Assessment of intercropping indices, yield performance, and economics of Rajmah-based intercropping system under rainfed conditions in North Bank Plain Zone of Assam

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Abstract: - A field experiment was conducted in the research field of the All India Coordinate Research project on Dryland Agriculture, Biswanath Chariali center, Biswanath College of Agriculture, Assam Agricultural University during the *rabi* season of 2020-21 to assess intercropping indices, yield performance and economics of rajmah based intercropping system under the *rainfed* situation of North Bank Plain Zone of Assam. The competitive behavior of component crops in the different intercropping systems was determined in terms of land equivalent ratio (LER), relative crowding coefficient (RCC), aggressivity (A), and monetary advantage index (MAI). The results revealed that the plant height and number of primary branches per plant were recorded maximum in sole rajmah irrespective of all intercropping treatments. Rajmah + lentil (2:1) ratio of intercropping system have the highest aggressivity value (+1.19 & -1.19 respectively) followed by rajmah + linseed (2:1) ratio with aggressivity value of (+1.04 & -1.04) and the lowest was observed in rajmah + linseed (1:1) ratio (+0.04 and -0.04 respectively). The treatment rajmah + lentil (2:1) intercropping system was also found to be more economical and had the highest monetary advantages index (Rs. 6012.08/-). Among the intercropping treatments, the relative crowding coefficient was >1 in rajmah grown with linseed and lentil in both 1:1 ratio and 2:1 ratio indicating yield advantage. Rajmah intercropped with lentil under the 2:1 ratio recorded the highest land equivalent ratio (1.18) and rajmah equivalent yield (13.46 qha^{-1}). Economic analysis of the intercropping system also resulted in the highest net return of Rs. 63,942.00 per ha and benefit: cost ratio of 2.93 under rajmah + lentil (2:1) ratio and the lowest was recorded under rajmah + toria (2:1) with a value of the net return of Rs.10,259.00 and B: C ratio of 1.31.

Key-Words: - Aggressivity, benefit-cost ratio, Intercropping, Land equivalent ratio, Relative crowding coefficient

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1 Introduction

Rajmah (*Phaseolus vulgaris* L.) or kidney bean is a member of the Fabaceae family and is one of the most important pulse crops grown all over the country. As it possesses a very high amount of nutrients, it is honored as the "king of nutrition" [1]. Although it is mostly grown for seed it is also extensively grown as a green vegetable due to good sources of vitamins and minerals. Generally, pulse crops including rajmah are grown as a sole crop with wide spacing due to which they yielded less return [2, 3]. Therefore intercropping of pulse crops with other cereal, pulse and oilseed crops may significantly lead to higher profit, especially in adverse weather conditions [4, 5]. The rajmah also fits well in the intensive cropping system under *the rainfed* agro-ecological situation of the state. Intercropping is one of the most prominent cultivation systems of smallholder farmers due to the shortage of land, and the practice ensures the avoidance of risks associated with complete crop failure [6]. Intercropping also provides efficient utilization of natural resources like light, soil, water, plant nutrients, etc. And reduces the risk to the cost of production, decreases pest damage, suppresses weed growth than monoculture, and improves yield and quality [7, 8]. Because the rajmah based intercropped with four *rabi* crops (toria, linseed, lentil, and buckwheat) was undertaken for evaluation at AICRP for Dryland Agriculture, BN College of Agriculture, AAU, Biswanath Chariali, Assam during *rabi* season 2020-21. The experiment was laid out in a randomized block design involving three replications. The crop rajmah was sown as the sole crop which was intercropped with toria (TS-38), linseed (T-397), lentil (KLS 218), and buckwheat (local) in two proportions each *viz.* 1:1 and 2:1 ratio. The treatment consists of T_1: sole rajmah, T_2: sole toria, T_3: sole linseed, T_4: sole lentil, T_5: sole buckwheat, T_6: rajmah + toria (1:1), T_7: rajmah + linseed (1:1), T_8: rajmah + lentil (1:1), T_9: rajmah + buckwheat (1:1), T_{10}: rajmah + toria (2:1),

T_{11}: rajmah + linseed (2:1) T_{12}: rajmah + lentil (2:1) and T_{13}: rajmah + buckwheat (2:1).

