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Cabbage (*Brassica oleracea* L. var. *capitata*) cv. Rareball introduction with Knol Khol and Broad Bean intercropping: yield efficiency under foot hills of Imphal-West

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Abstract

The present investigation was carried out during the Rabi season of 2016-17 at COA, CAU Imphal, Manipur and is located at North-Eastern Hill Region of India with 94°E longitude; 24°N latitude and an altitude of 875.0 meter above mean sea level on Cabbage (*Brassica oleracea* L. var. *capitata*) cv. Rareball intercropping with Knol Khol (*Brassica oleracea* L. var. *gongylodes*) and Broad Bean (*Vicia faba* L.) for yield efficiency. Cabbage (48.15 t ha⁻¹), knol khol (36.42 t ha⁻¹) and broad bean (7.55 t ha⁻¹) were recorded highest yield as sole crops. Among the intercropped treatments maximum land equivalent ratio (1.43) were recorded in elephant foot cabbage intercropped with double row of broad bean and cabbage equivalent yield (63.18 t ha⁻¹) were recorded in cabbage intercropped with double row of knol khol. On economic analysis of the treatments it had been observed that double row of knol khol in cabbage had the highest gross return, net return and eventually higher B: C ratio under Manipur condition.

Keywords: Cabbage Equivalent yield, Intercropping, Land equivalent ratio

Introduction

Cabbage (*Brassica oleracea* L. var. *capitata*), also known as white cabbage or headed cabbage belongs to the family cruciferae and having chromosome number 2n=2x=18. It is one of the most important vegetables in the world. It is grown widely in Europe, Russia, Asia, USA, Canada, South America, Japan, and East Africa. In India, the major cabbage producing states are Uttar Pradesh, Bihar, Odisha, West Bengal, Assam, Maharashtra and Karnataka. The other important cabbage growing areas are Haryana, Rajasthan, Gujarat, Uttaranchal hills, Himachal Pradesh and Nilgiri hills in Tamil Nadu. Cabbage is used as fried or cooked vegetable in sambhar or curries. It is also eaten raw as salad. In some countries abroad, it is preserved and consumed as Sauerkraut. Cabbage contains chemical compounds like glucosinolates, glutathione, isothiocyanates, indoles and brassinins that acts as anti-carcinogen. It is also a rich source of vitamin C and has high fibre content and calcium which reduce the risk of colon cancer. It also contains phosphorus which is helpful in utilization of calcium and assimilation of carbohydrate and fats in human body. The origin of *Brassica oleracea* is obscure. All the cole crops, including cabbage have originated in Mediterranean region. The wild diploid, *Brassica oleracea* var. *sylvestris* L. a leafy kale like plant which occurs in northern shore of Mediterranean Sea and on lime cliffs in north eastern England and along the North Sea, is the progenitor of the cultivated kale and leafy non-heading cabbage. The hard-headed white cabbage selected in north Europe descended from this wild leafy non-heading cabbage, originating in eastern Mediterranean region and Asia Minor which was probably brought by Celts. Like other cole crops, cabbage was also originated by evolution, mainly by mutation and introgression from wild species, human selection and adaptation. The oldest record of cabbage was in 2000- 2500 BC. Perhaps the modern day white headed cabbage was selected in Germany around 1150 AD and moved to England in the 14th century. Savoy cabbage (var. *sabauda*) originated earlier in Italy, probably from the Portuguese kale (var. *costata*). In India, cabbage was introduced almost at same time as cauliflower. It was introduced into the country by the Portuguese and it was grown during the Mughal period and it became popular during the British period. (Swarup, 2006) [8]. In India, it is cultivated in 0.38 million ha with the total production of 8.75 million Mt and average productivity of 22.68 Mt/ha. It is ready to harvest in 3-4 months. It contributes 5.3 percent of total vegetables production of India. For early crop, spacing of 60 cm x 30 cm is maintained.

West Bengal contributes 22, 07, 240 Mt of cabbage from 78,550 ha area with an average productivity of 28.1 Mt/ha and in Manipur cabbage is grown in area of 7600 ha with production of 91000 Mt in the year 2015-2016. (DAC, 2017).

Materials and Methods

The present investigation was carried out in College of agriculture, Central Agricultural University, Imphal, Manipur. It is located at North-Eastern Hill Region of India with 94°E longitude; 24°N latitude and an altitude of 875.0 meter above mean sea level during the year 2016-17 with cabbage cv. Rareball, knol khol cv, winner and broad bean local variety. The experimental soil is of Acidic (pH 5.40) and clay soil. The experiment was laid out in a Randomized Block Design with seven treatments and three replications. The treatments comprised of cabbage sole crop (T₁), single row of knol khol planted in the inter-rows cabbage (T₂), double row of knol khol planted in the inter-rows cabbage (T₃), single row of broad bean planted in the inter-rows cabbage (T₄), double row of broad bean planted in the inter-rows cabbage (T₅), knol khol sole crop (T₆) and broad bean sole crop (T₇). Spacing of 60 x 30 cm row to row and plant to plant was adopted for cabbage constantly. Knol khol planted at a distance of 30 x 30 cm row to row and plant to plant in sole cropping, Broad beansown at a distance of 30 x 20 cm row to row and plant to plant in sole cropping. Where as in single row planting, only one row of broad bean/knol khol planted in the inter-rows of cabbage and in double row planting, 2 rows of knol khol/broad bean planted in the inter-rows of cabbage. The number of knol khol plants present in single row (56), double row (112) and the sole crop (64) will vary accordingly and number of broad bean plants present in single row (84), double row (168) and the sole crop (96) will vary accordingly. One month old seedlings of cabbage and knol khol are transplanted whereas pre-germinated broad bean seed are directly sown in plot size of 2.4m x 2.4m. Recommended cultural practices and plant protection measures were carried out regularly. The harvested heads, knob and pods of cabbage, knol khol and broad beans respectively from each plot were weighed separately and yield per plot was obtained then converted into tonnes per hectare. Yield efficiency of the system has been studied in terms of land equivalent ratio (LER) and cabbage equivalent yield (EEY). LER was calculated as suggested by Willey and Osiru (1972) [9].

