International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 141-145

Received: 20-09-2019
Accepted: 25-10-2019

Akshatha K
Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Bagalkot, Karnataka, India

Anand B Mastiholi
Department of Agronomy, KRCCH, Arabhavi, Karnataka, India

Vishwanath YC
Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Bagalkot, Karnataka, India

Gasti VD
Department of Vegetable Science, College of Horticulture, Bagalkot, Karnataka, India

Mallikarjun G Awati
Department of Crop Physiology, College of Horticulture, Bagalkot, Karnataka, India

Correspondence
Akshatha K
Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Bagalkot, Karnataka, India

Effect of intercropping system on yield components of ajwain (*Trachyspermum ammi* Sprague) and fennel (*Foeniculum vulgare* Mill) with leafy vegetables

Akshatha K, Anand B Mastiholi, Vishwanath YC, Gasti VD and Mallikarjun G Awati

Abstract
The field experiment entitled "Effect of intercropping system on yield components of ajwain (*Trachyspermum ammi* Sprague) and fennel (*Foeniculum vulgare* Mill) with leafy vegetables" was conducted at MHREC, UHS, Bagalkot during *Kharif* season of 2018-19. The experiment was laid out in Randomized Complete Block Design (RCBD) with different treatment combinations and replicated 4 times consisting of treatments, T_1: Ajwain + Fenugreek (1:2), T_2: Ajwain + Amaranthus (1:2), T_3: Ajwain + Coriander (1:2), T_4: Ajwain + Dill (1:2), T_5: Fennel + Fenugreek (1:2), T_6: Fennel + Amaranthus (1:2), T_7: Fennel + Coriander (1:2), T_8: Fennel + Dill (1:2), T_9: Sole Ajwain and T_{10}: Sole Fennel. Among ajwain number of umbels per plant (166.82), seed yield per plot (1.40 Kg) was recorded higher in sole ajwain, which was *on par* with ajwain + coriander and highest harvesting index (%) of 14.87 was recorded ajwain + dill. Similarly, among fennel highest number of umbels per plant (47.52), seed yield per plot (1.88kg) was recorded higher in sole fennel which was *on par* with fennel + coriander and highest harvest index (%) of 5.89 was recorded in fennel + amaranthus.

Keywords: Ajwain, fennel, amaranthus, fenugreek, coriander, dill, intercropping

Introduction
Fennel is one of the important major seed spice crops, botanically named as (*Foeniculum vulgare* Mill.), belongs to the family umbelliferae (Apiaceae) and having chromosome number of 2n=22. Fennel is believed to be native of Southern Europe and Mediterranean region. It is widely cultivated throughout the temperate and subtropical region of the world (Mehta *et al*., 2011) [11]. In India fennel is mainly grown in Gujarat and Rajasthan and to some extent in Uttar Pradesh, Karnataka, Andhra Pradesh, Punjab, Madhya Pradesh, Bihar, Haryana and Jammu and Kashmir as a winter crop and cultivated in an area of 0.75 lakh hectares with a production of 1.25 lakh tonnes with an average productivity of 1.66 tonnes per hectare (Anon., 2018) [2].

Ajwain (*Trachyspermum ammi* Sprague.) belongs to the Apiaceae family. Ajwain is widely distributed and cultivated in various regions such as Iran, Pakistan, Afghanistan, and India as well as Europe while, it is indigenous to Egypt. The essential oil from seeds is used in perfumery, essence and medicinal preparations. The fruit possesses stimulant, antispasmodic and carminative properties. Ajwain is mainly grown in Rajasthan, Gujarat, Madhya Pradesh, Tamil Nadu and Uttar Pradesh. Important seed spice crop of Rajasthan with Area, production and productivity of ajwain in Rajasthan are 0.06 lakh hectares, 0.04 lakh metric tonnes, and 680 kg/ha, respectively (Parsoya *et al*.,2018) [15].

Amaranthus (*Amaranthus sp)* collectively known as Amaranth, is a genus of annual or short-lived perennial plants which belongs to Amaranthaceae family. The word "Amaranth" is derived from Greek word "amarantos" which means "unfading flower". Amaranth seeds contain exceptionally complete protein for plant sources. Besides protein, they prove to be a good source of dietary fiber and dietary minerals such as iron, magnesium, phosphorus, copper and especially manganese. The leaves are also consumed as a nutritious leaf vegetable, being used both for cooking and salads. Hence, it is touted as a "grain of the future" for its good nutritional value (Das, S., 2016) [6].