2 Materials and Method

The field experiment was conducted at the experimental field of All India Coordinated Research Project for Dryland Agriculture, Biswanath College of Agriculture, Biswanath Chariali, Assam Agricultural University, during *the rabi* season of 2020-21. It is situated at 86.70 m above mean sea level with a longitude of 93˚08′01″ East and 26˚43′30″ north. The texture of the soil of the experimental field was sandy loam with a p^H of 4.98 and organic carbon of 0.58%. The soil was medium in available nitrogen (330.10 Kg ha^{-1}), available phosphorus (23.26 Kg ha^{-1}), and available potassium (171.35 Kg ha^{-1}). The rajmah based intercropping was evaluated in a randomized block design with 13 treatment combinations involving three(3) replication. The individual size of the plot was $20m^2$ (5m x 4m) and the variety selected for rajmah was 'Uday', TS-38 for toria, T-397 for linseed, KLS-218 for lentil, and Local variety for buckwheat. The seed rate of rajmah, toria, linseed, lentil, and buckwheat were 75 kg ha^{-1}, 10 kg ha^{-1}, 20 kg ha^{-1}, 30 kg ha^{-1}, and 20 kg ha^{-1} respectively. The experimental plot was ploughed by tractor-drawn plough followed by harrowing. Laddering was done properly to retain water uniformly in fields. Weeds and other stubbles were removed from the field at the time of final land preparation. The depth of sowing was maintained at about 3-5cm and seeds were covered with soil. Rows were prepared for sowing manually at 30cm and plant-to-plant distance was kept at 10cm. The fertilizer was applied as per recommendation following the package of practices of Assam in terms of Urea, SSP, and MOP. The crops were sown in the field on 12.11.2020 and 13.11.2020. Harvesting of the crops was different according to the duration of the crops and rajmah was harvested on 08.03.2021, linseed on 19.03.2021, toria on 12.02.2021, and buckwheat on 27.02.2021.

Weekly meteorological data in standard meteorological weel (SMW) during the period of experimentation was recorded at the meteorological observatory of the department of Agricultural Meteorology, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali and presented graphically in Fig. 1.

A considerable fluctuation was noticed in the case of observed weather parameters throughout the crop period. The mean relative humidity ranged from 87% to 95% in the morning hours and 44% to 73.7% in the evening hours and the weekly average maximum and minimum temperature ranged from 21.6˚ to 32.5˚C and 5.9˚C to 18˚C, respectively. The total rainfall received during the crop growing period was 83.2mm out of which the highest amount (32.4mm) was recorded from 7th to 13th March 2021. The mean bright sunshine hours varied from 1.0 to 9.3 hours per day during the crop growing period and the average wind speed varies from 0.97 to 5.09 km/hr.

2.1 Assessment of intercropping indices

2.1.1 Land Equivalent Ratio (LER): Land Equivalent Ratio is one of the common indices adopted in the intercropping system to measure the productivity of land [9]. LER is an index used for determining the effectiveness of intercropping [10].

LER is expressed as $\frac{Y_{ij}}{Y_{ii}}+\frac{Y_{ji}}{Y_{jj}}$ where, Y_{ij} and Y_{ji} are intercrop yields of the component crops i and j, and Y_{ii} and Y_{jj} are sole crop yields, respectively.

When LER measures 1.0, it indicates that the amount of land required for plant 'i' and plant 'j' to grow together is the same as that for the plant 'i' and 'j' in a pure stand (i.e., there is no advantage to intercropping over pure stand). When LER>1, a large area of land is needed to produce the same yield of the sole crop of each component than with an intercropping [7, 11].

2.1.2 Price Equivalent Ratio (PER): The ratio obtained under the intercropping system as compared to the price that could have been obtained under sole cropping.

$$PER=\frac{(Yab \times Yap)+(Yba \times Ybp)}{\frac{1}{2}(Yaa \times Yap+Ybb \times Ybp)}$$

Where, Y_{aa} is the yield of the component crop 'a' as sole crop, Y_{bb} is the yield of the component crop 'b' as sole crop, Y_{ab} is the yield of the component crop 'a' as intercrop in combination with 'b', Y_{ba} is the yield of the component crop 'b' as intercrop in combination with 'a', Y_{ap} is the market price of the produce of component crop 'a'and Y_{bp} is the market price of the produce of component crop 'b'

2.1.3 Relative crowding coefficient (RCC): each crop in the intercropping has its RCC (K) which provides a measure of whether that component has produced more or fewer yields than expected. If the K value is >1, then there is a yield advantage of crop A in intercropping but if the K value is equal to or less than 1, it means there is no yield advantages or disadvantage respectively [12, 13].

