International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(5): 572-576

Received: 28-07-2020
Accepted: 30-06-2020

Vipin Kumar
Department of Forest Products, Dr. YSP UHF Nauni, Solan, Himachal Pradesh, India

Dr. Meenu Sood
Department of Forest Products, Dr. YSP UHF Nauni, Solan, Himachal Pradesh, India

Corresponding Author:
Vipin Kumar
Department of Forest Products, Dr. YSP UHF Nauni, Solan, Himachal Pradesh, India

The performances of *Linum usitatissimum* on different organic manures and fertilizers under peach based horti medicinal system of agroforestry

Vipin Kumar and Dr. Meenu Sood

DOI: https://doi.org/10.22271/chemi.2020.v8.i5h.10357

Abstract
Linum usitatissimum commonly known as Alsi is a medicinal plant. Mid Himalayas are the bowl of stone fruits and peach is one of the important stone fruit of Himachal Pradesh Farmers are raising the orchards, hence keeping in view the importance of medicinal and aromatic plants under peach orchard is very good option. Farmers of many states in India have made the choice of cultivating medicinal plants and making profits by cultivating it. The use of FYM @ (2t/ha and 4t/ha), vermicompost @ (2t/ha and 4t/ha) and jeevamrutha @ (500l/ha) at appropriate doses was found beneficial minimizing competition for critical resources. The most beneficial treatment is fertilizers T_6(NPK) under peach base *Linum usitatissimum* crop. Maximum plant height (54.15 cm) at harvesting stage was observed with NPK 120:60:30 kg/ha + peach. The maximum numbers of branches per plant (4.85) were recorded in T_6. Maximum fresh aerial biomass per plant (11.98 g/plant) and estimated fresh aerial biomass per hectare (39.93 q/ha) was recorded as T_6. Maximum dry aerial biomass per plant (8.22 g/plant) and estimated dry aerial biomass per hectare (27.40 q/ha) was observed as T_6. Maximum seed yield (10.16 q/ha) was found in T_6. The highest gross return (Rs. 1,01,600) for *Linum usitatissimum* was recorded under T_6. The maximum total net return (Rs. 1,25,026) was recorded in T_6. Benefit cost ratio of *Linum usitatissimum* plants was best result (2.13) in T_5. All over all characteristics maximum were observed in T_6 as compare to other treatments. The intercropping of *Linum usitatissimum* with peach was found more beneficial as compared to sole crop.

Keywords: Seed yield, fresh aerial biomass, dry aerial biomass, jeevamrutha, net income and benefit cost ratio

Introduction
Linum usitatissimum commonly known as Linseed, Alsi or flax seed etc. is one of the oldest cultivated crop, grown widely grown for oil, fiber and food (Oomah, 2001) [12]. It belongs to the genus *Linum* and family Linaceae. It is an annual herbaceous plant with shallow root system. The cultivars grown primarily for seed/oil purpose are relatively short in height and posses more secondary branches and seed bolls. The cultivars grown for fiber purpose are tall growing with straight culms and have fewer secondary branches. The Mediterranean and Southwest Asia have both been proposed as the centre of origin (Millam *et al.*, 2005) [10]. Flax seed oil is an excellent source of the omega-3 fatty acid, linolenic acid with typical levels of 55% in the oil (Oomah, 2001) [12] making it ideal for paints, varnishes and inks due to its fast polymerization properties. Increasing demand for edible oil sources with significant percentages of omega-3 fatty acids is resulting in consumption of flax seed as a functional food. Flax seed is also added to animal feed to improve animal reproductive performance and health (Heimbach, 2009; Turner *et al.*, 2014) [6, 17]. Textile properties of flax fibre are superlative to cotton. Flax is the third largest natural fibre crop and one of the five top oilseed crops in the World. In ancient Egypt, linen was used for wrapping the royal mummies and additionally linseed oil was used to embalm the bodies of deceased Pharaohs. Flaxseed is also rich in soluble and insoluble fibres and lignans, which makes it useful as a dietary supplement. Consumption of flaxseed in daily diet simplifies the risk of cardiovascular diseases such as coronary heart disease and stroke, anticancer effects in the breast, prostate and colon cancers, habitual constipation, great tensile strength, staple length, durability and fineness.

