

## Investigation of intercropping cauliflower and Spinach in north of Iran

Nahid Amoli

Member of scientific board Agricultural and Natural Resource Research Center of Mazandaran, Seed and plant improvement research Institute.

Corresponding author Email: [na\\_amoli@yahoo.com](mailto:na_amoli@yahoo.com)

**ABSTRACT:** In order to study possibility of obtaining higher yield, intercropping of cauliflower and spinach was conducted during two years (2008-2009) at Gharakheil research station. In this research used snow crown variety of cauliflower and Local Mazandaran spinach in sole culture and intercropping on September. Cauliflower seedling planted with distance rows 60,70 cm as main crop, Spinach as accommodation crop cultivated between rows of cauliflower. The experimental design was CBRD with 4 replications. In this study were evaluated total yield and components yield in sole culture and intercropping. The results showed there was suitable growth because of adaptability between cauliflower and Spinach in intercropping. The results showed that, the treatment with 60 cm distance in rows and one row Spinach between rows had the highest total yield. (43.19 ton/ha) LER (land equivalent ratio) showed highest (1.58). According the results mix culture cauliflower and spinach can be used by farmer with enough benefit in Mazandaran. In point of economic, one row Spinach between in 60 cm distance of Cauliflower, could get the maximum benefit and the most uses of the land. Thus, according to above treatment can recommended as the best on the farmers.

**Keywords:** Cauliflower, Intercropping, LER (Land Equivalent Ratio), Spinach, yield.

### INTRODUCTION

Research has shown that Mazandaran province climate (North of Iran) is suitable for planting cabbage and particularly cauliflower. The investigation on planting early varieties of cauliflower Snow crown selected density of 54,000 plants with 30×60 cm distance (Amoli and *et al*, 2009). Cauliflower and spinach are also rich in vitamin c and minerals such as iron and have role in valuable vegetable (Kashi, 1993). The use of these vegetable as intercropping can increase the production of both products at the same time having a product to avoid risk of loss and damage. Studies on the cultivation of crops and vegetables combined to show that some of the plants growing together have more yield than sole culture because of their special properties and physiological (Ahmadi and Rostami, 2003). Using inter crop system is one of providing nutrition by using from exist equipment. Intercropping is from plants pattern of natural sustainable like intact forest that shows, always combination of genus prefer than single genus (Preston, 2003). In traditional agriculture Iran observe many inter cropping system. In searching about vegetable and other crops shows some of plants for physiological and botanical characteristics produce more yield and high quality in comparative single culture (Mazaheri, 1994). Also cultivation such leafy vegetables like lettuce are important as second crop in paddy land. In other hand was proved that absorption and exchanging in paddy land. Successfully in inter cropping depends much select the main plant and method of inter cropping. In this situation, have to consider morphologically and physiologically main and major plants (Hiebsch, and Mccollum, 1987). In 2 current decade, investigated inter cropping in countries especially in developing countries that used garlic and red bean and red pepper with corn and tomato with cucumber (Mivechi langeroodi, 1995) cucumber with eggplant (Kashi, 1993). Overall success depends heavily on the choice of intercropping with major crops and plants along, as well as their growing methods are combined (Atri and *et al*, 1998). Sometimes choosing plants according preventable amount insect, such as cultivation opium in bean row distance for absorb Bean aphid for opium smelling and inter cropping carrot and leek for damage onion fly. Also sciences, could access obtain decrease virus mosaics by planting squash and zeamays by inter cropping (Ayisi, and *et al* 1997). According some of investigation, could use inter cropping as using combination prevent method by insect and diseases (Godan, 1987).

## MATERIAL AND METHODS

This study was carried out for 2 years in Gharakheil research station in north of Iran. Geographical properties this site is with 35°52' altitude and 43° 36' with annual precipitation , 800 mm in year. After rice harvesting, prepared paddy land in August. This experiment was conducted in completely blocks randomize design with 4 replications. Snow crown an early suitable variety cauliflower and also a local spinach that cultivated in north of Iran. Cauliflower planting was done by sowing and spinach by seed. Beginning of august prepared nursery with 100 cm in width and covered by manure fertilizer then sowing the cauliflower seed in rows for germination, irrigated when it was dry. Cauliflower seed germinated in nursery for the suitable temperature (25<sup>0</sup>c) within 4 to 5 days. After growing the bush and it was 4-5 leaves, it transport to ground after 40 days. Each plot consists of 4 lines and 5 meters apart cauliflower show is on row 30 cm. The using fertilizer for experiment was according nutrition cauliflower. It was manure fertilizer 10 ton/ha and nitrogen by urea form 200 kg ha<sup>-1</sup>(½ was before planting) and 150 kg ha<sup>-1</sup> potassium sulphat and 50 kg ha<sup>-1</sup> ammonium phosphate. The cauliflower plants cultivated and 30 cm distance in the rows. The seeds of spinach separated then according pattern of cultivation, planted in rows of cauliflower with 2 cm distance together. The planting date of cauliflower and spinach was on 20 September and simultaneous. This experiment was done dry farming conditional. Weeding was done twice times.

