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EFFECT OF PEA INTERCROPPING ON BIOLOGICAL EFFICIENCIES AND ECONOMICS OF SOME NON-LEGUME WINTER VEGETABLES

Syed Ali Qasim[1], Muhammad Akbar Anjum[1,*], Sajjad Hussain[1] and Shakeel Ahmad[2]

[1]Department of Horticulture, Faculty of Agricultural Sciences & Technology, Bahauddin Zakariya University, Multan-60800, Pakistan; [2]Department of Agronomy, Faculty of Agricultural Sciences & Technology, Bahauddin Zakariya University, Multan-60800, Pakistan
***Corresponding author's e.mail: akbaranjum@bzu.edu.pk**

Intercropping with legumes makes effective use of land and other resources and results in reduced cost of production. Increased agricultural production through intercropping with minimal cost is need of time to feed increasing population. The reported work evaluates the biological efficiencies and economics of pea, garlic, turnip and cauliflower grown as sole crops and when pea intercropped in garlic, turnip and cauliflower during 2010-12. All the vegetables generally yielded more when grown as single crop compared with when pea was intercropped in these vegetables. In peas in garlic intercropping, pea yield was not significantly affected; however, garlic yield was significantly reduced (65.8%). Pea intercropping in turnip or cauliflower resulted in significantly lower yields of both crops (29.1 and 28.0%, respectively) as compared with their sole cropping. All other characteristics (plant growth and yield components) of all the four crops which indicate biological efficiency generally were greater when grown as single crops and decreased in intercropping combinations. Analysis of intercropping treatments revealed that pea intercropping in turnip resulted in the highest marginal rate of return (8,875%), followed by pea intercropping in cauliflower (6,977%), due to lower input costs incurred per hectare. However, net benefit to the growers was higher (Rs. 327,925) in case of pea intercropping in cauliflower, followed by pea intercropping in garlic (Rs. 213,425).
Keywords: *Allium sativum*, *Brassica oleracea* var. Botrytis, *Brassica rapa*, *Pisum sativum*, Marginal rate of return, intercropping.

INTRODUCTION

Demand of vegetables is increasing with rapidly growing world population which will become 9 billions in year 2050. There is also large gap between demand and supply of vegetables in Pakistan. Hence, a cropping system that can increase the rate of vegetable production and/or lower the cost of production will provide economical opportunity for farmers. Intercropping has been identified as a promising system that makes effective use of land and other resources (Remison, 1982) like water and soil nutrients and results in reduced cost of production (Bijay *et al.*, 1978). It has also gained wide acceptability among farmers of tropical and sub-tropical countries because of its economic advantages resulting from the symbiotic association of legumes intercropped with other crops (Ahmed and Gunasema, 1979). Intercropping involving legumes has been found to be most useful (Adeniyi, 2011) as it improves soil fertility and gives better yields and economic returns (Lithourgidis *et al*., 2011).

Common beans are poor fixers (less than 56 kg ha^{-1} per growing season) and fix less than their nitrogen needs. Other grain legumes, such as peas, peanuts, cowpeas, soybeans and faba beans are good nitrogen fixers and can fix all of their nitrogen needs other than that absorbed from the soil. These legumes may fix up to 280 kg N ha^{-1} and are not usually fertilized (Lindemann and Glover, 2003). Almost all of the fixed nitrogen goes directly into the plant and little leaks into the soil for neighboring non-legume plants. Eventually, nitrogen returns to the soil for following crops when vegetation (roots, leaves, fruits) of the legume dies and decomposes (Lindemann and Glover, 2003; Rahman *et al*., 2009). Since, excessive use of inorganic fertilizers contribute to environmental damage such as nitrate pollution; legumes grown in intercropping are regarded as an alternative and sustainable way of introducing N into lower input agro-ecosystems (Fustec *et al*., 2010). The main effect of intercropping is because of more efficient utilization of available resources and increased productivity compared with each sole crop (Hauggaard-Nielsen and Jensen, 2001; Hauggaard-Nielsen *et al*., 2001; Zhang and Li, 2003; Szumigalski and van Acker, 2006; Dhima *et al*., 2007; Agegnehu *et al*., 2008; Launay *et al*., 2009; Mucheru-Muna *et al*., 2010; Mao *et al*., 2012). Yield is increased because growth resources such as light, water and nutrients are more efficiently absorbed and converted to crop biomass by the intercropping over time and space as a result of differences in competitive ability for growth resources between the component crops. This exploits the variation of the mixed crops in characteristics such as rates of canopy development, final canopy size (width and height), photosynthetic adaptation of canopies to irradiance conditions, and rooting depth (Tsubo *et al*., 2001). Intercropping with legumes is an excellent practice for controlling soil erosion and sustaining crop production (El-Swaify *et al*., 1988). Deep roots penetrate far into the soil breaking up hardpans and use moisture and nutrients from deeper zones in the soil. Shallow roots bind the soil at the surface and thereby help to reduce erosion. Also, shallow roots help to aerate the soil (Lithourgidis *et al*., 2011).