They are used in the textile industries for making of linen cloth and thread, canvas, duck, strong twine, carpets, fish and seine lines, cigarette paper, writing paper and insulating materials. Fibres from the stalks of flax grown for seed are too harsh and brittle for spinning but may be used for other purposes. Some of the benefits of linen are that it is allergy-free, absorbs humidity and allows the skin to breathe, antistatic, antibacterial and low elasticity. Linen can be washed many times without alteration. It can absorb moisture up to 20 times its weight before it feels damp. The residues remaining after the oil extraction from linseed contains about 35-40% protein and 3-4% oil, a rich source of feed to cattle. Linseed is a natural substance and belongs to the bulk forming agents. It is used for the treatment of disorders of the respiratory tract, eyes, infections, cold, flu, fever, rheumatism and gout. The traditional agroforestry systems in the Himachal Pradesh have shown that farmers are aware of the benefits of mixed cultures and grow at least three to six layer of trees in and around their fields. Mid hills are the bowl of stone fruits and peach is one of the important stone fruit of Himachal Pradesh farmers are raising the orchards.

Agroforestry offers convenient strategy for promoting their cultivation and conservation. In horti-medicinal system, inter planting of medicinal and aromatic plants with stone fruit crops provide a better alternative to growers for acquiring income as well as ameliorating environment.

Material Methods

The present study was conducted at Department of Fruit Science, College of Horticulture and Medicinal and Aromatic Plant Research Farm and Laboratory of Department of Forest Products, College of Forestry, YSP University of Horticulture and Forestry, Nauni, Solan (HP) during 2016 to 2018. The experimental farm of department of fruit science and department of forest products are located at an altitude of 1270 m in the mid hills of Himachal Pradesh. This is situated 15km away from Solan town towards south east direction. This is the transitional zone between sub-tropical and sub temprate region.

Experimental Methodology

The study consisted of two structural and functional components *viz*., Peach (*Prunus persica* L. var. July Elberta), fruit tree as woody perennial and medicinal and aromatic plants as intercrop. Besides this, the impact of three organic manures and fertilizers on the growth and productivity of these medicinal and aromatic plants, growing along with and without peach was also studied.

Treatments

The experiment comprised of nine treatments viz. T_1 (Peach + *Linum usitatissimum* + Peach + FYM 2t/ha), T_2 (Peach + *Linum usitatissimum* + FYM 4t/ha), T_3 (Peach + *Linum usitatissimum* + Vermicompost 2t/ha), T_4 (Peach + *Linum usitatissimum* + Vermicompost 4t/ha), T_5 (Peach + *Linum usitatissimum* + Jeevamarutha 500 l/ha), T_6 (Peach + *Linum usitatissimum* + RDF 120:60:30 NPK kg/ha), T_7 (Peach + *Linum usitatissimum*), T_8 (*Linum usitatissimum* + RDF 120:60:30 NPK kg/ha) and T_9 (Control). Sowing of seeds were done during last fortnight of October month in lines and a spacing of 30 x 10 cm for two consecutive years. Data on growth and yield was recorded. The data recorded was subjected to statistical analysis under Randomized Block Design. Analysis of variance was worked out and critical difference at 5 per cent level of significance was calculated with the help of latest computer software.

Result and Discussion

The perusal data recorded that the height of *Linum usitatissimum* was significantly influenced by the application of organic manures and fertilizers. Maximum plant height (54.15 cm) was observed in T_6 (Peach + *Linum usitatissimum*+ RDF NPK 120:60:30 kg/ha) in 2016-17 at harvesting stage and it was statistically superior to all other values followed by T_4 Peach + *Linum usitatissimum* + Vermicompost 4t/ha (52.84 cm) and T_2 Peach + *Linum usitatissimum* + FYM 4t/ha (50.64 cm), T_3 Peach + *Linum usitatissimum* + Vermicompost 2t/ha (49.65 cm) and T_1 Peach + *Linum usitatissimum* + FYM 2t/ha (48.25 cm). Treatment T_5 Peach + *Linum usitatissimum* + Jevaamarutha (46.72 cm) was statistically at par with T_8 *Linum usitatissimum* + RDF NPK 120:60:30 (46.95 cm). The plant height during 2017-18 under different treatments also followed the same trend. The results obtained for plant height (cm) showed the importance of nitrogen for the proper growth of the plant, which is in agreement with the report of Tisdale *et al*. (2003) [16] that N is necessary for most of the physiological growth processes, and its absence or deficiency causes stunted growth.