Studied Treatments:

- 1 - Single cauliflower planting, row spacing of 60 cm,
2. Single spinach planting, spacing rows 30 cm,
- 3 - Planting distance 60 cm between cauliflowers, spinach a line between rows,
4. Planting distance 70 cm between cauliflowers, spinach a line between rows,

The experiment variance analysis was done based on plan basics for yield and other variables from MSTATC programs and comparing the average treatment yields based on Duncan method (Rezaei and Soltani, 1998). To draw the graphs Excell was used. In order to evaluate and determine the profitability of intercropping systems, Land Equivalent Ratio (LER) was used. LER is obtained from division of each plant yield in intercropping over the maximum plant yield in pure culture (Mazaheri , 1994) if it result into a unit, there is no difference in refutability and if LER is more than 1(unit), the intercropping will be more profitable and (Hiebsch, 1987). Also, plant yielding in fact is the total yield of main and accommodation plant and is obtained from division of each intercropping yield over pure culture. In table 1, there is LER from division of each plant yield in intercropping over maximum plant yield in pure culture. The ratio for main and accommodation plant yield in intercropping in percent.

## RESULTS AND DISCUSSION

The results was observed significant difference at 1% in intercropping cauliflower with spinach which represents the difference between treatments was tested in two years (Table1). But in combined analysis had not significant different treatments of cauliflower and there is no significant in effect of repetitions in year. So did not yield statistically significant difference between 60 and 70 centimeters in two years. CV testing is 14.56%, which indicates the accuracy of a field trial (Table 1). No significant difference was observed in combined analysis of variance of spinach mixed with cauliflower in cultivation, between the levels of year but interaction of year×treatment had significant difference at 1% level and indicating has been having different functions the treatment in two years (Table 2). Average yield of cauliflower and spinach LER considerably higher, reflecting the culture's mix of pure cultures and increase (57%) treated with 60 cm distance between rows of cauliflower and planting a row of spinach between them, 46 percent increase in intercropping. Thus, treatments that LER is 1.57 and 1.46 (Table 3). Combined analysis of the characteristics measured cauliflower yield components showed that had significant differences yield in the number of leaves, leaf length, root length, diameter curd, with of the years. However, leaf width and curd weight traits had significant in year. In all the characters were



Photos of the superior treatment in Research Station Gharakheil

According to table 5, were compared interaction average yield and yield components with year arranged A from C class. For example, performance on a first year class in A and AB and second year were replaced BC and C. There was not different leaf width of cauliflower traits within two years and replaced in same class and received a steady trend. This table shows the characteristics alternative and yet different range and makes the clear superiority of some others. Although Cauliflower in sole culture were highest in the first year (A class) but were not significant cauliflower and spinach mixed and pure cultures and replaced in same class (AB class). This result indicates the ability to grow cauliflower and spinach mixture, this means that harvested cauliflower as well as pure cultures, spinach can be harvested from cultures. Number of leaves treatment increased will reduce yield as the number of leaves were in A,ABC class in second year( Table 5). Leaf of length with yield had performance direct and positive. We further conclude that provides the leaves more opportunity for the metabolism and storage of nutrients in the leaves (Preston, 2003). Table 6 indicates significant at 1% performance for length and width, number of leaves per year. Spinach are significant differences in intercropping compared with sole crop treatments, indicate that we planted spinach mixed with cauliflower will decrease yield compared to the sole crop. Comparison (Table 6), proves this result. Thus the sole spinach grown in rows 30 cm with 11.662 ton/ha in the first year and 18.063 ton/ha in A group the second year and other treatments were ranked in the lower classes. Also are shown yield spinach and components include, leaf number, leaf length, petiole length, leaf width and length blade the Category ( Table 7). Research over many years has shown that the plants are carefully selected increases quality performance mix cropping than sole crop (Shivarama, 1994). Such this result is consistent with the research, based on previous research carrots and radishes grown in intercropping row, LER equal to 1.66 to 2.15 is demonstrate the usefulness of mixed cultures ( Amoli, 2003), was also demonstrated in this study. Similar examples have been reported by researchers, advantage of intercropping lettuce and garlic after rice harvesting, it was shown of these two products have more than pure cultures( Amoli, Asad por, 2001).

