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Performance of coriander genotypes (*Coriandrum sativum* L.) for herbage yield and quality parameters under coconut during *Kharif* season

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Abstract
The present experiment on "Performance evaluation of coriander genotypes for herbage yield and quality under coconut ecosystem" was carried out at Coconut Nursery, Department of Spices and Plantation crops, Horticultural College and Research Institute, Coimbatore to identify the promising leafy coriander genotypes suitable for cultivation under coconut ecosystem. About fourteen coriander genotypes (leafy types) were used for this study and were evaluated during the months of June to July (*Kharif)*. The experiment was laid out in randomized block design (RBD) and replicated thrice. Data on growth and yield parameters such as number of days taken for germination, number of leaves per plant, number of branches per plant, plant height (cm), leaf area (cm^2), plant weight (g), shoot weight (g), herbage yield per plot ($kg/6m^2$), Estimated herbage yield (t/ha), quality parameters *viz.*, total phenols (mg/100g), total flavonoids (mg/100g), ascorbic acid (mg/100g) content were also estimated and analyzed statistically. The results revealed that, Acr-1 recorded the highest values of growth and yield parameters among the fourteen genotypes evaluated. CO Acc 2 recorded the highest values for, plant height (27.38 cm), number of leaves per plant (35.2), leaf weight (2.46 g) leaf area (181.5 cm^2), number of branches per day (9.2), plant weight (5.95 g), shoot weight (5.72 g), root length (10.04 cm), root weight (0.29 g) yield per plot (($5.98\ kg/6m^2$) and estimated yield (9.97t/ha), followed by CO Acc 11 and CO Acc 6 recorded which higher values then rest of the genotypes.

Keywords: coriander, coconut, genotypes, herbage, intercrop

Introduction
Coriander (*Coriandrum sativum* L.) is a tropical and sub-tropical crop indigenous to southern Europe and the Mediterranean region. The word coriander in derived from the Greek name for bug "kurion" (Diederichsen 1996) [5]. The green, young coriander leaves are also known as cilantro and are used as a herbal flavoring in the preparation of sauces, salads and seafood dishes and variety of ethnic foods (Singletary *et al.*, 2016) [23]. The coriander leaves are rich in minerals *viz.*, calcium (1246 mg/100 g), iron (42.46 mg/100g), magnesium (694 mg/100g), phosphorus (481 mg/100g), potassium (4466 mg/100g), sodium (211 mg/100g), zinc (4.72 mg/100g), vitamin C (566.7 mg/100g) (USDA 2013) [28]. It is a well known ayurvedic medicinal plant in India known as "Dhaniya." This plant can also be used to treat the disease such as digestive system disorders, respiratory tract disorders, and urinary tract infections. Coriander has been shown to have a pharmacological activities, such as antioxidant, anti-diabetic, anti-mutagenic, antilipidemic, and anti-spasmodic properties (Darughe *et al.*, 2012).
In India, this crop is cultivated in an area of 2,94,542 ha with an estimated yield of 11,01,920 metric tonnes in 2021. (Spice Board 2021). It is cultivated in Rajasthan, Madhya Pradesh, Tamil Nadu, Gujarat, Karnataka, Maharashtra, Orissa, and Andhra Pradesh on a larger scale.
In many parts of the state, the productivity of coconut plantation is low because it has been planted for more than 50 years. When the coconut is sufficiently enormous, the performance of this coconut plant has grown tall enough that light penetrates the coconut canopy and reaches the area beneath it (Polakiton *et al.*, 2020). The coconut growing habit of solo coconut palms spaced at 7.5 x 7.5 m successfully uses 22.3 percent of land area, while canopy utilization is about 30% and solar radiation interception is 45-50 percent (Maheswarappa *et al.*, 2010) [12]. Adoption of coconut based cropping system provides the additional income per unit area as well as sufficient work to the family labours throughout the year. Thus, coconut garden offers excellent opportunities for inclusion of compatible component crops for effective utilization of natural resources for increasing productivity and maximizing returns per unit area. With this background, the present investigation was taken up to study the performance of coriander

varieties and genotypes under coconut system for high herbage yield.