Fenugreek (*Trigonella foenum graecum*) is an annual plant belongs to the family Leguminosae. It is the famous spices in human food.

The seeds and green leaves of fenugreek are used in food as well as in medicinal application which is the old practice in human history. It has been used to increase the flavouring and colour, and also modifies the texture of food materials. Seeds of fenugreek spice have medicinal properties such as hypocholesterolemic, lactation aid, antibacterial, gastric stimulant, for anorexia, antidiabetic agent, galactogogue, hepatoprotective effect and anticancer (Acharya *et al*., 2008) [1].

Coriander (*Coriander sativum)* is an annual herb. It is a member of the carrot family (Umbelliferae) and often used in flavouring substances. The root, stem, leaves and fruits all have an aromatic odour that most considered pleasant. In addition to India, coriander is cultivated commercially in Morocco, Romania, France, Spain, Italy, Netherlands, Myanmar, Pakistan, Turkey, Mexico, Argentina, South and Western Australia and to some extent in the UK and USA. Coriander seeds are also known for their medicinal properties. As such, coriander is a popular ingredient in the preparation of Ayurvedic medicines. The new value-added products, volatile oil and oleoresins obtained from coriander seeds are also in high demand on the international markets (Diwan *et al*., 2018) [7].

Dill (*Anethum graveolens*) is an annual herb belongs to family Apiaceae. It is the only species in the genus *Anethum*. Dill is grown widely in Eurasia where its leaves and seeds are used as a herb or spice for flavouring food. Fresh and dried dill leaves are widely used as herbs in Europe and central Asia. Like caraway, the fernlike leaves of dill are aromatic and are used to flavour many foods such as gravlax (cured salmon) and other fish dishes, borscht, and other soups, as well as pickles (where the dill flower is sometimes used). Dill is best when used fresh, as it loses its flavour rapidly if dried, however, freeze-dried dill leaves retain their flavour relatively well for a few months (Vashishtha and Malhotra, 2005) [19].

Intercropping refers to growing of two or more crops simultaneously, on the same piece of land base crop necessarily in distinct row management. Crop intensification is in both time and space dimensions. There is intercrop competition during all or parts of crop growth. (Panda, 2014) [14]. It is well acknowledged that each intercropping system generates a typical and unique pattern of use of the existing resources, which may vary according to the chosen intercropping ratio, and it is likely to differ from that obtained, if the two species were cultivated alone. (Caporali *et al*., 1987) [5]. Competition for the use of resources may occur throughout the growth period or for a part of it, or may not occur at all if the availability of factors necessary for growth is constantly higher than the combined requirement from the plants. (Bonciarelli *et al.*, 1989) [3].

Intercropping between legumes and other suitable crops is an alternative system for small-scale farmers to improve income and food production per unit area, and lessen the risks of total crop failure due to environmental limitations (Prasad and Brook, 2005) [16]. A given intercropping system may be advantageous when there is a mutualistic relationship between the partners or when the interspecific competition is weaker than intraspecific competition. When either species, or the most productive species, are affected more by intraspecific competition than interspecific competition, the optimal plant population may be higher when intercropped than when grown separately (Willey, 1979) [20].

The intercropping system aimed at increasing productivity per unit area. Integration of suitable vegetable crops with wide spaced seed spice crop is necessary. Among seed spices, fennel and ajwain are wide space crop best suited for intercropping with vegetable crops. (Mehta *et al*., 2015) [13]. Intercropping offers greater financial returns. It can be the insurance that farmers need, especially when the region is vulnerable to extreme weather. Having diverse crops allows to have some income even if the primary crop is damaged or does not yield as much as expected. It also minimises soil run off and can prevent the growth of weeds. Intercropping is good for the primary crops. The secondary crops can provide shelter and even protect the primary crops. It also allows to grow cash crops or any crop that will actually supplement the primary crop in some way.

Based on the intercropping definitions above, the experiment was conducted to evaluate the performance of ajwain (*Trachyspermum ammi* Sprague) and fennel (*Foeniculum vulgare* Mill) under intercropping system with leafy vegetables.