$$K_{ab}=\frac{Yab \times Zba}{(Yaa-Yab) \times Zab}$$

$K_{ba} = \frac{Yba \text{ X } Zab}{(Ybb - Yba) \text{X } Zba}$

$K = K_{ab} \text{ x } K_{ba}$

Where, K_{ab} is the RCC of the component crop 'a' in the mixture, K_{ab} is the RCC of the component crop 'a' in the mixture, K is the RCC of the system, Y_{aa} is the yield of the component crop 'a' as the sole crop, Y_{bb} is the yield of the component crop 'b' as sole crop, Y_{ab} is the yield of the component crop 'a' as intercrop in combination with 'b' Y_{ba} is the yield of the component crop 'b' as intercrop in combination with 'a', Z_{ba} is sown proportion of component 'b' in combination with 'a' and Z_{ab} is sown proportion of component 'a' in combination with 'b'.

2.1.4 Aggressivity (A): Aggressivity is an important tool for evaluating the ability of their competitiveness and shows the relationship between dominant and dominated species grown together. When the value of aggressivity is zero it indicates that the component crops are equally competitive but if both crops have the same value, the positive sign will indicate for dominant species and the negative sign will indicate for dominated species [7, 14].

$A_{ab} = \frac{Mixture\ yield\ of}{expected\ yield\ of\ a} - \frac{Mixture\ yield\ of}{expected\ yield\ of\ b}$

$A_{ab} = \frac{Yab}{Yaa \text{ X } Zab} - \frac{Yba}{Ybb \text{ X } Zba}$

Where, A_{ab} is the aggressivity of 'a' in the mixture over 'b', Y_{aa} is the yield of component crop 'a' as sole crop, Y_{bb} is the yield of the component crop 'b' as sole crop, Y_{ab} is the yield of the component crop 'a' as intercrop in combination with 'b', Y_{ba} is the yield of the component crop 'b' as intercrop in combination with 'a', Z_{ba} is sown proportion of component 'b' in combination with 'a' and Z_{ab} is sown proportion of component 'a' in combination with 'b'

2.1.5 Monetary Advantage index (MAI): The economic advantage of the cropping system can determine by the monetary advantage index [15].

$MAI = \frac{LER-1}{LER}$ x Value of combined intercrop

2.1.6 Rajmah equivalent yield (q ha^{-1}) (REY): The yields of different *rabi* crops were converted into the equivalent yield of rajmah based on the price of the product by following the formula [16].

$REY = \text{Yield of rajmah} + \frac{\text{Yield of intercrop x Price of intercrop}}{\text{Price of rajmah}}$

2.1.7 Rainwater use efficiency (RWUE):

RWUE can be calculated according to Oweis [17] by dividing grain yield by precipitation during the growing period [18].

$RWUE = \frac{\text{Grain yield}}{cumulative\ rainfall(mm)\ from\ sowing\ to\ harvest}$

3 Results and discussion

3.1. Plant height and number of primary branches per plant: The plant height and the number of primary branches per plant were recorded maximum in sole rajmah irrespective of all intercropping treatments. (Table 1). This superiority of sole rajmah over other treatments might be due to the fact that the plants received more essential nutrients, water, sunlight, etc. in sufficient quantity that finally leading to vigorous vegetative growth of rajmah. Among different intercropping treatments two rows of rajmah alternating with one row of lentil plants gave maximum plant height (41.77cm) and the number of primary branches per plant 93.68). Being a leguminous crop, it could help rajmah to maintain superiority over other intercrops (linseed, toria, and buckwheat). Thus rajmah + lentil (2:1) could perform better among the intercropping treatments. However, there might be a competition for the available resources between rajmah and lentil too; as a result, lower growth of rajamh was noticed compared to sole rajmah. The lowest plant height and number of primary branches per plant of rajmah were noticed in intercropped with 1:1 toria followed by intercropped with toria 2:1 (Table 1). Rajmah and toria intercropping did not perform well which might be due to higher competition among rajmah and toria for growth. As the plant height of toria was more as compared to rajmah, there might have been a shading effect which probably adversely affected the growth and yield of rajmah. Tuti *et al*. [19] also found lower plant height and number of primary branches of toria in the case of wheat + toria intercropping with 2:1 ratios than 1:1 ratio.