Intercropping provides high insurance against crop failure, especially in areas subject to extreme weather conditions such as frost, drought and flood, and overall provides greater financial stability for farmers, making the system suitable particularly for labor-intensive small farms. Thus, if a single crop may often fail, farmers can reduce their risk for total crop failure by growing more than one crop in their fields (Clawson, 1985). Moreover, farmers may be better able to cope with seasonal price variability of commodities, which often can destabilize their income. Intercropping may result in increased yield of main or companion or both crops (Webb, 1980; Singh, 1993; Prasad and Mohan, 1995) as compared to sole cropping. However, it may result in reduced yield of one (Tom and Asiegbu, 2002; Alhaji, 2008; Mohammed *et al*., 2008; Egbe and Bar, 2010) or both the crops (Frey, 1973; Lamberts, 1980; Guldan *et al*., 1998; Khatiwada, 2000; Ghosh *et al*., 2006). However, in intercropping systems, not the yield but economic return is more important due to net benefit to the growers.

Garlic, turnip and cauliflower are main winter vegetables of Pakistan. Pea was selected as an intercrop because of its high nitrogen fixing activity. Hence, two vegetable crops can be grown using single dose of nitrogenous fertilizer by reducing the cost of nitrogenous fertilizer up to 50%. The current effort therefore was aimed at intercropping peas with some non-legume winter vegetables (i.e. garlic, turnip and cauliflower) and evaluating their growth, yields and economics.

MATERIALS AND METHODS

The present study was carried out at Vegetable Research Area, Department of Horticulture, Bahauddin Zakariya University, Multan, Pakistan to evaluate the effect of pea intercropping on biological efficiencies and yields of garlic, turnip and cauliflower under field conditions. The study was conducted during 2010-11, and repeated in 2011-12 to confirm the results.

Soil samples from various experimental blocks were collected randomly and analyzed for physico-chemical characteristics, which are given in Table 1. After sampling field was thoroughly tilled, leveled and the experiment was laid out according to Randomized Complete Block Design (RCBD). The vegetable cultivars grown in intercropping were peas cv. Early 6, garlic cv. GS-1, turnip cv. Purple Top and cauliflower Hybrid RS 5340 (Royal Sluis). These vegetables were grown alone and also in combination with pea. Garlic, turnip and cauliflower were main crops and pea was intercropped in these vegetables. Experimental area consisted of 21 plots in total (7 treatments and 3 replications). The intercropping treatments tested were as follows; T_1 = Pea alone, T_2 = Garlic alone, T_3 = Turnip alone T_4 = Cauliflower alone, T_5 = Peas in garlic, T_6 = Peas in turnip and T_7 = Peas in cauliflower.

Table 1. Physico-chemical characteristics of the soil before sowing the crops during the years 2010 and 2011

Characteristics	2010-11	2011-12
Texture	Loam	Loam
pH	8.02	8.04
EC (dS/m)	1.74	1.87
Organic Matter (%)	0.36	0.38
Available Phosphorous (ppm)	5.0	4.5
Available Potassium (ppm)	134	145

All the phosphorus (P_2O_5) and potassium (K_2O) were applied at the rate of 90 and 50 kg ha^{-1}, respectively, at sowing. Nitrogen (N) was applied at the rate of 90 kg ha^{-1} in three split doses; $^1/_3$ at sowing, $^1/_3$ after one month of sowing and remaining $^1/_3$ after first picking of peas. No additional dose of any fertilizer was applied to the intercrops.