Materials and Methods

The experiment was conducted at MHREC, UHS, Udyangiri, Bagalkot, which is situated in Northern Dry Zone of Karnataka (Zone-3) located at 16°10' North latitude, 74°42' East longitude and at an altitude of 542.0 meters above the mean sea level. The meteorological data for the crop growth period are furnished in Appendix-I. As per the meteorological data from June, 2018 to December, 2018 the mean temperature was 21.14 ^{0}C to 31.64 ^{0}C, relative humidity was 45.14 to 69.81 per cent and rain fall was 0.92 mm. However, optimum soil moisture was maintained by regular supply of water through irrigation. The mean rainfall of 46 mm, mean temperature of 20.31 ^{0}C to 31.79 ^{0}C and the relative humidity of 40.36 to 67.12 per cent were recorded during the experimental period.

The experiment was laid out in Randomized Complete Block Design (RCBD) with different treatment combinations and replicated four times consisting of treatments, T_1: Ajwain + Fenugreek (1:2), T_2: Ajwain + Amaranthus (1:2), T_3: Ajwain + Coriander (1:2), T_4: Ajwain + Dill (1:2), T_5: Fennel + Fenugreek (1:2), T_6: Fennel + Amaranthus (1:2), T_7: Fennel + Coriander (1:2), T_8: Fennel + Dill (1:2), T_9: Sole Ajwain and T_{10}: Sole Fennel.

The whole experimental plot was brought to a fine tilth by repeated ploughings followed by harrowing by tractor drawn cultivator. Finally, it was levelled and divided into plots of required size (3.6 m x 4.8 m) and number. Provision was between the replications and treatments for path, irrigation and bund. The recommended dose of FYM (10 t/ha) was applied to each plot and incorporated well in the soil 21 days prior to sowing. Chemical fertilizers were applied as per the treatment according to package of practice for fennel 50kg N, 10 kg P and for ajwain 60kg N, 40 kg P, 30 kg K. Seeds were sown on 22nd September, 2018. The seeds were sown as per the spacing by using line rope. The seeds were placed at a depth of 0.5 to 1 cm by mixture of farm yard manure and sand, then the experiment was irrigated immediately for obtaining uniform and good germination. Germination of seedling commenced from 10 days after sowing and excess seedlings were thinned out 20 days after sowing manually by retaining one healthy seedling per hill. Fertilizers were applied in the form of straight fertilizers. Nitrogen in the form of urea, phosphorous in the form of single super phosphate and potassium in the form of muriate of potash were applied as per the treatments. First weeding was done after 30 days of sowing and later on in periodic intervals. Totally six weedings

were done during the experimentation in order to keep the field weed free. A basal irrigation was given after sowing. Subsequent irrigations were given as per the crop requirement based on soil moisture content. Totally 15 irrigations were given during the growth period at 6-7 days interval.

Ajwain was harvested when the plants started showing the signs of yellowing, drying and withering. At maturity flowers and seeds become brown in umbels in ajwain. Fennel was harvested at green stage 4- 5 times at 10 -15 days interval. All the leafy vegetables were harvested at 30 DAS, the plants were pulled out. Five healthy and normal plants were selected randomly by avoiding the border plants and were tagged with a label in each plot as per treatments schedule for recording various observations on growth and yield parameters at 30, 60, 90,120 days after sowing (DAS) and at harvest as detailed below. In intercrops, various observations on yield parameters were recorded at harvest.

Yield parameters

1. Number of umbels per plant

The umbels of five randomly selected plants from each plot at the time of harvesting were counted and average number of umbels per plant was recorded

2. Number of umbellate per umbel

The umbellate of five randomly selected plants from each plot at the time of harvesting were counted and average number of umbellate per plant was recorded.

3. Number of seeds per umbellate

The seeds of 25 selected umbellate from sampled plants of each plot were counted and they were recorded as number of seeds per umbellate

4. Test weight (1000 Seeds in g)

One thousand seeds were counted in random samples drawn from the final winnowed and cleaned produce of each plot. These counted seeds were weighed on electric balance and this weight was expressed as test weight in grams (g)

5. Seed yield (kg plot^{-1})

After threshing and winnowing, clean seeds obtained from individual plot were weighed and the weight was recorded. The average was computed and expressed as yield in kilogram per plot.

6. Seed yield (q ha^{-1})

After threshing and winnowing, clean seeds obtained from individual plot were weighed and the weight was recorded in kilogram per plot. This was then converted into quintals per hectare for calculation purpose.

7. Biomass yield (kg plot^{-1})

The harvested and sun-dried crop from each plot was weighed and the weight was recorded. The average was computed and expressed as yield in kilogram per plot.

