



## Production potential of rapeseed (*Brassica rapa* var. *dichotoma*) – based intercropping systems under rainfed conditions

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### Abstract

A field experiment was conducted during the *Rabi* season of 2009-10 and 2010-11 at Jorhat to evaluate the productivity of rapeseed (Torja) based intercropping systems under rainfed conditions. Altogether 17 treatments consisted of sole crops of rapeseed (Torja), linseed, Yellow Sarson, lentil and buckwheat along with intercropping of Torja with the other four crops in 1:1, 2:1 and 2:2 row proportions were laid out in randomized block design with three replications. Intercropping treatments proved superior in terms of growth, yield attributes and yield of Torja when intercropped with linseed. The seed yields of intercrop, buckwheat, Yellow Sarson and linseed were comparatively higher than lentil. Among different intercropping systems, Torja equivalent yield was recorded highest in Torja + Yellow Sarson closely followed by Torja + buckwheat and Torja + linseed when row proportion was maintained at 2:2. In terms of monetary advantage based on LER value, the best was recorded with intercropping Torja + linseed in 2:2 row proportion.

**Key words:** *Buckwheat, Intercropping, Linseed, Lentil, Torja, Yellow Sarson, Torja Equivalent yield*

### Introduction

Rapeseed – mustard group is the main *Rabi* oilseed crop of Assam with an area of 2.45 lakh hectares. On an average, the state contributes 3.6 and 1.7 per cent in rapeseed – mustard acreage and production of the country (Anonymous, 2010). Linseed, Yellow Sarson, lentil and buckwheat are also important *Rabi* crops of the state, but the productivity of these crops is low and uncertain because the crops are grown in poor and marginal land under rainfed condition. Intercropping has been recognized as a potentially beneficial system of crop production and can provide substantial yield advantage compared to sole cropping (Willey, 1979). Since information on rapeseed (Torja) based intercropping with linseed, Yellow Sarson, lentil and buckwheat with regards to comparative performance, competition relations and economics of these systems are lacking, the present study was undertaken.

### Materials and Methods

Field experiments were conducted under rainfed condition during the *Rabi* seasons of 2009-10 and 2010-11 at the Instructional-cum Research Farm of

Assam Agricultural University, Jorhat to find out the suitable intercrop and row proportion in rapeseed (Torja)-based intercropping system. Altogether 17 treatments consisting of sole crops of rapeseed (Torja), linseed, Yellow Sarson, lentil and buckwheat along with intercropping of Torja with other 4 crops in 1:1, 2:1 and 2:2 row proportions (Table 1) were laid out in randomized block design with three replications. The soil was sandy loam containing 0.72% organic carbon, 240.0 kg/ha available N, 17.1 kg/ha available  $P_2O_5$  and 106.2 kg/ha available  $K_2O$  with pH 5.2. The crops were sown on 12 November, 2009 and 30 October, 2010 and harvested as per maturity of the crops. A row spacing of 25 cm was adopted for all the crops with a plant to plant spacing of 10cm in Torja and Yellow Sarson and 15cm in lentil and buckwheat. A uniform fertilizer dose of 20, 35 and 15 kg/ha N,  $P_2O_5$  and  $K_2O$  were applied as basal one day ahead of sowing. An additional dose of 20 kg N/ha was top dressed in Torja, Yellow Sarson and linseed crop. The cultivars used in the study were ‘TS-36’ (Torja), ‘Binoy’ (Yellow Sarson), ‘T-397’ (linseed), ‘B-77’ (lentil), and local (buckwheat). The rainfall received during

Table 1. Effect of intercropping on growth, yield attributes and yield of Toria (mean data of 2 seasons)