In figure 1, yield of cauliflower and spinach, with its grouping, also Figure 2 shows the LER. The usefulness of combined cultures in question have been approved and using this system could be recommended planting. The results showed that between cauliflower and spinach, mixed culture, there is growingcoordination. Calculating the Land Equivalent Ratio (LER) 1.57 was observed. Resende and et al in 2000 could reach lettuce and radish intercropping more beneficial to obtain pure cultures (Resende and et al,2000). Mix garlic and beans culture, its usefulness in pure culture showed 2.80 LER showed (Lameei hervan, 2003). LER of intercropping tomato and lettuce for 2.3 has been reported Indicating shows the usefulness of the mixed culture (Resende,2000). Overall performance has increased relative to pure cultures. It can be recommended to farmers. Given these findings, planting a spinach row between rows 60 cm cauliflower is superior to other treatments, and it can be recommended to farmers planting and harvesting is enforceable. Regarding the results, by having two rows of cauliflower with simultaneous planting and harvesting in the province. According to the survey results, cauliflower and spinach mixed culture at the end of the October cultivated and harvested in spinach. Between rows of cauliflower and space for growing are available at this time, curd began to appear, begins about harvested a month and a half after the cauliflower.

Table 1. Combined analysis of variance for yield cauliflower in two years

S.O.V	D.F	SS	MS
Year ( Y)	1	576.436	576.436**
Error	6	939.140	22.490
Cauliflower ( Ca)	2	111.832	55.916 <sup>ns</sup>
Y× Ca	2	40.863	20.433 <sup>ns</sup>
Error	12	286.827	23.902
Total	23	1156.897	-

CV= 14.56% ns,\*and \*\*:Not significant, significant at 5%and 1% level , respectively

Table 2. Combined analysis of variance for yield spinach in two years

S.O.V	D.F	SS	MS
Year ( Y)	1	120.064	120.064 **
Error	6	12.698	2.116
Spinach ( Sp)	2	147.713	73.756**
Y× Sp	2	11.209	5.605 ns
Error	12	26.668	2.222
Total	23	-	-

CV= 13% ns,\*and \*\*:Not significant, significant at 5%and 1% level , respectively

Table 3. Mean comparison of yield spinach and cauliflower in sole and inter cropping

Treatments	LER	Total yield (t/h)	Yield Mean Spinach (t/h)	Yield Mean Cauliflower (t/h )
Single cauliflower planting, row spacing of 60 cm	1	36.56	-	36.56a
Single spinach planting, spacing rows 30 cm	1	14.86	14.86a	-
Planting distance 60 cm between cauliflowers, spinach a line between rows	1.57	43.91	10.55b	32.64a
Planting distance 70 cm between cauliflowers, spinach a line between rows	1.46	40.51	8.99b	31.52a

Means followed by similar letters in each column are not significantly different at 1% level, according to Duncan's Multiple Range Test.

Table 4. Combined analysis of variance for yield, yield components cauliflower in sole and intercropping two years

S.O.V	MS						
	Yield(ton/ha)	Leaf numbers	leaf length	leaf width	Root length	Curd weight	Curd diameter
Year	573.43 **	32.667*	600 **	1.500 <sup>ns</sup>	135.37 **	0.076 <sup>ns</sup>	57.04 *
Error	23.49	4.333	37.528	7.056	6.653	0.056	4.48
Cauliflower	55.91 <sup>ns</sup>	5.542 <sup>ns</sup>	18 <sup>ns</sup>	2.52 <sup>ns</sup>	4.625 <sup>ns</sup>	0.033 <sup>ns</sup>	2.024 <sup>ns</sup>
Year × Cauliflower	20.421 <sup>ns</sup>	0.792 <sup>ns</sup>	19.50 <sup>ns</sup>	0.875 <sup>ns</sup>	0.875 <sup>ns</sup>	0.028 <sup>ns</sup>	1.54 <sup>ns</sup>
Error	23.902	2.333	7.861	5.597	3.194	0.014	2.236
CV	1.59%	8.57%	4.94%	9.13%	8.88%	13.92%	11.91%

ns,\*and \*\*:Not significant, significant at 5%and 1% level , respectively

Table 5. Means of yield and yield components of cauliflower in sole and mix cropping

Treatment	Yield (ton/ha)	Leaf numbers	Leaf length (cm)	leaf width (cm)	Root length ( cm)	Curd weight (gr)	Curd diameter (cm)
Cauliflower sole cropping ( first year)	42.75a	17.50abc	62a	26.50a	23.25a	950a	14.25c
Cauliflower inter cropping 60 cm ( first year)	35ab	15.70c	61.25a	26a	23a	800ab	15.75bc
Cauliflower inter cropping 70 cm ( first year)	36.26ab	16.75bc	62a	a 26	a 21.25	720b	15.75bc
Cauliflower sole cropping ( second year)	30.36bc	19.25ab	54.50b	26.50a	18b	a 950	a 18.25
Cauliflower inter cropping 60 cm ( second year)	29.52bc	18abc	52.25bc	a 24.75	18b	900ab	18ab
Cauliflower inter cropping 70 cm ( second year)	26.13c	19.75a	48.50c	25.75a	18b	950a	a 18.75

Means followed by similar letters in each column are not significantly different at 1% level, according to Duncan's Multiple Range Test.

