value (0.08) but near to 0 i.e. aggressivity = 0 that component crop (Niger) was equally competitive to main crop. Here pigeonpea + soybean (I_1) and pigeonpea + pearl millet (I_2) cropping systems recorded aggressivity value more than 0; both the systems had different in competitive ability. These indices decide the suitability of intercropping systems for cultivation. Similar findings was confirmed by Yenebala, 2017)

Relative crowding coefficient (RCC) plays an important role in determining the competition effects and advantages of intercropping. According to Willey (1979), in an intercropping system, each crop has its own RCC (K). The component crop with higher "K" value is the dominant and that with low "K" value is dominated. To determine if there is a yield advantage in intercropping, the product of the coefficient of both component crops is obtained and that is usually designated as "K". If the product of RCC of the two species is equal, less or greater than one it means that the intercropping system has no advantage, disadvantage or advantage, respectively. RCC during both the year (2016-17 and 2017-18) confirmed greater in pigeonpea + soybean (I_1) i.e. 2.40 and 2.52, cropping system. As RCC value was greater than 1 means yield advantages over sole crops. Lower RCC was obtained in pigeonpea + niger (I_3) (0.74) cropping system means $K < 1$ yield disadvantage confirmed over other treatments during first year. In second year it was slightly more than 1 in pigeonpea +

niger(I₃) (1.12) cropping system i.e. RCC/ K = 1 no difference in yield of both the crops over rest of the systems.

Competition index (CI) during 2016-17 year of experimentation was observed in pigeonpea + soybean (I₁) i.e. 0.10 cropping system. In next year pigeonpea + niger(I₃) i.e. 0.09, was recorded lower CI. CI is the ratio of yield difference of both the crops grown in sole and intercropping to the sole yield of both the crops. As it measures the yield of various crops when grown together as well as separately. It indicates suitability of crops under intercropping.

Competition ratio (CR) is another way to know the degree with which one crop competes with the intercrop. Competition ratio (CR) during both the year of experimentation was observed in pigeonpea + soybean (I₁)(3.01 and 2.59) system. CR was the ratio of individuals LER'S of the two component crops, corrected by multiplying with their sowing proportion.

Economic analysis

Economic analysis is essential as the farmers are often interested in profits and costs of a newly evolved technology. They also like to know about risks involved in the adoption of new practices. The data revealed that system net monetary returns of pigeonpea + soybean (I₁) found maximum Rs. 54,449 ha⁻¹ over pigeonpea + pearl millet (I₂), pigeonpea + niger (I₃), sole pigeonpea (I₄), Sole soybean(I₅), sole pearl millet (I₆) and sole niger (I₇) during pooled analysis. Negative values of net monetary returns were confirmed in sole soybean I₅), sole pearl millet (I₆) and in sole niger (I₇) during pooled analysis.

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