The number of branches per plant of *Linum usitatissimum* were observed at harvesting stage. The data showed that the maximum number of branches per plant (4.85) at harvesting stage were recorded in T_6 (Peach + *Linum usitatissimum*+ RDF NPK 120:60:30 kg/ha) that was statistically superior, whereas the minimum (2.25) in T_9 (control), where no fertilizers and no manures was given during 2016-17. Similar observations for number of branches were recorded during 2017-18, where T_6 registered maximum number of branches/plant (4.23) that was statistically superior to all other treatments. The minimum number of branches/plant (1.57) were recorded in T_9 (control). The overall impact of different doses of fertilizers and organic manures on fresh and dry weight of *Linum usitatissimum* was studied for two consecutive years. In congruence to present studies reported that nitrogen, phosphorus and potassium increased the growth and yield pea Akhtar *et al*. (2003) [1] in *Pisum sativum.*

The data showed that among different treatments comparatively higher fresh yield/plant (11.98 g) was recorded in T_6 (Peach + *Linum usitatissimum*+ RDF NPK 120:60:30 kg/ha) in 2016-17 that was statistically superior. Minimum fresh aerial biomass (6.09 g/plant) was found T_9 (control). In 2017-18, maximum aerial fresh weight (9.75 g/plant) was recorded in T_6 where, plants were grown under peach and supplied with NPK 120:60:30 kg/ha that was statistically superior than other treatments. The minimum aerial fresh weight/plant (4.18 g) was recorded in T_9 (control) where, medicinal plants were grown without peach, without fertilizers and organic manures. The present studies find support from the work of Mohsin *et al*. (1999) [11] who reported that total biomass production was highest plantation intercropped with *Mentha* species, followed by those intercropped with *Cymbopogon* species and it was lowest in pure stands (*Populas deltoids*) clone 'G-3'. Bisht *et al*. (2000) [3] in *Zingiber Officinale and Curcuma longa* under *Grewia optiva,Celtis australis, Quercus leucotrichophora and Buhunia variegata*.

Among different treatments comparatively higher estimated fresh aerial biomass/ha (39.93 q/ha) was recorded in T_6 (Peach + *Linum usitatissimum*+ RDF NPK 120:60:30 kg/ha) that was statistically higher than other treatments. Minimum fresh aerial biomass was recorded in T_9 (20.30 q/ha) in 2016-17 (Table. 13). Similarly during 2017-18, maximum fresh aerial biomass was recorded in T_6 (32.50 q/ha) where, plants

were grown under peach and supplied with NPK 120:60:30 kg/ha that was statistically superior. The minimum fresh aerial biomass (13.93 q/ha) was recorded in T_9 (control) where, plants were grown without peach as well as organic manures and fertilizers. The data showed that fertilizers are more effective for increasing the fresh aerial biomass/plant of *L. usitatissimum* as compared to organic manures under peach. The present results coincides with those of Sehgal and Thakur (2008) [14] who reported that the application of organic manures improved performance and production efficiency of medicinal herbs intercropped with trees.

The perusal data showed that the dry aerial biomass/plant of *L. usitatissimum* was significantly influenced by different doses of organic manures and fertilizers. During 2016-2017, maximum average dry aerial biomass/plant (8.22 g) was observed in T_6, where *L. usitatissimum* was grown under peach and supplied with NPK 120:60:30 kg/ha and it was statistically superior than other treatments. Minimum average dry aerial biomass/plant (2.33 g) was recorded in T_9 (control), where *L. usitatissimum* was grown open field in 2016-17 respectively. The data recorded on dry aerial biomass/plant also followed the same trend during 2017-18. *Linum usitatissimum* was grown without peach and without organic manures as well as fertilizers. These results are similar to those of Palada *et al*. (2005) [13], Maheshwari *et al*. (2000) [8] and Menon (2003) who reported higher yield when intercropped with tree species than control.