Table 6. Combined analysis of variance for yield , yield components spinach in sole and inter cropping in two year

S.O.V	MS					
	Yield	Leaf numbers	Petiole length	Blade length	Blade width	Leaf length
Year	120.064**	77.042**	0.667ns	486*	48.167**	84.37ns
Error	2.116	4.264	1.306	61.222	1.528	2.708
Spinach	73.856**	2.042ns	0.167ns	3.792ns	0.500ns	2.167ns
Year × Spinach	5.605 ns	0.792 ns	1.067ns	8.375ns	0.167ns	2 ns
Error	2.222	1.806	1.056	11.806	0.611	2.583
CV	13%	14.08%	23.83%	17.45%	17.37%	15.2%

ns,\*and \*\*:Not significant, significant at 5%and 1% level , respectively

Table 7. Means of yield and yield components of spinach in sole and mix cropping

Treatment	Yield	Leaf numbers	Petiole length	Blade length	Blade width	Leaf length
Spinach sole cropping ( first year)	11.662b	7.50bc	6.50a	14.25cd	3c	6.5de
Spinach inter cropping 60 cm ( first year)	8.862bc	7.5bc	5.750b	15c	2.75c	6.25de
Spinach inter cropping 70 cm ( first year)	7.175c	7.25bc	5.50b	13.75cd	3.50cd	6.25de
Spinach sole cropping ( second year)	18.63a	11.75a	6a	25a	6a	10.25a
Spinach inter cropping 60 cm( second year)	12.240b	10.50a	6.25	21.75bc	5.75a	9b
Spinach inter cropping 70 cm ( second year)	10.82bc	11.75a	6.50a	23.25a	6a	11a

Means followed by similar letters in each column are not significantly different at 1% level, according to Duncan's Multiple Range Test.

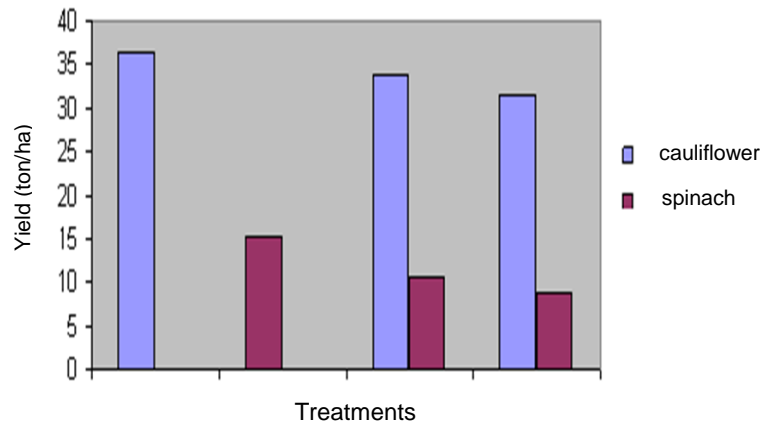


Figure 1 . Yield of cauliflower and spinach

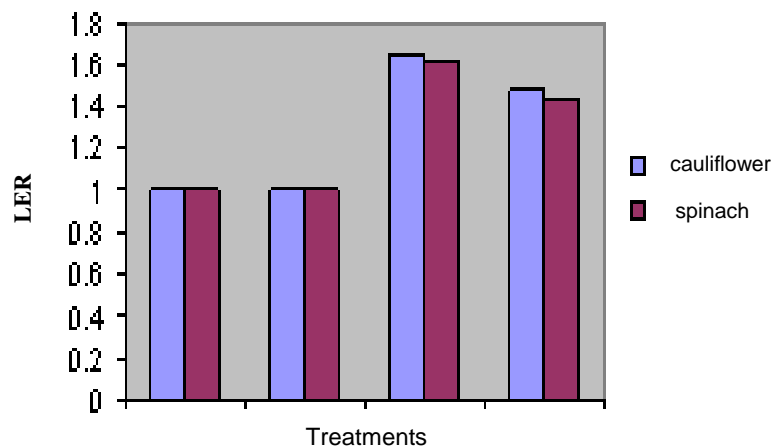


Figure 2 . LER of cauliflower and spinach

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