Treatment	Plant height (cm)	Silique/plant	Seeds/silique	1000 seed weight (g)	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)	Oil content (%)	Oil yield (kg/ha)
<b>Intercropping</b>									
Toria + linseed	99.5	128.7	17.0	2.7	6.8	22.2	31.4	35.7	244.6
Toria + Yellow Sarson	92.6	88.4	16.9	2.8	5.3	18.4	29.7	36.1	191.8
Toria + lentil	95.4	111.7	15.2	2.9	6.6	22.0	30.3	36.5	239.9
Toria + buckwheat	101.4	91.3	16.9	2.7	4.5	14.6	31.5	35.2	158.8
CD (P=0.05)	3.8	11.1	NS	NS	0.4	1.8	NS	NS	20.7
<b>Row proportion</b>									
1:1	95.5	94.0	16.1	2.7	5.5	17.8	30.2	35.3	196.4
2:1	97.6	115.4	17.0	2.7	6.2	21.5	29.1	36.3	226.4
2:2	98.6	105.7	16.4	2.8	5.7	18.2	32.8	36.0	203.5
CD (P=0.05)	3.0	NS	NS	NS	0.3	1.5	NS	NS	18.4
<b>Sole vs Intercropping</b>									
Sole Toria	96.5	80.1	14.7	3.08	7.7	30.2	25.6	34.9	269.7
Intercropping	97.3	105.0	16.5	2.75	5.8	19.2	30.7	35.9	208.8
CD (P=0.05)	NS	NS	NS	NS	0.3	1.3	2.0	NS	14.8

Table 2. Effect of intercropping on growth, yield attributes and yield of intercrops (mean data of 2 seasons)

Treatment	Plant height (cm)	Siliquae/plant	Seeds/siliqua	1000 seed weight (g)	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)	Oil or protein content (%)	Oil or protein yield (kg/ha)
<b>Linseed</b>									
Toria + linseed (1:1)	61.5	21.8	7.6	6.50	7.15	27.45	28.0	37.1	264.99
Toria + linseed (2:1)	62.1	20.9	6.9	6.42	2.31	8.60	27.7	36.7	80.66
Toria + linseed (2:2)	60.2	21.1	7.5	6.45	1.41	3.82	36.5	36.3	60.92
Toria + linseed (2:2)	66.6	21.5	7.8	6.57	2.40	8.09	31.3	36.9	84.89
CD (P=0.05)	NS	NS	NS	NS	1.00	3.70	NS	NS	61.28
<b>Yellow sarson</b>									
Toria + Yellow Sarson (1:1)	99.1	41.2	23.0	2.68	9.19	26.22	34.9	35.6	327.30
Toria + Yellow Sarson (2:1)	96.2	37.6	19.5	2.80	4.18	6.72	53.2	35.4	125.72
Toria + Yellow Sarson (2:1)	95.6	31.6	21.5	2.85	3.01	5.72	56.0	35.2	106.78
Toria + Yellow Sarson (2:2)	96.5	36.9	19.9	2.60	4.45	10.08	46.3	34.9	155.71
CD (P=0.05)	NS	NS	NS	NS	2.99	3.41	NS	NS	84.51
<b>Lentil</b>									
Toria + lentil (1:1)	23.9	10.8	1.3	16.80	3.26	13.30	25.5	21.8	71.59
Toria + lentil (2:1)	23.0	7.8	1.3	17.64	0.62	2.49	33.5	20.0	12.19
Toria + lentil (2:1)	25.3	5.1	1.4	11.62	0.42	1.52	34.5	19.5	8.02
Toria + lentil (2:2)	27.6	8.8	1.4	16.12	0.98	3.94	26.9	20.7	14.49
CD (P=0.05)	NS	NS	NS	NS	0.27	1.45	NS	NS	10.25
<b>Buckwheat</b>									
Toria + buckwheat (1:1)	93.8	56.1	8.8	14.85	11.08	28.34	39.0	13.5	151.99
Toria + buckwheat(2:1)	94.9	40.4	10.5	14.90	5.83	16.97	34.5	13.8	80.75
Toria + buckwheat(2:1)	94.3	62.3	8.9	14.70	3.82	11.51	33.5	12.7	49.10
buckwheat(2:2)	95.6	49.3	9.1	14.54	5.74	16.72	34.4	13.8	62.20
CD (P=0.05)	NS	NS	NS	NS	2.52	5.59	NS	NS	57.29

the crop growth period was 27.3 mm, and 61.2 mm in the first and second season's respectively.

## Results and Discussion

### Rapeseed (Torja)

All the growth and yield attributes of Torja were not influenced significantly due to sole and intercropping with other crops (Table 1). However, the seed, stover and oil yields of Torja were recorded significantly higher in sole cropping. The effect of intercropping on the plant height of Torja was significantly visible when Torja was intercropped with buckwheat owing to dominant plant stature of buckwheat that posed competition to Torja for light and space resulting in taller plants of associated torja crop. This was followed by Torja + linseed intercropping which might be due to better competitive nature of linseed. The number of siliquae per plant of Torja was recorded highest when Torja was intercropped with linseed. Similarly, the seed, stover and oil yields were recorded highest in Torja + linseed intercropping. Higher number of siliquae per plant might have significantly influenced the seed yield of Torja. Among different row proportions, 2:1 row proportion produced significantly higher seed, stover and oil yields over 1:1 and 2:2 row proportions. More siliquae/ plant and seeds/ siliqua in 2:1 row proportion could be the reason for higher biological and oil yields of Torja (Table 1).