Table 1: Performances of *Linum usitatissimum* under peach based Agroforestry system in 2016-17

Characters / Treatments	Plant height (cm)	Number of branches/ plant	Fresh aerial biomass/ plant (g)	Estimated fresh aerial biomass (q/ha)	Dry aerial biomass/ plant (g)	Estimated dry aerial biomass (q/ha)	Seed yield/ plant (g)	Estimated seed yield (q/ha)
T1	48.25	2.85	8.45	28.16	4.70	15.67	2.87	9.55
T2	50.64	3.15	9.84	32.80	6.09	20.30	2.92	9.73
T3	49.65	2.85	8.79	29.30	5.04	16.80	2.89	9.62
T4	52.84	3.95	10.54	35.13	6.79	22.63	2.99	9.97
T5	46.72	2.74	7.25	24.17	3.49	11.63	2.85	9.50
T6	54.15	4.85	11.98	39.93	8.22	27.40	3.05	10.16
T7	45.58	2.15	6.89	22.97	3.13	10.43	2.28	7.60
T8	46.95	3.14	7.98	26.60	4.22	14.07	2.83	9.44
T9	40.23	2.25	6.09	20.30	2.33	7.77	2.05	6.82
Mean	48.33	3.10	8.65	28.82	4.89	16.30	2.75	9.15
CD at 5%	0.44	0.07	0.16	0.54	0.16	0.65	0.03	0.10

Dry aerial biomass/ha in *Linum usitatissimum* differed significantly under different treatments. Maximum average estimated dry aerial biomass/ha (27.40 q/ha) was recorded in T_6 (Peach + *Linum usitatissimum*+ RDF NPK 120:60:30 kg/ha) that was statistically superior, whereas the minimum (7.77 q/ha) biomass in T_9 (control), where no peach, no fertilizers and manures were given during 2016-17. Similar observations for dry aerial biomass/ha were recorded during 2017-18, where T_6 recorded maximum aerial biomass (23.10 q/ha) and minimum dry aerial biomass/ha (4.53 q/ha) was recorded in T_9 (control) where without peach, no fertilizers and manures were applied. Dry aerial biomass/ha were higher during first year of study as compared to second year.

The perusal of data revealed that in *L. usitatissimum* maximum average seed yield (3.05 gm/plant) was recorded in T_6 where plants were grown under peach and supplied with NPK 120:60:30 kg/ha that was statistically superior than all other treatments followed by T_4 Peach + *Linum usitatissimum* + Vermicompost 4t/ha (2.99 g/plant) and T_2 Peach + *Linum usitatissimum* + FYM 4t/ha (2.92 g/plant), T_3 Peach + *Linum usitatissimum* + Vermicompost 2t/ha (2.89 g/plant) and T_1 Peach + *Linum usitatissimum* + FYM 2t/ha (2.87 g/plant). Whereas treatment T_5 Peach + *Linum usitatissimum* + Jevaamarutha (2.85 g/plant) was statistically at par with T_8 *Linum usitatissimum* + RDF NPK 120:60:30 (2.83 g/plant) and minimum seed yield (2.05 g/plant) was recorded in T_9 (control) where plants were cultivated without peach and without application of organic manures and fertilizers during 2016-17. During 2017-18, average higher seed yield/plant (2.41 g) was also observed in T_6 (Peach + *L. usitatissimum* + RDF NPK 120:60:30 kg/ha) which was statistically different from all other treatments. The minimum seed yield (1.60 g) was recorded in T_9 (no peach + no fertilizers + no organic manures). The data showed that fertilizers were more effective for increasing the seed yield of *L. usitatissimum* as compared to organic manures under peach. The present studies find support from the work of Baig *et al*. (2004) who reported that grain and straw yield of rice were significantly impressed by the application of *Sesbania esculanta* and FYM.

Seed yield of *L. usitatissimum* was maximum (10.16 q/ha) in T_6 (Peach + *Linum usitatissimum* + RDF NPK 120:60:30 kg/ha) and it was statistically different from all other treatments. It was followed by T_4 Peach + *Linum usitatissimum* + Vermicompost 4t/ha (9.97 q/ha) and T_2 Peach + *Linum usitatissimum* + FYM 4t/ha (9.73 q/ha), T_3 Peach + *Linum usitatissimum* + Vermicompost 2t/ha (9.62 q/ha) which was statistically at par with T_1 Peach + *Linum usitatissimum* + FYM 2t/ha (9.55 q/ha). Treatment T_5 Peach + *Linum usitatissimum* + Jevaamarutha (9.50 q/ha) was statistically at par with T_8 *Linum usitatissimum* + RDF NPK 120:60:30 (9.44 q/ha). The minimum seed yield (6.82 q/ha) was recorded in T_9 (control), where without peach, no fertilizers and manures were applied during 2016-17. Similar observations for seed yield were recorded during 2017-18, where T_6 recorded maximum seed yield (8.03 q/ha) and it was statistically different from all other values, followed by T_4 Peach + *Linum usitatissimum* + Vermicompost 4t/ha (7.76 q/ha) and T_2 Peach + *Linum usitatissimum* + FYM 4t/ha (7.63 q/ha), T_3 Peach + *Linum usitatissimum* + Vermicompost 2t/ha (7.56 q/ha) and T_1 Peach + *Linum usitatissimum* + FYM 2t/ha (7.36 q/ha). Whereas, treatment T_5 Peach + *Linum usitatissimum* + Jevaamarutha (6.99 q/ha) was statistically at par with T_8 *Linum usitatissimum* + RDF NPK 120:60:30 (6.91 q/ha). The minimum estimated seed yield (5.35 q/ha) was recorded in T_9 (control). Thus the data showed that when organic manures and fertilizers were applied, higher seed yield under peach was obtained as compared to sole crop. Similar results were noticed by Channanbasappa *et al*. 2009 in *Ocimum sanctum*, *Stevia rabudiana*, *Mentha arvensis*, *Periwinkle*, *Withania somnifera*, *Centella asiatica* and *Eclipta alba* under areca nut.