8. Biomass yield (q ha^{-1})

The harvested and sun-dried crop from each plot was weighed and the weight was recorded in kilogram per plot and converted to quintals per hectare.

9. Harvest index (%)

Harvest index was calculated for each treatment by using the following formula given by Donald 1976 and expressed in per cent.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (q ha}^{-1})}{\text{Biological yield (q ha}^{-1})} \times 100$$

Results and Discussion

Significantly the higher umbels per plant, umbellate per umbel, seeds per umbellate, were obtained in sole ajwain (166.81, 15.09 and 13.73, respectively) and sole fennel (47.52, 44.70 and 29.51 respectively) over all intercropping systems (Table 5). Similarly, higher seed yield and biomass yield were obtained in sole ajwain (1.40 and 12.47 kg/plot, respectively) and sole fennel (1.88 and 43.52 kg/plot, respectively) over all intercropping systems (Table 6 and 7). With respect to intercropping systems, significantly higher yield attributes of ajwain and fennel was recorded when intercropped with coriander. In sole ajwain and sole fennel the higher yield attributes and yield of ajwain and fennel was obtained due to less competition for growth resources with any other crop leading to better absorption of nutrients and water by ajwain and fennel. The higher yield attributes and yield of ajwain and fennel intercropped with coriander crops was recorded due to higher growth parameters leading due to higher translocation of photosynthates from source to sink as compared to other crops. The higher yield under pure stand was also reported by Mehta *et al*. (2010) [12] in coriander as compared to their yields under intercropping systems.

Further examination of experimental data revealed that intercropping of ajwain and fennel with amaranthus significantly reduced ajwain and fennel yield and yield attributes. Tiwari *et al*. (2002) [18] reported depressing effect on growth and performance of fennel when intercropped with vegetable crop. Similarly Mehta *et al*. (2015) [13] and Kumar *et al*. (2006) [10] reported decrease in yield of fennel with intercropping. Similar result has also been reported by Hussain (2003) [9] in pea.

Harvesting index of ajwain and fennel were influenced significantly due to different intercropping system, Among ajwain intercropping system ajwain + dill (14.87) obtained maximum harvest index compare to other treatments. Among fennel intercropping system fennel + amaranthus got maximum harvesting index (5.89) might be due to more competition for space, water, nutrients and sunlight which resulted less number of branches per plant at different growth stages leading to which lower harvest index. This was also reported by Kumar *et al*. (2013) in mustard as compared to their yields under intercropping systems. These results also corroborated with findings of Boori *et al*. (2017) [4] in fennel. Mehta *et al*. (2015) [13] also reported similar results in fennel. Singh *et al*. (2017) [17] also reported similar results, Gunes *et al* (2007) [8] also reported that intercropping with chickpea increased the harvest index of wheat.

Table 1: Number of umbels per plant, umbellate per umbel, seeds per umbellate and test weight (g) in ajwain and fennel at harvest as influenced by different intercropping systems.

Treatments	Number of umbels		Number of umbellate per umbel		Number of seeds per umbellate		Test weight (g)	
	Ajwain	Fennel	Ajwain	Fennel	Ajwain	Fennel	Ajwain	Fennel
T_1: Ajwain + Fenugreek (1: 2)	146.25^{bc}	-	12.15^{b}	-	11.77^{b}	-	0.66	-
T_2: Ajwain + Amaranthus (1: 2)	130.35^{c}	-	8.92^{c}	-	9.90^{c}	-	0.66	-
T_3: Ajwain + Coriander (1: 2)	162.10^{ab}	-	14.10^{a}	-	13.50^{a}	-	0.67	-
T_4: Ajwain + Dill (1: 2)	147.05^{bc}	-	12.35^{b}	-	11.57^{b}	-	0.66	-
T_5: Fennel + Fenugreek (1: 2)	-	32.82^{b}	-	34.30^{b}	-	21.12^{b}	-	7.50
T_6: Fennel + Amaranthus (1: 2)	-	27.32^{c}	-	25.22^{c}	-	17.02^{c}	-	7.52
T_7: Fennel + Coriander (1: 2)	-	43.62^{a}	-	42.05^{a}	-	27.90^{a}	-	7.62
T_8: Fennel + Dill (1: 2)	-	31.52^{b}	-	35.25^{b}	-	21.12^{b}	-	7.50
T_9: sole Ajwain	166.81^{a}	-	15.09^{a}	-	13.73^{a}	-	0.68	-
T_{10}: Sole Fennel	-	47.52^{a}	-	44.70^{a}	-	29.51^{a}	-	7.62
S.Em ±	5.49	1.35	0.42	1.96	0.53	1.15	0.04	0.32
CD (0.05)	16.92	4.17	1.30	6.05	1.64	3.57	NS	NS
CV (%)	7.29	7.40	6.75	10.82	8.81	9.93	7.71	8.64