Each experimental plot contained three beds and each bed was 1 m wide and 2 m long, i.e. each experimental plot had an area of 6 m^2. Garlic, turnip and cauliflower were grown on both sides of the beds and peas were intercropped in between these vegetables. Seeds of peas and turnip and cloves of garlic were sown on November 05 during both the years, i.e. 2010 and 2011 while one month old seedlings of cauliflower were transplanted in field on the same date. The plant to plant distances kept were as pea = 10 cm, garlic = 10 cm, turnip = 10 cm and cauliflower = 30 cm. The plant to plant distance was same in sole crop and intercrops. All other cultural practices like irrigation, weeding and plant protection measures were the same for all experimental plots during the entire period of experiment. Plants were allowed to grow till their edible maturity and data regarding various growth and yield parameters were recorded. Data collected were analyzed statistically by using Fisher's Analysis of Variance (ANOVA) technique. The treatment means were compared by employing Duncan's Multiple Range (DMR) test at $p = 0.05$. Co-stat statistical package software was used for the purpose. To estimate economic return of the intercropping treatments, marginal rate of return (MRR) was calculated. MRR is a term used to identify the rate of return per unit investment and was calculated by using the prevailing average market prices of inputs and the produce following the formula of CIMMYT (1988).

Marginal rate of return (MRR) = MNB/MC × 100
Where, MNB is marginal net benefit and MC is marginal cost.

RESULTS AND DISCUSSION

***Effect of pea intercropping and time on growth and yield of garlic*:** Data procured on different growth and yield characteristics of garlic were subjected to statistical analysis, which indicated significant differences between the intercropping treatments for all the parameters except number of cloves per bulb. However, the differences between the years and among the means of interaction between years and intercropping treatments were found statistically non-significant for all the parameters (Table 2).

The maximum plant height, leaf number and fresh and dry weights of garlic leaves were recorded when garlic was grown alone because there was no competition for soil nutrients and applied fertilizer for plant growth. Other factor possibly was availability of maximum soil and air space for root and shoot growth. Growth of garlic plants decreased significantly when pea was intercropped in garlic due to competition for essential nutrients, moisture, light, soil space, space for shoot growth and applied chemical fertilizer between two crops. Dry weight of leaves is directly related with fresh weight of leaves; therefore, it followed the same patterns as for fresh weight of leaves.

Similarly, the maximum bulb diameter, and fresh and dry bulb weights were obtained when garlic was grown alone probably due to better plant growth in terms of plant height and leaf number. Increased leaf number is possibly responsible for increased bulb size and weight. The bulb diameter and fresh and dry weights decreased greatly when pea was intercropped in garlic probably due to reduced plant height and decreased leaf number. However, number of clove per bulb was not affected by the intercropping. Clove number per bulb is possibly a genetic character and was not influenced by the intercropping treatments.

The maximum bulb yield recorded in garlic when grown as single crop was due to maximum bulb diameter and weight. A significant decrease (65.78%) occurred in bulb yield when pea was intercropped in garlic probably due to decrease in bulb size and weight in this intercropping treatment as there was an active competition between two crops for attaining essential nutrients for their growth. Similar results were concluded when chilies intercropped in garlic (Mallanagouda *et al*., 1995).

***Effect of pea intercropping and time on growth and yield of turnip*:** Statistical analysis of the data collected on different growth and yield characteristics of turnip exhibited non-significant differences between the years and among the means of interaction between years and intercropping treatments. However, the differences between intercropping treatments were found statistically significant for all the parameters (Table 3).

Maximum number of leaves per plant, and fresh and dry weights of leaves were recorded when turnip was grown alone because there was normal plant population and no

Table 2. Effect of pea intercropping on growth and yield of garlic

Characteristics	**T_2 (Garlic alone)**	**T_5 (Pea in Garlic)**
Plant height (cm)	57.71 a*	34.66 b
Number of leaves/plant	9.23 a	7.49 b
Fresh weight of leaves (g)	39.51 a	19.71 b
Dry weight of leaves (g)	8.41 a	4.22 b
Bulb diameter (cm)	5.15 a	3.45 b
Number of cloves/bulb	23.67 a	23.22 a
Fresh bulb weight (g)	63.37 a	36.23 b
Dry bulb weight (g)	17.62 a	10.60 b
Bulb yield (t/ha)	6.40 a	2.19 b

* Treatment means sharing similar letter in a row are statistically non-significant at $p = 0.05$ (DMR test).