Table 2: Performances of *Linum usitatissimum* under peach based Agroforestry system in 2017-18

Characters / Treatments	Plant height (cm)	Number of branches/ plant	Fresh aerial biomass/ plant (g)	Estimated fresh aerial biomass (q/ha)	Dry aerial biomass/ plant (g)	Estimated dry aerial biomass (q/ha)	Seed yield/ plant (g)	Estimated seed yield (q/ha)
T1	44.30	2.09	6.46	21.53	4.28	14.28	2.21	7.36
T2	47.02	2.50	7.87	26.23	5.05	16.83	2.29	7.63
T3	45.27	2.17	6.86	22.87	4.04	13.47	2.27	7.56
T4	48.96	3.27	8.83	29.43	6.01	20.03	2.33	7.76
T5	42.15	2.08	5.24	17.47	2.42	8.07	2.10	6.99
T6	50.80	4.23	9.75	32.50	6.93	23.10	2.41	8.03
T7	41.45	1.54	4.86	16.20	2.04	6.80	1.69	5.64
T8	42.69	2.47	5.94	19.80	3.12	10.40	2.07	6.91
T9	36.62	1.57	4.18	13.93	1.36	4.53	1.60	5.35
Mean	44.36	2.44	6.67	22.22	3.92	13.06	2.11	7.03
CD at 5%	0.45	0.10	0.19	0.64	0.19	0.64	0.03	0.10

Economic Analysis of *Linum usitatissimum* under peach based Agroforestry system

The economics of peach based horti medicinal system of agroforestry system, consisting of medicinal plants, *Linum usitatissimum* as intercrop was calculated. The cost of cultivation, gross returns and net returns of *L. usitatissimum* were determined separately in the presence and absence of peach to know the economic profitability of tree- crop combination. Price of peach fruit Rs.30/kg and *Linum usitatissimum* Rs.150/kg in 2016-17.

The data showed that highest gross return (Rs. 1,01,600) for *L. usitatissimum* was recorded under T_6 in horti medicinal system of agroforestry where plants were supplied with NPK 120:60:30 kg/ha. It was statistically superior to all other treatments. Among different treatments the minimum gross return (Rs. 68,200) was found in T_9 (control) *i.e*. without peach, no fertilizers and organic manures during 2016-17. In 2017-18 significantly highest gross income (Rs. 80,300) was recorded in T_6 (Peach + *Linum usitatissimum*+ RDF NPK 120:60:30 kg/ha) and minimum gross income (Rs. 53,500) in T_9 (Control).

The total net return from agroforestry was calculated by adding net return obtained from intercrops and from tree component growing under agroforestry system. Among different treatments maximum total net return from agroforestry system (Rs. 1,25,026) was recorded in T_6 where, plants were cultivated under peach with fertilizers (NPK 120:60:30 kg/ha) and it was significantly different from all other values. Minimum net return was recorded in T_9 (Rs. 17,075.85) during 2016-17, where plants were grown without peach, no fertilizers and organic manures. During 2017-18, the maximum total net return from agroforestry system (Rs. 98,185.85) was recorded under T_6 (Peach + *Linum usitatissimum* + RDF NPK 120:60:30 kg/ha) that was statistically different from other treatments and minimum was recorded in T_4 (Peach + *Linum usitatissimum* + Vermicompost 4t/ha) (Rs. -39,024.20). The total net return was recorded higher during first year compared to second year of study.