Material and Methods

Three readings were taken from each plot and an average value of 35 to 50% PAR penetrated into the coconut garden. The site recorded the temperature ranging between 21^0 C and 22.5^0 C in the month of June 2021. The coriander genotypes were raised under the shade of 50 year old coconut (WCT) garden in randomized block design with three replications. Fourteen different genotypes *Viz*., CO Acc 1, CO Acc 2, CO Acc 3, CO Acc 4, CO Acc 5, CO Acc 6, CO Acc 7, CO Acc 8, CO Acc 9, CO Acc 10, CO Acc 11, CO Acc 12, CO Acc 13, CO Acc 14 were used for the study. The seeds were collected from NRCSS, Ajmer. Line sowing of coriander was taking with quality seeds of 50 g per plot. The seeds were split into halves by rubbing with hand before sowing and seeds were soaked overnight in water to enhance better germination. Beds size 3x2 m^2 size were prepared and sowing was taken up at a spacing of 30 cm between lines.

Plant growth characters were recorded *viz.*,days taken for germination, plant height (cm), plant weight (g), shoot weight (g), number of leaves per plant, leaf area (cm^2), number branches per plant, herbage yield per plot (kg), estimated herbage yield (t/ha), total phenols (mg/100g), total flavonoids (mg/100g), ascorbic acid (mg/100g). The quality parameters were analysed as per the procedure Singleton *et al.*, (1965) [24] for total phenols, Dewanto *et al.*, (2002) [4] for total flavonoids and AOAC (2005) [2] for ascorbic acid content. Statistical analysis was done by adopting the procedure described by Panse and Sukhatme (1985) [15].

Result and Discussion

The data pertaining to growth characters *viz*., days taken for germination, plant height, plant weight and shoot weight for different genotypes are reported in Table 1.

The genotype CO Acc-11 recorded minimum number of days taken for initial germination (7.50 days). The genotypes CO Acc-1, CO Acc-2, CO Acc-6, CO Acc-8, CO Acc-4, CO Acc-10, CO Acc-12 are on par with CO Acc-11. Likewise on observing days for completion of germination CO Acc-11 and CO Acc-2 (11.00 days) recorded minimum days while the genotypes CO Acc-1, CO Acc-6, CO Acc-8, CO Acc-9, and CO Acc-12 were on par with CO Acc-11 and CO Acc-2. The variation in number of days taken for germination may due to the genotypic trait of the genotype and response to microclimatic condition created due to coconut shade. Sarada *et al.*, (2018) [21] stated that high temperature will be the limiting factor for germination and growth of the coriander. Since temperature has considerable effect on germination characters viz., germination rate and days taken to germination, it is therefore the most critical factor in the determination of success or failure of crop establishment. This reduction or inhibition in germination rate at undesirable temperatures can be attributed to the reduction or inhibition of enzymatic activity which is responsible for seed germination process. The fast germination would be resulted from the maintenance of optimum low temperature under shade condition as from the experimental finding of Gowtham and Mohanalakshmi (2018) [7].

Plant height significantly varied among the genotypes of coriander cultivated under coconut shade condition as given in Table 1. Genotypes CO Acc-2 and CO Acc-8 recorded maximum plant height which were on par with each other at 20 DAS (7.95 and 7.39 cm), 30 DAS (15.66 and 15.54 cm) and at harvest (27.38 cm and 25.86) respectively. Genotypes, CO Acc-4 and CO Acc-8 performed well at 20 DAS but the performance gradually slowed down on upcoming days. Though the variation in plant height is due to the inherent character of the genotype, the influence of coconut shade might have resulted in gradual increase in the height of the plant. Gowtham and Mohanalakshmi (2018) [7] reported that the highest plant height was recorded in coriander under shadenet conditions than in open field condition, which supports the experimental results Imam and Ranjbar (2000) [8] stated that decreased light penetration into middle and lower layers of canopy decreases the auxin decompositions and there by enhances the plant height. Reports by Singh *et al.*, (1994) [22] and Tehlan and Malik (2010) [27] are supports our observation. It is reported that the plant height was significantly higher under 50% shadenet intensities than under 75% and 35% which might be due to apical dominance stimulated by low light intensity. It denotes that high shade intensity also has negative influence in plant growth.