3.2 Yield sole crop

The seed yield, stover yield and biological yield of rajmah significantly influenced by different

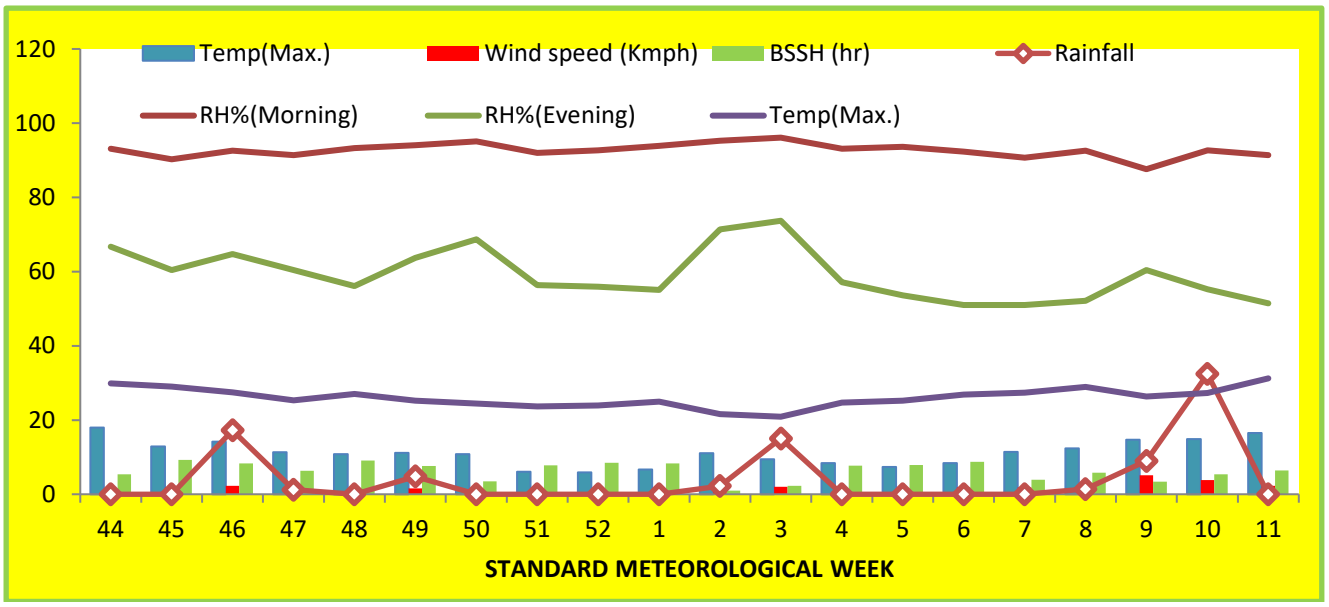

Fig.1: Meteorological data during crop growing period

Table 1: Growth and yield attributes of rajmah

Treatment	Rajmah					Intercrop				
	Plant height (cm)	Branch plant^{-1}	Pod plant^{-1}	Seed pod^{-1}	Test wt. (g)	Plant height (cm)	Branch plant^{-1}	Pod plant^{-1}	Seed Pod^{-1}	Test wt.(g)
Sole Rajmah	43.17	3.98	8.71	3.83	318.40	-	-	-	-	-
Sole Toria	-	-	-	-	-	71.64	4.33	140.9	14.68	3.67
Sole Linseed	-	-	-	-	-	46.17	3.22	24.3	8.98	6.11
Sole Lentil	-	-	-	-	-	25.00	3.33	32.06	1.95	14.27
Sole Buckwheat	-	-	-	-	-	78.63	3.92	35.81	10.8	12.51
Rajmah + Toria (1:1)	33.27	3.03	6.10	3.00	299.46	69.69	3.80	112.67	14.58	3.32
Rajmah + Linseed (1:1)	40.83	3.47	7.78	3.33	307.62	46.03	2.98	23.87	8.93	5.8
Rajmah + Lentil (1:1)	41.05	3.53	8.10	3.34	309.94	20.50	3.25	30.27	1.87	13.88
Rajmah + Buckwheat (1:1)	38.10	3.23	7.19	3.09	303.74	75.22	3.33	31.8	9.8	11.7
Rajmah +	37.67	3.15	6.71	3.04	301.36	69.33	3.83	84.07	13.6	3.28