Table 2: Seed yield (kg plot^{-1} and q ha^{-1}) in ajwain and fennel as influenced by different intercropping system

Treatments	Seed yield (kg plot^{-1})		Seed yield (q ha^{-1})	
	Ajwain	Fennel	Ajwain	Fennel
T_1: Ajwain + Fenugreek (1: 2)	0.92^{bc}	-	8.81^{cd}	-
T_2: Ajwain + Amaranthus (1: 2)	0.77^{c}	-	7.93^{d}	-
T_3: Ajwain + Coriander (1: 2)	1.30^{a}	-	10.42^{b}	-
T_4: Ajwain + Dill (1: 2)	0.97^{b}	-	9.46^{bc}	-
T_5: Fennel + Fenugreek (1: 2)	-	1.47^{b}	-	14.33^{b}
T_6: Fennel + Amaranthus (1: 2)	-	1.17^{c}	-	11.48^{c}
T_7: Fennel + Coriander (1: 2)	-	1.82^{a}	-	17.99^{a}
T_8: Fennel + Dill (1: 2)	-	1.50^{b}	-	14.88^{b}
T_9: sole Ajwain	1.40^{a}	-	12.78^{a}	-
T_{10}: Sole Fennel	-	1.88^{a}	-	18.57^{a}
S.Em ±	0.05	0.04	0.37	0.45
CD (0.05)	0.15	0.14	1.16	1.41
CV (%)	9.42	5.98	7.66	5.95

Table 3: Biomass yield in ajwain and fennel (kg plot^{-1}) and (q ha^{-1}) as influenced by different intercropping system

Treatments	Biomass yield (kg plot^{-1})		Biomass yield (q ha^{-1})	
	Ajwain	Fennel	Ajwain	Fennel
T_1: Ajwain + Fenugreek (1: 2)	7.50^{b}	-	71.02^{b}	-
T_2: Ajwain + Amaranthus (1: 2)	5.32^{c}	-	50.44^{c}	-
T_3: Ajwain + Coriander (1: 2)	11.55^{a}	-	109.29^{a}	-
T_4: Ajwain + Dill (1: 2)	6.50^{b}	-	61.74^{b}	-
T_5: Fennel + Fenugreek (1: 2)	-	25.47^{b}	-	241.35^{b}
T_6: Fennel + Amaranthus (1: 2)	-	20.10^{c}	-	190.15^{c}
T_7: Fennel + Coriander (1: 2)	-	40.95^{a}	-	387.76^{a}
T_8: Fennel + Dill (1: 2)	-	25.12^{b}	-	238.10^{b}
T_9: sole Ajwain	12.47^{a}	-	118.05^{a}	-
T_{10}: Sole Fennel	-	43.52^{a}	-	412.24^{a}
S.Em ±	0.33	1.33	3.17	12.64
CD (0.05)	1.06	4.10	9.78	38.98
CV (%)	7.95	8.59	7.73	8.60

Table 4: Harvesting index (%) in ajwain and fennel as influenced by different intercropping system

Treatments	Harvesting index (%)	
	Ajwain	Fennel
T_1: Ajwain + Fenugreek (1: 2)	12.40^{bc}	-
T_2: Ajwain + Amaranthus (1: 2)	14.28^{ab}	-
T_3: Ajwain + Coriander (1: 2)	11.17^{c}	-
T_4: Ajwain + Dill (1: 2)	14.87^{a}	-
T_5: Fennel + Fenugreek (1: 2)	-	5.51^{a}
T_6: Fennel + Amaranthus (1: 2)	-	5.89^{a}
T_7: Fennel + Coriander (1: 2)	-	4.11^{b}
T_8: Fennel + Dill (1: 2)	-	5.76^{a}
T_9: sole Ajwain	11.22^{c}	-
T_{10}: Sole Fennel	-	4.04^{b}
S.Em ±	0.73	0.37
CD (0.05)	2.27	1.15
CV (%)	11.54	14.79

Conclusion

The findings of the present investigation clearly revealed that in case of ajwain number of umbels per plant (166.82), seed yield per plot (1.40 Kg) was recorded higher in sole ajwain, which was *on par* with ajwain + coriander and highest harvesting index (%) of 14.87 was recorded ajwain + dill. Similarly, in case of fennel highest number of umbels per plant (47.52), seed yield per plot (1.88kg) was recorded higher in sole fennel which was *on par* with fennel + coriander and highest harvest index (%) of 5.89 was recorded in fennel + amaranthus.