Table 3. Effect of pea intercropping on growth and yield of turnip

Characteristics	**T_3 (Turnip alone)**	**T_6 (Pea in Turnip)**
Number of leaves/plant	20.28 a*	15.66 b
Fresh weight of leaves (g)	147.52 a	86.14 b
Dry weight of leaves (g)	28.82 a	18.04 b
Root diameter (cm)	8.67 a	6.53 b
Fresh root weight (g)	194.06 a	114.90 b
Dry root weight (g)	33.74 a	22.59 b
Root yield (t/ha)	28.83 a	20.45 b

* Treatment means sharing similar letter in a row are statistically non-significant at $p = 0.05$ (DMR test).

competition for soil nutrients, water, air space and sunlight. The number of leaves per plant decreased greatly (22.78%) when turnip was intercropped with pea due to high plant population and great competition for soil nutrients between turnip and peas. Similarly, fresh and dry weights of leaves were also decreased significantly (41.61 and 37.40%, respectively) indicating that pea intercropping in turnip severely reduced the vegetative growth of turnip.

The maximum root diameter, and fresh and dry root weights were obtained in turnip sole cropping because number and weight of turnip leaves were the maximum in sole cropping, which enhanced the process of photosynthesis. Photosynthesis produced sufficient amount of carbohydrates which increased the root diameter and ultimately fresh and dry root weights. When pea was intercropped in turnip, the root diameter, and fresh and dry root weights decreased because of reduced leaf number. Competition for all available resources between turnip and pea also played an important role in decreasing fresh and dry root weights of turnip.

The maximum yield in sole cropping of turnip was probably due to better vegetative growth and more root diameter and weight. The main reasons for decrease of yield (29.07%) when pea was intercropped in turnip were reduced vegetative growth, lesser root weight and decreased root diameter. Similar results were concluded when pea intercropped with turnip (Frey, 1973) and carrot intercropped with lettuce (Caetano *et al*., 1999).

Effect of pea intercropping and time on growth and yield of cauliflower**:** Data recorded on different growth and yield characteristics of cauliflower were subjected to statistical analysis, which revealed non-significant differences between the years and among the means of interaction between years and intercropping treatments. However, the differences between intercropping treatments for all the parameters were found statistically significant except for number of leaves plant^{-1} (Table 4).

The maximum fresh and dry weights of leaves and roots were recorded when cauliflower was grown alone. The decreased fresh and dry weights of leaves and roots when pea intercropped in cauliflower were because plant population was high and competition between two crops for essential nutrients and other resources was more as compared to sole cropping. Similar results were observed when cauliflower was intercropped with maize (Khatiwada, 2000). However, leaf number in cauliflower was not affected by the intercropping treatment. This indicated that cauliflower had competitive advantage when intercropped with pea.

The maximum curd diameter and fresh and dry weights were recorded when cauliflower was grown alone which might be attributed to maximum vegetative growth in this treatment. Fresh and dry weights of curd followed the same pattern and both were decreased significantly when pea was intercropped in cauliflower because of reduced vegetative growth. Similarly, in another experiment, intercropping of cauliflower with maize resulted in reduced curd diameter (Khatiwada, 2000). Intercropping of cauliflower with snap bean also reduced curd diameter and fresh weight as compared to sole cauliflower (Yildirim and Guvenc, 2005).

The curd yield was greater in cauliflower sole cropping, which decreased significantly (28.00%), when pea was intercropped in cauliflower because of reduced curd diameter and curd weight, in this intercropping treatment. Similar results have been reported when pea was intercropped in cauliflower, potato, lettuce, radish, turnip, coriander and spinach (Hussain, 2003), coffee intercropped in cabbage, tomato, dry beans, potato, carrots and soybeans (Njoroge and Kimemia, 1995), cabbage intercropped in spinach, fenugreek, coriander and radish (Rahangdale *et al*., 1995), and cauliflower intercropped in maize (Khatiwada, 2000) and snap bean (Yildirim and Guvenc, 2005). Unlu *et al.* (2010) intercropped pea and green bean in cabbage, the yield and the head size of the cabbage were affected negatively due to intercropping, indicating that pea and green bean were unsuccessful as intercrops in cabbage.

Effect of intercropping treatments and time on growth and yield of intercrop (pea)**:** Statistical analysis of the data procured on different growth and yield characteristics of pea revealed that there were no significant differences between

Table 4. Effect of pea intercropping on growth and yield of cauliflower

Characteristics	T_4 (Cauliflower alone)	T_7 (Pea in Cauliflower)
Number of leaves/plant	20.61 a*	20.60 a
Fresh weight of leaves (g)	631.13 a	504.03 b
Dry weight of leaves (g)	122.61 a	101.31 b
Fresh root weight (g)	35.53 a	28.86 b
Dry root weight (g)	10.19 a	7.50 b
Curd diameter (cm)	20.49 a	17.09 b
Fresh curd weight (g)	1030.31 a	712.95 b
Dry curd weight (g)	251.90 a	169.83 b
Curd yield (t/ha)	28.61 a	20.60 b

* Treatment means sharing similar letter in a row are statistically non-significant at $p = 0.05$ (DMR test).

the years and among the means of interaction between years and intercropping treatments. However, the differences between intercropping treatments were found statistically significant for all the parameters studied (Table 5).