Table 3: Economic analysis of *Linum usitatissimum* under peach based agroforestry system on gross income, cost of cultivation, net income and B: C ratio 2016-17

Characters / Treatments	Gross return from intercrop (Rs/ha)	Cost of cultivation (Rs/ha)	Net Income from intercrop (Rs/ha)	Average net return from peach (Rs/ha)	Total net return from AF system (Rs/ha)	B:C
T1	95,500	59,624.15	35,875.85	83,550	1,19,426	2.00
T2	97,300	63,124.15	34,175.85	83,550	1,17,726	1.86
T3	96,200	86,124.15	10,075.85	83,550	93,626	1.09
T4	99,700	1,16,124.2	-16,424.2	83,550	67,126	0.58
T5	95,000	57,124.15	37,875.85	83,550	1,21,426	2.13
T6	1,01,600	60,124.15	41,475.85	83,550	1,25,026	2.08
T7	76,000	56,124.15	19,875.85	83,550	1,03,426	1.84
T8	94,400	55,124.15	39,275.85	-	-	1.71
T9	68,200	51,124.15	17,075.85	-	-	1.33
Mean	91,544	67,179.71	24,364.73	83,550	106,826	1.62

Table 4: Economic analysis of *Linum usitatissimum* under peach based agroforestry system on gross income, cost of cultivation, net income and B: C ratio 2017-18.

Characters / Treatments	Gross return from intercrop (Rs/ha)	Cost of cultivation (Rs/ha)	Net Income from intercrop (Rs/ha)	Average net return from peach (Rs/ha)	Total net return from AF system (Rs/ha)	B:C
T1	73,600	60,124.15	13,475.85	78,510	91,985.85	1.53
T2	76,300	63,624.15	12,675.85	78,510	91,185.85	1.43
T3	75,600	86,624.15	-11,024.2	78,510	67,485.85	0.78
T4	77,600	1,16,624.2	-39,024.2	78,510	39,485.85	0.34
T5	69,900	57,624.15	12,275.85	78,510	90,785.85	1.58
T6	80,300	60,624.15	19,675.85	78,510	98,185.85	1.62
T7	56,400	56,624.15	-224.15	78,510	78,285.85	1.38
T8	69,100	55,624.15	13,475.85	-	-	1.24
T9	53,500	51,624.15	1,875.85	-	-	1.03
Mean	70,256	67,679.71	2,575.84	78,510	79,628.71	1.21

The perusal of data presented in Table 16 revealed that maximum benefit cost ratio (2.13) was recorded in T_5 (Peach + Jeevamrutha) and minimum benefit cost ratio (0.58) was found in T_4 (Peach + 4t/ha Vermicompost) during 2016-17. These values were statistically different from all other values. In 2017-18 maximum benefit cost ratio (1.62) was recorded in T_6 (Peach + NPK 120:60:30 kg/ha) and minimum (0.34) was recorded in T_4 (Peach + 4t/ha Vermicompost). Similar results were found by Thakur and Raj Kumar (2006) in *Tagetes minuta* and *Ocimum basilicum* under *Leucaena leucocephala* and *Morus alba*, Chauhan *et al*. (1997) in *Citronella java* under *Eucalyptus* also reported higher returns from intercropped plants than sole crop.

Conclusion

The investigations were conducted for two consecutive years (2016-17 and 2017-18) on the effect of organic manures and fertilizers under peach on the growth and productivity of *Linum usitatissimum* along with economic appraisal of the system. The aim of this studies were to evaluate the possibilities of growing medicinal and aromatic plants as intercrops under fruit based agroforestry system for diversification and boosting the economy of the farmers.

The results indicated that the growth parameters of *Linum usitatissimum* like plant height, number of branches per plant differed significantly with the application of fertilizers followed by organic manures under horti-medicinal system of agroforestry. The studies revealed that the applications of fertilizers were effective in improving the growth of medicinal and aromatic plants with tree and without tree.

The results obtained from the present investigations showed that the performance of *Linum usitatissimum*, was well under horti medicinal system of agroforestry as compared to sole crop. The growth, yield and physiological attributes of medicinal herbs were not adversely affected by the presence of peach tree.