Significant variation was observed for plant weight among the fourteen genotypes studied under coconut shaded condition at 3 different harvest intervals. The genotypes CO Acc-11, CO Acc-2, CO Acc-6 and CO Acc-4 recorded maximum plant weight at 20 DAS viz., 0.26 g, 0.25 g, 0.23 g and 0.22 g respectively which were on par with each other. The genotypes CO Acc-11, CO Acc-2, CO Acc-6, CO Acc-5, CO Acc-8, CO Acc-12 and CO Acc-4 recorded maximum plant weight at 30 DAS *viz.*, 1.30 g, 1.30 g, 1.16 g, 1.14 g, 1.12 g, 1.11 g and 1.09 g respectively which were on par with each other. At the time of harvest, CO Acc-2, CO Acc-11 and CO Acc-6 recorded maximum plant weight *viz*., 5.95 g, 5.54 g and 5.33 g respectively. In all the stages, genotypes COR-2 and COR-11 recorded maximum plant weight among the genotypes evaluated. The finding is in accordance with Rajamanickam (2019) [20] that the coriander genotypes attained maximum plant weight under shade net during the months of April to June. Surya Raj and Anitha (2018) [26] reported that the higher plant weight as well an biomass yield in coriander was recorded under rain shelter compared to open field conditions. Hence, it is concluded that the increased plant weight is also influenced by the microclimatic condition prevailing to the crop in addition to varietal character.

Variation in shoot weight plant per plant also significantly varied among the studied genotypes at different intervals. In all the three stages viz., 20 DAS, 30 DAS and at harvest, genotypes CO Acc-2 and CO Acc-11 recorded maximum shoot weight per plant (0.23 g and 0.23 g; 1.27 g and 1.23 g; 5.72 g and 5.55 g) respectively. The variation in shoot weight may be due to the difference in the vigour, leaf area, expressed by the genotype at different growth stages.

Significant variation was recorded with respect to number of leaves plant per plant and Leaf area per plant among the genotypes evaluated under coconut shade condition. (Table 2) Though many genotypes recorded maximum number of leaves per plant at 20 DAS, 30 DAS and at harvest, the genotypes CO Acc-2, CO Acc-11and CO Acc-6 recorded maximum values on par with each other in all the stages. During 20 DAS, 30 DAS and at harvest, CO Acc-2 recorded 3.40, 12.70 and 35.2 number of leaves per plant, CO Acc-11 recorded 3.00, 11.50, 33.00 number of leaves per plant, CO Acc-6 recorded 3.00, 10.60, 32.60 number of leaves per plant. The results are in line with the result confirmed by Sarada *et* *al* (2018) [21], Prabhu and Balakrishnamoorthy (2006). The difference in leaf number of different day interval may be attained due to the varietal response to the response to the shaded condition under coconut ecosystem. Gowtham and Mohanalakshmi (2017) reported that crops grown under shadenet condition recorded maximum mean leaves. The findings are in line with Surya Raj and Anitha (2018) [26], Ashok and Ravivarman (2021) [1], Rajamanickam (2019) [20] and Mahajan *et al.,* (2017) [11]. Mahajan *et al.,* reported that the maximum number of leaves per plant under shade intensity might be attributed to the varietal trait and availability of more absorbed photosynthetical active radiation (APAR) resulting in more photosynthetic rate and increased leaf number.

The genotype CO Acc-2 (0.14 g, 0.69 g and 2.46 g) and CO Acc-11 (0.13 g, 0.66 g and 2.45 g) recorded highest leaf weight per plant at 20 DAS, 30DAS and at harvest respectively which were on par with each other. Genotype CO Acc 6 recorded maximum leaf weight per plant during 20 DAS (0.12 g) and at harvest (2.20 g) which are on par with CO Acc-2 and CO Acc-11. The variation in leaf weight with genotype may be due to the accumulation of biomolecules and other biochemical characters which was affected due to shaded condition.

Table 1: Performance of coriander genotypes for growth characters under coconut ecosystem