### Intercrops

The effects of different row proportions of intercropping were marked on plant height and yield attributes of intercrops over their sole crops. The seed, stover and oil yields were significantly higher in sole crops than that under intercropping systems mainly because of reduced plant population (Table 2). Different intercropping along with row proportions could not differ significantly with one another in respect of yield. However, intercroppings of Torja + linseed, Torja + Yellow Sarson and Torja + lentil in 2:2 row proportion recorded higher seed, stover and oil/protein yields than the other proportions. In Torja + buckwheat intercropping, the seed, stover and protein yields of buckwheat in 1:1 row proportion was distinctly higher than the other row proportions. The variable plant population, growth behavior of crops and elasticity of individual plants

in mixtures of different species were responsible for variations in biological (seed and stover) and oil/protein yields of crops. None of the intercropping systems could bring about any significant variation in harvest index and oil/protein content of intercrops as compared to their respective sole crop.

### Land equivalent ratio, competition ratio, aggressively and relative crowding coefficient

Intercropping advantage measured in terms of land equivalent ratio (LER) in intercropping systems revealed that almost all the intercropping in all row proportions were superior to their sole cropping (Table 3). However, intercropping of Torja + linseed in 2:2 and 1:1 row proportions and Torja + Yellow Sarson in 2:1 and 2:2 row proportions recorded higher LER values over the other intercropping systems which might be due to relative yield increase of Torja in association with linseed and Yellow Sarson. The advantage of intercropping in respect of LER was marginal in other intercropping systems. Narayan *et al.* (1999) also reported higher LER in Indian mustard + linseed intercropping system. All the intercrops were less competitive than Torja in all row proportions except that of Torja + buckwheat in 1:1 and 2:1 row proportions which tends to be more competitive than Torja, because of tallness of buckwheat.

The aggressiveness of all the intercrops was negative indicating Torja be the dominant component in all the intercropping systems. The highest aggressiveness value of Torja was recorded in Torja + lentil in 2:1 row proportion followed by Torja + linseed, Torja + Yellow Sarson and Torja + buckwheat with the same row proportion. The least magnitude of dominance of Torja was found in Torja + buckwheat system indicating almost identical competitive behavior of the two crops.

The intercropping of Torja with linseed, Yellow Sarson, lentil and buckwheat at all row proportions was advantageous except that of Torja + buckwheat in 2:1 row proportion, as the product of relative crowding co-efficient ( $K$ ) was  $>1$  and showed the complimentary relationship. Intercropping of Torja + linseed in 2:2 row proportion proved to be the best since the system indicated the highest  $K$  value which

Table 3. Effect of intercropping on competition functions (mean data of 2 seasons)

Treatment	LER	Toria	Intercrop	Toria	Intercrop	Toria	Intercrop	Product
Toria + linseed (1:1)	1.20	2.77	0.40	0.53	-0.53	3.04	0.51	1.55
Toria + linseed (2:1)	1.02	2.31	0.55	0.86	-0.86	2.74	0.56	1.53
Toria + linseed (2:2)	1.28	2.83	0.35	0.61	-0.61	3.35	0.51	1.71
Toria + Yellow Sarson (1:1)	1.01	1.61	0.62	0.24	-0.23	1.64	0.62	1.02
Toria + Yellow Sarson (2:1)	1.18	1.23	0.81	0.61	-0.61	1.75	1.83	1.45
Toria + Yellow Sarson (2:2)	1.12	1.35	0.74	0.16	-0.16	1.78	0.92	1.63
Toria + lentil (1:1)	1.03	4.45	0.24	0.63	-0.63	5.87	0.19	1.12
Toria + lentil (2:1)	1.05	3.51	0.29	1.12	-1.12	4.80	0.24	1.15
Toria + lentil (2:2)	1.08	2.55	0.41	0.46	-0.46	3.65	0.35	1.28
Toria + buckwheat (1:1)	1.08	1.03	1.10	0.17	-0.17	1.15	1.38	1.58
Toria + buckwheat (2:1)	1.00	0.91	1.13	0.28	-0.28	0.89	1.02	0.91
Toria + buckwheat (2:2)	1.07	1.07	0.92	0.04	-0.04	1.25	1.35	1.68