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

Y_{ab} is yield of species “a” in association with species “b” and Y_{ba} is the yield of species “b” in association with species “a”. Y_{aa} and Y_{bb} represent the pure stand yield of species “a” and “b”, respectively.

The yields of knol khol and broad bean were converted into crop equivalent yield based on the price of cabbage. Crop

equivalent yield was calculated as described by Reddy and Reddi (2008) [7].

$$\text{Equivalent of cabbage} = \frac{\text{Yield of cabbage} \times \text{Price of "cabbage"}}{\text{Price of "cabbage"}}$$

$$\text{Equivalent of intercrop} = \frac{\text{Yield of intercrop} \times \text{Price of intercrop}}{\text{Price of "cabbage"}}$$

Crop equivalent yield = Equivalent of cabbage + Equivalent of intercrop

Results and Discussion

Yield of cabbage was significantly affected with the intercropping of knol khol and broad bean as mentioned in the Table 2. Cabbage (48.15 t ha⁻¹), knol khol (36.42 t ha⁻¹) and broad bean (7.55 t ha⁻¹) sole crops recorded superior yield. Favorable conditions for growth provided significantly higher yield in sole crops. These findings are similar to Choudhuri and Jana (2012) [3]. In the present study highest LER (1.43) was recorded in cabbage with double row of broad bean (Table 1), indicated that 43 percentage additional productivity per unit area can be achieved by growing two crops (cabbage and two rows of broad bean) together than by growing them separately. Additional yield supplied by the intercrop enhanced the biological efficiency of intercropping system. Single row of knol khol planted in the inter-rows cabbage gave the minimum land equivalent ratio (1.09). Whereas all sole crop treatments recorded similar land equivalent ratio (1.00). These findings are in agreement with Amanullah *et al.* (2006) [1] in cassava intercropping system, Amanullah *et al.* (2006) [1] in cassava and cowpea intercropping system, Njoku and Muoneke (2008) [5] in cassava intercropping system, Prabhakar and Sukla (1990) [6] in okra and beans during monsoon, capsicum and onion in winter, and melon and radish in summer. It is obvious from the data of equivalent yield on cabbage basis that treatment T3 i.e. double row of knol khol intercropped with cabbage (63.18 t/ha) gave the highest equivalent yield followed by treatment T5 i.e. double row of broad bean intercropped with cabbage (52.82 t/ha) as shown graphically in Table 1. In treatment T3 i.e. double row of knol khol intercropped with cabbage, more number of plants and high marketing price of knol khol resulted in higher equivalent yield. In cabbage + knol khol (1:2) combination, even though the yield was less in cabbage but the yield of knol khol was higher. Moreover, price of knol khol were comparatively more and ultimately resulted in higher crop equivalent yield on conversion to cabbage basis. Similar results were also reported by Yildirim and Turan (2013) [10] in broccoli, Amanullah *et al.* (2006) [1] in cassava intercropping system, Amanullah *et al.* (2006) [1] in cassava and cowpea intercropping system and Chattopadhyay *et al.* (2008) [2] in elephant foot yam intercropping system.

Table 1: Effect of intercropping on yield advantage of elephant foot yam

Treatments	Cabbage Land equivalent	Intercrop land equivalent	LER	Cabbage equivalent	Intercrop equivalent	Cabbage equivalent yield
T1	1.00		1.00	48.15		48.15
T2	0.75	0.34	1.09	36.1	15.45	51.55
T3	0.72	0.61	1.33	34.71	28.47	63.18
T4	0.93	0.39	1.32	44.71	7.95	52.66
T5	0.85	0.58	1.43	41.11	11.72	52.82
T6	-	1.00	1.00		48.56	48.56
T7	-	1.00	1.00		20.14	20.14
S.Em (±)			0.06	1.22		3.38
CD (0.05)			0.18	3.98		12.15

Table 2: Yield and price of elephant foot yam and intercrops

Treatments	Yield (t/ha)			Rate (Rs/ton)			Gross returns
	Cabbage	Khol Khol	Broad Bean	Cabbage	Khol Khol	Broad Bean	(Rs/ha)
T ₁	48.15	-	-	15000	-	-	722322
T ₂	36.10	11.59	-	15000	20000	-	773284
T ₃	34.71	21.35	-	15000	20000	-	947633
T ₄	44.71	-	2.98	15000	-	40000	789883
T ₅	41.11	-	4.39	15000	-	40000	792323
T ₆	-	36.42	-	-	20000	-	728430
T ₇	-	-	7.55	-	-	40000	302130

Conclusion

From the present findings of the experiment it can be concluded that with respect to the cabbage growth and yield although cabbage sole crop (T₁) was found good but on comparison among the intercropping system single row of broad bean intercropped with cabbage produced highest yield and also remained at par with treatment i.e. sole cropping cabbage. However, in case of crop equivalent yield, double row of knol khol with cabbage had produced maximum yield while double row of broad bean in cabbage had maximum LER.

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