Genotype	Days taken for germination		Plant Height (Cm)			Plant weight (g)			Shoot weight (g)/ plant		
	Initial germination	Complete germination	20 DAS	30 DAS	At harvest	20 DAS	30 DAS	At harvest	20 DAS	30 DAS	At Harvest
CO Acc 1	8.00	11.50	6.68	12.88	23.20	0.20	0.99	4.70	0.17	1.03	4.50
CO Acc 2	8.50	11.00	7.95	15.66	27.38	0.25	1.30	5.95	0.23	1.27	5.72
CO Acc 3	9.00	13.00	6.42	11.78	21.30	0.20	1.04	4.95	0.16	0.94	4.73
CO Acc 4	8.50	13.50	7.33	12.57	19.16	0.22	1.09	4.20	0.19	1.02	3.98
CO Acc 5	8.00	13.00	6.83	13.69	24.78	0.17	1.14	5.33	0.15	1.04	5.19
CO Acc 6	8.00	12.00	6.93	13.39	22.82	0.23	1.16	2.05	0.20	1.20	5.37
CO Acc 7	9.00	14.50	6.20	11.62	20.52	0.20	1.04	4.65	0.14	0.97	4.35
CO Acc 8	8.00	11.50	7.19	13.02	24.30	0.16	1.12	1.58	0.18	1.04	1.50
CO Acc 9	8.00	12.00	6.86	12.00	21.48	0.17	1.06	2.84	0.15	1.09	2.46
CO Acc 10	8.00	13.50	5.70	11.00	18.26	0.17	0.97	3.73	0.14	0.85	3.50
CO Acc 11	7.50	11.00	7.39	15.54	25.86	0.26	1.30	5.54	0.23	1.23	5.55
CO Acc 12	8.00	12.00	6.07	11.93	18.72	0.17	1.11	3.85	0.15	1.05	3.66
CO Acc 13	12.00	15.50	6.22	10.22	19.74	0.19	0.72	4.83	0.16	0.67	3.21
CO Acc 14	9.50	15.50	7.10	12.07	18.54	0.21	1.06	3.22	0.19	0.95	3.06
Mean	8.57	12.82	6.78	12.67	21.86	0.20	1.08	4.10	0.17	1.03	4.06
Sed	0.39	0.55	0.39	0.49	0.72	0.02	0.11	0.32	0.02	0.11	0.30
CD (0.05)	0.81	1.13	0.80	1.01	1.47	0.04	0.22	0.66	0.04	0.22	0.62
CV (%)	5.60	5.26	7.04	4.73	4.01	12.92	12.34	9.52	13.26	12.94	9.16

Table 2: Performance of coriander genotypes for leaf growth characters under coconut ecosystem

Genotype	Number of leaves per plant			Leaf area (cm^2) per plant			Number of branches per plant
	20 DAS	30 DAS	At harvest	20 DAS	30 DAS	At harvest	
CO Acc 1	2.80	10.70	24.0	4.39	20.16	126.75	8.2
CO Acc 2	3.40	12.70	35.2	6.12	28.17	181.5	9.2
CO Acc 3	2.90	10.20	27.8	4.01	18.11	125.94	3.8
CO Acc 4	3.00	10.60	25.6	4.54	19.39	76.45	7.8
CO Acc 5	2.50	10.10	27.4	4.68	19.24	126.11	8.0
CO Acc 6	3.00	10.60	32.6	4.83	21.48	149.96	8.4
CO Acc 7	2.70	10.30	24.8	3.93	19.91	86.90	7.4
CO Acc 8	2.80	7.40	12.2	4.56	16.82	52.73	2.4
CO Acc 9	2.90	11.10	32.0	3.92	18.12	91.68	6.6
CO Acc 10	2.40	9.50	19.4	4.42	18.22	69.29	6.4
CO Acc 11	3.00	11.50	33.0	5.82	23.32	158.48	9.2
CO Acc 12	2.70	9.20	22.2	4.15	17.48	94.35	7.2
CO Acc 13	2.80	8.30	22.2	4.90	15.75	96.83	4.9
CO Acc 14	2.60	10.50	20.6	4.38	21.35	93.59	7.8
Mean	2.82	10.19	25.64	4.62	19.82	110.52	6.95
Sed	0.20	1.03	1.54	0.44	1.65	12.71	0.49
CD (0.05)	0.41	2.12	3.17	0.90	3.40	26.13	1.01
CV (%)	8.59	12.37	7.36	11.64	10.22	14.09	8.62

Table 3: Performance of coriander genotypes for herbage yield and quality under coconut ecosystem

Genotype	Yield/plot (6 m^2)	Estimated yield (t/ha)	Total phenols (mg/ g sample)	Total Flavonoids (mg/ g sample)	Ascorbic acid (mg/100g)
CO Acc 1	3.18	5.30	2.36	15.50	58.82
CO Acc 2	5.98	9.97	2.94	12.88	102.94
CO Acc 3	3.46	5.77	2.64	12.33	172.79
CO Acc 4	3.51	5.85	1.99	9.21	73.52
CO Acc 5	4.49	7.48	2.08	11.29	93.29
CO Acc 6	5.58	9.30	1.71	11.71	66.00
CO Acc 7	3.08	5.13	2.35	9.63	88.00
CO Acc 8	4.78	7.97	2.46	10.33	279.41
CO Acc 9	4.71	7.85	2.33	11.71	80.88
CO Acc 10	3.96	6.60	2.15	17.17	77.00
CO Acc 11	5.91	9.85	1.98	12.21	47.79
CO Acc 12	5.02	8.37	1.87	11.17	69.85
CO Acc 13	2.72	4.53	2.54	11.00	106.61
CO Acc 14	3.05	5.08	2.20	12.25	220.58
Mean	4.25	7.08	2.26	12.03	109.82
Sed	0.09	0.15	0.08	0.52	16.5
CD (0.05)	0.19	0.31	0.16	1.07	33.92
CV (%)	2.63	2.63	4.35	5.3	18.4