Toria (2:1)										
Rajmah + Linseed (2:1)	41.17	3.60	8.29	3.45	312.75	45.57	2.28	22.98	8.53	5.5
Rajmah + Lentil (2:1)	41.77	3.68	8.54	3.53	314.33	19.93	3.17	30.19	1.85	13.56
Rajmah + Buckwheat (2:1)	39.13	3.27	7.38	3.13	306.65	75.02	2.89	30.24	9.5	11.3
S.Ed±	0.16	0.04	0.03	0.03	0.08	-	-	-	-	-
CD (p=0.05)	0.33	0.08	0.07	0.07	0.18	-	-	-	-	-

intercropping systems (Table 2). They have recorded the maximum in sole rajmah (T_1) which might be due to the best performance of n sole rajmah recorded in number of branches per plant, yield attributes like pod per plant, seed per pod, and 1000 seed weight. (Table 1). As a lentil is a leguminous crop it could help the rajmah to maintain superiority over linseed, toria, and buckwheat for which rajmah + lentil (2:1) could perform better among the intercropping treatments. The lowest yield was recorded in rajmah intercropped with toria in a 1:1 ratio followed by rajmah intercropped with toria in a 2:1 ratio. Ramavatar *et al* . [20] reported that cluster bean and pearl millet intercropping systems in a 2:1 ratio have the maximum seed yield of cluster bean. Barod *et al*. [21] noted a higher grain yield of pigeon pea from the green gram + pigeon pea (2:1) intercropping system.

3.3 Yield of Intercrop

Among different treatment, sole cropping of all the intercrops viz. toria**,** linseed, lentil, and buckwheat emerged as the best treatment as it produced maximum plant height (cm), the number of branches per plant, seed yield (qha^{-1}), stover yield and biological yield (qha^{-1}) which was superior over the intercropping ratios (1:1 and 2:1). (Table 2). The probable reasons might be due to efficient utilization of available resources in favor of producing maximum growth as well as yield attributing characteristics without any competition resulting in a higher yield of the crop. Similar results were also reported by Gupta *et al.* [22] and Kalaghati *et al.* [23] in different intercropping systems.

3.4 Equivalent yield of the system

Among different treatments of the sole crop, sole rajmah (T_1) produced the highest yield (13.38 qha^{-1}). Among the intercropping system, rajmah + lentil intercropping (2:1) produced the maximum equivalent yield (13.46 $qha^{-1)}$ and it was followed by the treatment rajmah + lentil (1:1) ratio (11.66 qha^{-1}). Singh *et al*. recorded that wheat + chickpea (2:1) was the highest wheat equivalent yield [24]**.** This was due to the higher yield performance of rajmah in the sole and intercropping system and the extra yield of lentil as a bonus in intercropping system. Since the yield and market rate of lentil had an edge over the rate of rajmah, sole rajmah ranked next to rajmah + lentil in the 2:1 ratio. Such similar findings were also reported by Thirugnanavel *et al.* and Rao & Swamy [25, 26]. The lower yield of component crops in double row ratios resulted in lower rajmah equivalent yield. Thus, the possible reason for maximum rajmah in sole crop as well as in intercrop with lentil among different treatments was due to higher yield and prices of both crops (Table 2).

Table 2. The yield of sole crop & intercrops, equivalent yield, and rainwater use efficiency

Treatment	Seed yield(qha^{-1})		Stover yield(qha^{-1})		Biological yield(qha^{-1})		REY (qha^{-1})	RWUE (Kg ha^{-1}mm^{-1})
	rajmah	intercrop	rajmah	intercrop	rajmah	intercrop		
Sole Rajmah	13.38	-	15.34	-	28.72	-	13.38	13.06
Sole Toria	-	10.04	-	22.71	-	32.75	6.97	5.86
Sole Linseed	-	8.89	-	24.34	-	33.23	4.94	4.82
Sole Lentil	-	6.66	-	18.32	-	24.98	7.40	7.23
Sole Buckwheat	-	13.73	-	32.46	-	46.19	8.20	9.31
Rajmah + Toria (1:1)	3.03	6.01	5.12	14.65	8.15	20.66	7.20	6.47
Rajmah + Linseed (1:1)	7.17	4.94	9.98	16.44	17.15	21.38	9.91	9.68
Rajmah + Lentil (1:1)	8.18	3.13	10.42	11.27	18.60	14.40	11.66	11.39
Rajmah + Buckwheat (1:1)	4.21	8.16	6.54	21.32	10.74	29.48	9.08	9.64
Rajmah + Toria (2:1)	3.49	4.07	5.70	10.77	9.19	14.84	6.32	5.78
Rajmah + Linseed (2:1)	9.65	3.33	11.52	13.22	21.17	16.55	11.51	11.24
Rajmah + Lentil (2:1)	10.56	2.61	12.39	10.22	22.95	12.83	13.46	13.14
Rajmah + Buckwheat (2:1)	6.25	5.5	8.58	16	14.84	21.5	9.54	9.84
S.Ed±	0.08	-	0.08	-	0.14	-	0.10	-
CD(P=0.05)	0.18	-	0.18	-	0.29	-	0.21	-