Inorganic fertilizers and organic manures influenced the growth and yield parameters of *Linum usitatissimum*. In general fertilizer dose NPK 120:60:30 in respective crop was more effective in improving growth and yield attributes of medicinal plants intercropped under peach tree followed by organic manures and minimum in sole crop.

The intercropping of medicinal and aromatic plants (MAP's) with peach was found more beneficial as compared to sole crop. The result revealed that horti- medicinal system of agroforestry is more profitable and the use of fertilizers and organic manures gear up the growth by improving soil physicochemical properties, enhancing microbial activity and increasing nutrient availability to plants which helped in enhancing the yield of medicinal herbs under horti medicinal system of agroforestry. Uses of NPK increased the availability of nutrients to the plant.

Based on present findings, this can be concluded that *Linum usitatissimum* can be successfully grown under peach based agroforestry system for getting more economic returns.

References

1. Akhtar N, Muhammad A, Muhammad A. Growth and yield response of pea (*Pisum sativum* L.) crop to phosphorus and potassium application. Pakistan Journal of Agricultural Sciences. 2003; 40:3-4.
2. Baig MR, Ziaeldin MS, Mahler RL. Rehabilitation of problem soils through environmental friendly technologies: effect of Sesbania (*Sesbania aculeata*) and farmyard manure. Arab Gulf Journal of Scientific Research. 2004; 22:51-59.
3. Bisht JK, Chandra S, Chauhan VS, Singh RD. Performance of ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) with fodder tree based silvi-horti system in Hills. Indian Journal of Agricultural Sciences. 2000; 70:431-433.
4. Channanbasappa KS, Kumar P, Madiwalar SL. Production potential of medicinal and aromatic plants (MAP's) as efficient intercrops under arecanut. *My Forest.* 2009; 45:53-60.
5. Chauhan HS, Singh K, Patra DD. Performance of aromatic crops in Eucalyptus based agroforestry system. Journal of Medicinal and Aromatic Plant Sciences. 1997; 19:724-728.
6. Heimbach JT. Determination of the generally recognized as safe status of the addition of whole and milled flaxseed to conventional foods and meat and poultry products. In Flax Canada, 2009, 2015, 1e178.
7. Port Royal VA, JHeimbach LLC, Huang S, Milles D. Gamma-linolenic Acid: Metabolism and Its roles in nutrition and medicine, AOCS press: Champaign, IL, USA, 1996.
8. Maheshwari SK, Sharma RK, Mishra PK, Gangrade SK. Response of Kalmegh (*Andrographis paniculata*) to dates of planting and harvesting in a shallow black soil. AICRP on Medicinal and Aromatic Plants, College of Agriculture, JNKVV, Indore, India, 2000.
9. Menon. Performance of kacholam (*Kaempferia galanga*) ecotypes as influenced by variations in shade and preparatory cultivation. Journal of Medicinal and Aromatic Plant Sciences. 2003; 25:976-980.
10. Millam S, Bohus O, Anna P. Plant cell and biotechnology studies in *Linum usitatissimum*-A review. Plant Cell Tissue Organ Culture. 2005; 82:93-103.
11. Mohsin F, Singh RP, Singh K. Biomass distribution in *Populus deltoids* under agroforestry system. Indian Forester. 1999; 125:794-798.
12. Oomah BD. Flaxseed as a functional food source. Journal of the Science of Food and Agriculture. 2001; 81:889-894.
13. Palada MC, Mitchell JM, Becker BN, Nair PKR. The integration of medicinal plants and culinary herbs in agroforestry systems for the caribbean: a study in the U.S. virgin islands. Acta Horticulturae. 2005; 676:245-249.
14. Sehgal S, Thakur PS. Growth and production ability of medicinal herbs under agroforestry system and effect of organic manures. Indian Journal of Plant Physiology. 2008; 13:177-184.
15. Thakur P, Raj Kumar. Growth and production behavior of medicinal and aromatic herbs grown under hedgerows of *Leucaena* and *Morus*. Indian Journal of Agroforestry. 2006; 8:12-21.
16. Tisdale SL, Nelson WL, Beaton JD, Havlin JL. Soil fertility and fertilizers. 5th Edition, Prentice-Hall of India, Pvt. Ltd., New Delhi, 2003.
17. Turner TD, Mapiye C, Aalhus JL, Beaulieu AD, Patience JF, Zijlstra RT. Flaxseed fed pork: n-3 fatty acid enrichment and contribution to dietary recommendations. Meat Science. 2014; 96:541-547.