The maximum plant height, fresh and dry weights of aerial parts and roots, number of pods per plant, pod length and weight, number of seeds per pod, 1000-seed weight, and pod yield of pea were recorded when it was grown alone. Although non-significant but a slight decrease in all the parameters was observed when pea was intercropped in garlic. The values of these parameters decreased significantly when it was intercropped in turnip. When it was intercropped in cauliflower, the values were minimum and statistically different from all the intercropping treatments for the corresponding parameters.

A slight but non-significant decrease in plant height, fresh and dry weights of aerial parts and roots of pea when intercropped in garlic was probably due to the competition between two crops for essential nutrients. Garlic is not a heavy feeder vegetable and both pea and garlic are shallow rooted but pea has ability to exploit available resources more efficiently so vegetative growth of pea decreased at a small level. The differences were statistically significant when pea was intercropped in turnip because turnip needs more nutrients as compared to pea, for this reason the competition was high between two crops. When pea was intercropped in cauliflower, vegetative growth of pea decreased to a greater extent because cauliflower is also a heavy feeder vegetable and needs maximum nutrients for its growth and development. Roots of turnip and cauliflower can penetrate deeper than the pea and can utilize water and nutrients more efficiently. Turnip and cauliflower have large canopies with broad leaves, which intercepted more light and casted shade on pea plants, affecting their rate of photosynthesis. For these reason, turnip and cauliflower greatly suppressed vegetative growth of pea. Plant weight is a function of plant height and number of leaves. Values related to fresh and dry weights of aerial portion and roots of peas followed the same pattern, as dry weight is related function of fresh weight. Similar results have been reported when pea was intercropped in cauliflower, potato, radish, turnip, and spinach (Hussain, 2003), cowpea intercropped in maize (Alhaji, 2008) and pigeon pea intercropped in maize (Tom and Asiegbu, 2002). Pigeon pea produced less total dry matter of aerial portion (leaves + stem) when intercropped in maize while the dry matter content was maximum in sole cropping (Tom and Asiegbu, 2002).

The maximum number of pods per plant was recorded when pea was grown alone because of maximum height of plants with maximum leaves and canopy. The enough leaves and green area resulted in increased rate of photosynthesis; due to sufficient glucose produced by photosynthesis, plant produced maximum number of pods per plant. As the height of pea was reduced, it caused a decrease in number of leaves or green area for photosynthesis resulting in reduced amount of glucose and finally culminating into reduced number of pods per plant. Similar results have been reported in cowpea when intercropped with maize (Alhaji, 2008) and sorghum (Mohammed *et al*., 2008), pigeon pea intercropped with sorghum (Egbe and Bar, 2010) and soybean (Ghosh *et al*., 2006).

Similarly, the pod length, number of seeds per pod, 1000-seed weight and average pod weight were the maximum when peas were grown alone because of good vegetative growth, which directly influences the sexual growth. As vegetative growth of pea was decreased in intercropping treatments, it finally resulted in small sized pods culminating into minimum number of seeds per pod. Therefore, the smallest pods (3.68 cm in length) with minimum seed number (2.84) were produced when pea was intercropped in cauliflower. As the pod length and 1000-seed weight decreased, pod weight was also reduced when pea was intercropped in turnip and cauliflower. Similar results have been reported in other leguminous crops in intercropping. For example, a significant decrease in pod length and seed number per pod and seed and total weight of cowpea were recorded when intercropped in sorghum (Mohammed *et al*., 2008) or maize (Alhaji, 2008), and also when pigeon pea

Table 5. Effect of intercropping treatments on growth and yield of pea

Characteristics	T_1 (Pea alone)	T_5 (Pea in Garlic)	T_6 (Pea in Turnip)	T_7 (Pea in Cauliflower)
Plant height (cm)	58.87 a*	56.93 a	37.92 b	34.09 c
Fresh weight of aerial parts (g)	20.45 a	19.30 a	17.81 b	13.31 c
Dry weight of aerial parts (g)	4.25 a*	3.87 a	3.32 b	2.61 c
Fresh root weight (g)	1.56 a*	1.37 a	0.89 b	0.63 c
Dry root weight (g)	0.41 a*	0.35 a	0.24 b	0.17 c
No of pods/plant	5.40 a	5.20 a	4.39 b	2.53 c
Pod length (cm)	6.69 a	6.67 a	5.42 b	3.68 c
No of seeds/pod	5.08 a	4.69 a	4.43 b	2.84 c
1000-seed weight (g)	411.33 a	389.66 a	299.66 b	203.33 c
Average pod weight (g)	4.25 a	3.96 a	2.75 b	1.61 c
Pod yield (t/ha)	3.66 a*	3.49 a	2.25 b	1.41 c

* Treatment means sharing similar letters in a row are statistically non-significant at $p = 0.05$ (DMR test).