3.5 Assessment of intercropping advantages

3.5.1 Land equivalent ratio: The land equivalent ratio (LER) due to intercropping of different intercrops (toria, linseed, lentil, and buckwheat) with rajmah in different row proportions were evaluated among the treatments, the highest LER (1.18) was recorded in treatment (T_{12}) i.e. rajmah +

lentil of 2:1 row ratio which was followed by T_{11}(1.10) i.e rajmah + linseed 2:1 ratio. The lowest LER (0.67) was found in T_{10} i.e. rajmah + toria (2:1) ratio. [23] (Table 3)

3.5.2 Price equivalent ratio: The price equivalent ratio (PER) of rajmah was influenced by different intercrops grown with rajmah. The maximum PER was recorded in rajmah + lentil (2:1) ratio intercropping (1.30) followed by rajmah + linseed (2:1) ratio (1.26). The treatment T_{10} i.e. rajmah + toria (2:1) ratio resulted in the lowest value of PER (0.20). (Table 3). This is the conformity with the findings of Mandal *et al.* in maize with legume intercropping system [27].

3.5.2 Monetary advantage index: Rajmah intercropping with lentil in 2:1 ratio had the maximum monetary advantage index (MAI) value of Rs. 6012. 08 which as followed by T_8 i.e. rajmah + lentil at 1:1 ratio (Rs. 2594.45) (Table 3)Kumar *et. al.* reported that the monetary advantage of the experiment was higher under mixed cropping [28]. The least MAI was recorded in T_{10} i.e. rajmah + toroa at 2:1 ratio (Rs. -6506.02) followed by T_6 i.e. rajmah + toria at ratio (Rs. -3672.12). (Table 3). Khalid and Khalil [29] recorded the highest MAI (1296.7) observed with maize-cowpea intercropping at the mix proportion of 67:50.

3.5.3 Rainwater use efficiency: Among the intercropping treatments, the highest RWEU was found in T_{12} i.e. rajmah intercropped with lentil in a 2:1 row ratio (13.14 kg ha^{-1} mm^{-1}) and the lowest value was observed in rajmah + toria (2:1) (5.78 kg ha^{-1} mm^{-1}) which was followed by rajmah + toria (1:1) (6.47 kg ha^{-1} mm^{-1}) Sharma *et al.* also resulted the highest RWUE in sesame + black gram (1:1) was more over sole sesame this indicating the benefits of intercropping over sole cropping for better use of rainwater [18]. The differences were due to the variation in the yield of the intercropping system. (Table 2)

3.5.4 Aggressivity: The treatment T_{12} i.e. rajmah (1,19) intercropped with lentil (-1.19) in a row ratio of 2:1 had the highest value of aggressively which was followed by rajmah + linseed (2:1) (Table 3). On the other hand, T_7 i.e. rajmah (-0.04) intercropped with linseed (0.04) in a 1:1 ratio was found lowest value of aggressively. The positive values of aggressivity seen in all intercropping treatments indicate that it acts as a dominating component in both the intercropping systems. The treatments producing positive value of rajmah + lentil (1:1), Rajmah + linseed (2:1), and rajmah + buckwheat (2:1). The treatments having negative values of rajmah + toria (1:1), rajmah + linseed (1:1), rajmah + buckwheat (1:1) and rajmah + toria (2:1) which indicate poor competitiveness. (Table 3). Similar results were reported in the case of lentil and mustard intercropping system, among the different row ratios of lentil and mustard, 6:1 has the highest aggressivity value (0.205) for both lentil and mustard followed by 4:2 (0.162) and the lowest in 4:4 (0.003) showing that mustard was a better competitor in 6:1 than 4:4.) [30]