LER, Land equivalent ratio; CR, competitive ratio, A, aggressiveness; K, relative crowding coefficient

Table 4. Effect of intercropping on Toria equivalent yield, net return, B-C ratio and monetary advantage (mean data of 2 seasons)

Treatment	Toria equivalent yield (q/ha)	Net return (Rs/ha)	B-C ratio	Monetary advantage (Rs/ha)
<b>Sole crops</b>				
Toria	7.7	8663.8	0.8	-
Linseed	7.2	8938.8	1.0	-
Yellow Sarson	10.0	16511.2	1.5	-
Lentil	4.8	2776.5	0.3	-
Buckwheat	9.8	16440.9	1.4	-
CD(P=0.05)	0.5	-	-	-
<b>Intercropping</b>				
Toria + linseed	8.8 (2.0)	12293.0	1.3	3181.0
Toria + Yellow Sarson	9.5 (4.4)	13416.0	1.3	1796.5
Toria + lentil	7.7 (0.9)	9068.9	1.0	1046.4
Toria + buckwheat	8.9 (4.5)	13161.3	1.4	1039.1
CD (P=0.05)	NS	-	-	-
<b>Row proportion</b>				
1:1	8.7 (3.1)	11920.6	1.2	1522.3
2:1	8.4 (2.3)	11009.1	1.1	1170.1
2:2	9.2 (3.5)	12945.4	1.3	2744.1
CD (P=0.05)	NS	-	-	-
<b>Sole vs intercropping</b>				
Sole	7.9	10438.3	1.1	-
Intercropping	8.7 (3.0)	11991.0	1.2	-
CD (P=0.05)	NS	-	-	-

(Figures in parenthesis represent Toria equivalent yield for intercrop)

was followed by Toria + buckwheat, Toria + Yellow Sarson and Toria + lentil in the same row proportion.

### **Toria equivalent yield**

On average of two seasons, sole Yellow Sarson being at par with sole buckwheat recorded significantly higher toria equivalent yield than other sole crops (Table 4). None of the intercropping systems could bring about any significant difference in Toria equivalent yield, however, Toria + Yellow Sarson intercropping produced the highest Toria equivalent yield which was followed by Toria + buckwheat, Toria + linseed and Toria + lentil intercropping system.

Different row proportions did not show any significant effect on Toria equivalent yield, however, the row proportion of 2:2 recorded the highest and 1:1 recorded the lowest Toria-equivalent yield. The differential behaviour in Toria equivalent yield was on account of productivity of crops in intercropping systems and their relative market prices.

### **Economics of intercropping**

Higher net return and benefit-cost ratio was recorded in intercropping over sole cropping (Table 4). Among sole crops, sole Yellow Sarson recorded the highest net return and benefit-cost ratio followed by sole buckwheat. Intercropping of Toria + Yellow Sarson resulted in highest net return followed by Toria + buckwheat, Toria + linseed, and Toria + lentil. However, the benefit-cost ratio was recorded highest in toria + buckwheat intercropping followed by Toria + Yellow Sarson being at par with Toria + linseed. In terms of monetary advantage the highest was recorded in Toria + linseed. The row proportion of 2:2 recorded the highest net return, benefit-cost ratio and monetary advantage. On the basis of findings it can be concluded that linseed, Yellow Sarson and buckwheat can be grown successfully as intercrop with Toria in 2:2 row proportion under rainfed condition. From the biological efficiency point of view and monetary advantage, Toria + linseed in 2:2 row proportion was found to be the most efficient intercropping system.

### **References**

- Anonymous, 2010. *Annual Report*. Directorate of Rapeseed–Mustard Research, Bharatpur, India.
- Narayan D, Prakash OM and Bhushan LS. 1999. Intercropping of Indian mustard (*B. juncea*) with barley (*Hordeum vulgare*), rock salad (*Eruca sativa*) and linseed (*Linum usitatissimum*) under limited irrigation conditions in reclaimed ravine land of river Yamuna. *Indian J Agril Sci* **69**: 321-324.
- Willey RW. 1979. Intercropping – Its importance and research needs. Part-I Competition and yield advantage. *Field crops Abstract* **32**: 1-10.