References

1. Acharya SN, Thomas JE, Basu SK. Fenugreek, an alternative crop for semiarid regions of North America. Crop science. 48(3):841-853. Agronomia. 2008; 21:3-17.
2. Anonymous. *Annu. Rep*. (2017-18) NRC on Seed Spices, Tabiji, Ajmer, Rajasthan, India. 4-5. Basi biologiche e Vantaggi Produttivi (In Italian, with English abstract) Riv, 2018.
3. Bonciarelli F. Avvicendamento e consociazione, in: Fondamenti di agronomia generale, 1989.
4. Boori PK, Shivran AC, Meena S, Giana GK. Growth and productivity of fennel (*Foeniculum Vulgare* Mill.) as influenced by intercropping with fenugreek (*Trigonella Foenum-Graecum* L.) and sulphur fertilization. Agricultural Science Digest. 2017; 37(1): 32-36.
5. Caporali F, Paolini R, Campiglia E. La consociazione fra piante erbacee, Nota I, 1987.
6. Das S. Amaranthus: A promising crop of future. Springer, 2016.
7. Diwan G, Bisen BP, Maida P. Effect of nitrogen doses and row spacing on growth and seed yield of coriander (*Coriandrum sativum* L.). Inter. J chem. Stu. 2018; 6(4):2768-2772.
8. Gunes A, Inal A, Adak S, Alpaslan M, Bagci EG, Ero T. Mineral nutrition of wheat, chickpea and lentil as affected by mixed cropping and soil moisture. Nutrient Cycling in Agroecosystems. 2007; 78:83-96.
9. Hussain N, Shamsi IH, Khan S, Akbar H, Shah WA. Effect of legume intercrops and nitrogen levels on the yield performance of maize. Asian J Plant Sci. 2003; 2(2):242-246.
10. Kumar A, Singh R, Chhillar RK. Nitrogen requirement of fennel (*Foeniculum vulgare* L.) based cropping systems. Indian J Agri. Sci. 2006; 76(10):599-602.
11. Mehta RS, Anwer MM, Aishwath OP. Growth and yield of fennel (*Foeniculum vulgare* Mill.) as influenced by irrigation, nutrient levels and crop geometry. J Spices Aromat. Crops. 2011; 20(2):77-80.
12. Mehta RS, Meena SS, Anwer MM. Performance of coriander (*Coriandrum sativum* L.) based intercropping system. Indian J Agron. 2010; 55(4):286-289.
13. Mehta RS, Singh B, Meena SS, Lal G, Singh R, Aishwath OP. Fennel (*Foeniculum vulgare* Mill.) based intercropping for higher system productivity. Int. J Seed Spices. 2015; 5(1):56-62.
14. Panda Cropping and farming system. Agrobios, 2014, 16.
15. Parsoya M, Mehta RS, Meena SS, Kumar V. Study on AJWAIN (*Trachyspermum ammisprage*) Based Intercropping System for Enhancing System Productivity, 2018; **7**(3):22-29. http://krishi.icar.gov.in/jspui/handle/123456789/19299.
16. Prasad RB, Brook RM. Effect of varying maize densities on intercropped maize and soybean in Nepal. Experimental Agric. 2005; 41:365-382.
17. Singh B, Aulakh CS. Effect on Growth and Yield of Intercrops in Wheat+Chickpea Intercropping under Limited Nutrition and Moisture, Ind. J Eco. 2017; 44(5):507-511.
18. Tiwari RS, Agarwal A, Sengar SC. Effect of intercropping on yield and economics of fennel (*Foeniculum vulgare* Mill.). Crop Res. 2002; 23(2):369-374.
19. Vashishtha BB, Malhotra SK. Seed spices crops–Status and production potential in low rain areas. Sustainable Agriculture Systems for the Drylands. 2005; 4(1):173.
20. Willey RW. Intercropping – its importance and research needs Competition in horticulture crops and yield advantages. Field Crops Abstr. 1979; 32:1-10.