3.5.5 Relative crowding coefficient: The relative crowding coefficient (RCC) of rajmah in various row ratios was less than 1 in the treatment T_6 (rajmah + toria 1:1 ratio) T_{10} (rajmah + toria 2:1 ratio) and T_{13} (rajmah + buckwheat 2:1 rato) whereas the intercrop gave more yield than expected. The higher relative crowding coefficient which indicates yield advantage compared with their monoculture. The present results can be held up by the report given by Devi *et. al.* where The relative crowding co-efficient of lentil was greater than in all the treatments except the 1:1 row ratio indicating yield advantage compared with their monoculture due to cooperation [30]. Among various intercrops, T_{12} i.e. rajmah + lentil in 2:1 ratio resulted from the highest relative crowding coefficient, and the lowest was recorded in T_{10} (rajmah + toria 2:1 ratio). (Table 3)

3.5.6 Economics: The highest net return of Rs. 63,942 ha^{-1} was achieved from rajmah + lentil with the row ratio (2:1) (Table 3) and the lowest net return of rajmah + lentil with the row ratio (2:1) (Table 3) and the lowest net return of Rs. 10,259/ was achieved from rajmah + toria in 2:1 row ratio. The intercropping of rajmah + lentil (2:1) ratio resulted the maximum benefit-cost ratio (2.93) which was followed by rajmah + linseed (2:1) ratio (2.55) and the lowest benefit-cost ratio was noted in rajmah + toria (1.31) in 2:1 row ratio among various intercropping system. The present report can be supported by the findings noted by Tripathi *et al.* where maize + cowpea-wheat combination was the most productive and economic intercrop combination, with an increase in net economic return (43.63%) and B: C ratio of 1.94 [31].

Table 3. Assessment of rajmah based intercropping advantages

Treatment	LER	MAI	PER	Relative crowding coefficient		Aggressivity		Net return (Rs)	B: C ratio
				Rajmah (K_R)	Intercrop (K_I)	Rajmah	Intercrop		
Sole Rajmah	1	-	-	-	-	-	-	64092.00	2.99
Sole Toria	1	-	-	-	-	-	-	20097.00	1.87
Sole Linseed	1	-	-	-	-	-	-	13426.67	1.60
Sole Lentil	1	-	-	-	-	-	-	28980.00	2.19
Sole Buckwheat	1	-	-	-	-	-	-	46739.00	3.13
Rajmah + Toria (1:1)	0.83	-3672.12	0.68	0.29	1.49	-0.74	0.74	15148.67	1.47
Rajmah + Linseed (1:1)	1.09	2146.98	1.08	1.15	1.25	-0.04	0.04	38640.00	2.18
Rajmah + Lentil (1:1)	1.08	2594.45	1.12	1.57	0.89	0.28	-0.28	50243.00	2.49
Rajmah + Buckwheat (1:1)	0.90	-2129.26	0.86	0.46	1.46	-0.56	0.56	37851.33	2.13
Rajmah + Toria (2:1)	0.67	-6506.02	0.20	0.35	1.02	-0.43	0.43	10259.00	1.31
Rajmah + Linseed (2:1)	1.10	2272.00	1.26	2.59	0.90	1.04	-1.04	50367.33	2.55
Rajmah + Lentil (2:1)	1.18	6012.08	1.30	3.75	0.97	1.19	-1.19	63942.00	2.93
Rajmah + Buckwheat (2:1)	0.87	-3006.89	0.88	0.88	1.00	0.20	-0.20	39804.00	2.22

4 Conclusion

From the experiment, it may be concluded that sole of rajmah, toria, linseed, lentil, and buckwheat produced maximum seed yield as compared to their intercropping combinations with rajmah, toria, linseed, lentil, and buckwheat produced maximum seed yield as compared to their intercropping combinations. Among the five different rabi crops studied, lentil and linseed were found to be more efficient when intercropped with rajmah. The highest land equivalent ratio, equivalent yield, aggressively, and monetary advantage index were recorded in the rajmah + lentil intercropping of 2:1 ratio. The relative crowding coefficient was > 1 in rajmah among the intercropping treatments indicating yield advantage compared with their sole cropping except T_6 (rajmah + toria 1:1 ratio), T_{10} (rajmah + toria ratio), and T_{13} (rajmah + buckwheat 2:1 ratio) treatments. Rajmah's intercropping system was found to be more economical and advantageous than other intercropping systems.

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