Table 6. Marginal analysis of different intercropping treatments

Intercropping treatment	Total cost* (Rs. ha^{-1})	Net benefit (Rs. ha^{-1})	Marginal cost (Rs.)	Marginal net benefit (Rs.)	Marginal rate of return (%)
Pea alone	12,300	10,475	-	-	-
Pea in Garlic	21,550	213,425	9,250	202,950	2,194
Pea in Turnip	13,950	156,925	1,650	146,450	8,875
Pea in Cauliflower	16,850	327,925	4,550	317,450	6,977

*Includes cost of all inputs and cultural operations.

intercropped in maize (Tom and Asiegbu, 2002). Seed and pod weights also decreased when pigeon pea was intercropped in soybean (Ghosh *et al*., 2006) or in sorghum (Egbe and Bar, 2010), respectively.

The maximum pod yield was recorded in the treatment where pea was grown alone. This increase in yield was directly related with increase in plant height, number of pods per plant, pod length, number of seeds per pod, 1000-seed weight and average pod weight. The decrease in above mentioned parameters of pea finally caused a great reduction in pod yield (38.5 to 61.5%) on intercropping especially in turnip and cauliflower. In a study, mungbean and peanut as mono-crops had significantly higher number of pods per plant, number of seeds per pod, plant biomass and bean yields but the plants were adversely affected when planted as intercrop with corn because corn was taller and more competitive for growth resources (Arakama, 2009). Banik and Sharma (2009) conducted a field experiment on baby corn–legume intercropping system and found that yield of legume crops was significantly reduced when intercropped in baby corn due to differences in resource utilization efficiencies of maize and intercrops. Similar results have also been reported by several workers when pea crop was intercropped in cauliflower, potato, lettuce, radish, turnip, coriander and spinach (Hussain, 2003), in chilies (Guldan *et al*., 1998) and turnip (Frey, 1973), dry beans intercropped in potato (Lamberts, 1980), and cowpea intercropped in maize (Alhaji, 2008).

***Marginal rate of return*:** Among the three intercropping treatments, pea in turnip with lowest cost of production resulted in higher marginal rate of return. This was followed by pea in cauliflower intercropping with intermediate cost of production but with higher net benefit. On the other hand pea in garlic intercropping resulted in lowest marginal rate of return due to higher cost of production (Table 6).

Economics of any cropping system depends upon its cost of production, productivity and market price of the produce. Lower cost of production with higher yield(s) and higher price of commodity/commodities are usually more economical with higher net return. In the present study, when pea intercropped in turnip gave higher marginal rate of return, possibly due to low cost of production. This was followed by pea in cauliflower intercropping, where not only cost of production but also higher market price of cauliflower curds contributed to the net benefit. According to Brintha and Seran (2009), intercropping occupies greater land use and results in higher net return per unit area. Higher economic return from intercropping as compared to mono-cropping has already been reported for mustard-onion and mustard-garlic intercropping systems (Saker *et al*., 2007). In intercropping systems, economic value and net benefit to the growers is also important (Dordas *et al*., 2012) as overall feasibility, adoptability and sustainability of any system depends upon its economic benefits. In the present study, pea in cauliflower gave the highest net benefit, followed by pea in garlic intercropping system.

***Conclusion*:** From the results of present study, it can be concluded that peas can be successfully intercropped in garlic without significant reduction in the yield of peas. However, yield of garlic was significantly decreased. Pea intercropping in turnip or cauliflower resulted in significant decrease in growth and yields of both crops. Although marginal rate of return was higher in pea in turnip intercropping, net benefit to the growers revealed that pea intercropping in cauliflower was more profitable, followed by pea in garlic intercropping when cauliflower and garlic were grown on both sides of raised beds 1 m apart keeping plant to plant distances of 30 and 10 cm, respectively and pea was intercropped in these vegetables at a planting distance of 10 cm.

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