Leaf area

Significant variation has been recorded in leaf area per plant (cm^2) with respect to genotypes evaluated under coconut shaded situation. Maximum leaf area at 20 DAS, 30 DAS and at harvest were recorded in CO Acc-2 (6.12 cm^2, 28.17 cm^2, 181.5 cm^2) and CO Acc-11 recorded maximum leaf area at 20 DAS (5.82 cm^2) and at harvest (158.48 cm^2) which are on par with each other. It is in line with the findings of Mahajan *et al.*, (2017) [11] and Rajamanickam (2019) [20]. The highest leaf area has been recorded by these varieties due to maximum number of leaves per plant at different intervals and influence of shade in increasing photosynthethic rate through the action in cell division and cell elongation (Pandey and Sinha, 2004) [14] in fenugreek and coriander.

Number of branches per plant

The genotypes, CO Acc-2 (9.2), CO Acc-11 (9.2), CO Acc-6 (8.4) and CO Acc-1 (8.2) have recorded the highest number of branches per plant. The variations in number of branches per plant might be considered as the result of genotypical trait and the influence of coconut shade conditions in all the evaluated genotypes. The findings are in line with the results Rajamanickam (2019) [20]. The greater plant height might have helped in the production of more number of branches per plant this finding is supported by Dixit (2007) [6] and Meena and Malhotra (2006) [13] in coriander in coriander.

Herbage yield

Significant variations were registered among the genotypes for herbage yield per plot and estimated herbage yield per ha. CO Acc-2 (5.98 kg) and CO Acc-11 (5.91) recorded maximum herbage yield per plot which are on par with each other. On considering estimated herbage yield, CO Acc-2 recorded maximum estimated herbage yield (9.97 t/ha) followed by CO Acc-11 (9.85 t/ha) which were on par with each other. These results are in line with the findings of Rajamanickam (2019) [20], Mahajan *et al.*, (2017) [11] and Tehlon and Malik (2010) in coriander under shade condition. Mahajan added that, there was no interactive influence of genotype and shading conditions in herbage yield of coriander. Hence, the herbage higher yield by the CO Acc-2 followed by CO Acc-11 would be the influence of Shade effect under coconut plantation. Ashok and Ravivarman (2021) [1] stated that the notable increase in single plant fresh weight under protected structure is proportional to increase in plant height, number of branches and number of leaves per plant. This is in line with the findings that, high yielding genotypes CO Acc-2 and CO Acc- 11 recorded maximum values than other evaluated genotypes of plant height, number of branches and number of leaves per plant.

Quality parameters

Significant variation was recorded for the quality parameter among 14 different genotypes under coconut ecosystem. The results for the quality parameters are depicted as below.

The variation for total phenol content ranged from 1.71 to 2.94 mg/100g sample. Genotype CO Acc-2 has recorded the highest to total phenol content (2.94 mg/100g) sample, followed by CO Acc-3 (2.64 mg/100g) and CO Acc-8 (2.46 mg/100g) and lowest range in CO Acc-6, Similar variation in total phenolic content was also reported by Wangensteen *et al.*, (2004) [29].

Total flavonoids are a group of compounds such as gallic acid, pyragaccol, cataccin etc which are helpful for metabolic activities. Significant variation was recorded for total flavonoids content among the studied genotypes under coconut shade. Genotypes has been reported maximum total flavonoids content (17.17 mg/100g) followed by CO Acc-1 (15.50 mg/100g), Whereas lowest total flavonoids was recorded in CO Acc-4 (3.21 mg/100g). The result of the study are in agreement with the previous works of Jangra *et al.*, (2018) [9] and Badae *et al*., (2020) in coriander.

Ascorbic acid is a water soluble vitamin abundant in green leafy vegetables Coriander is also one of the potent source of ascorbic acid, a potent antioxidant agent.

The variation for ascorbic acid content varied from 47.79 mg/100g to 279.41 mg/100g. Significantly highest ascorbic acid content was observed in the genotype CO Acc-8 279.41(mg/100g) followed by CO Acc-14 (220.8 mg/100g) whereas lowest ascorbic acid content was recorded in CO Acc-11 (47.79 mg/100g). The results are in line with Khanum *et al.* (2013) [10] and Priyadashi *et al.* (2016) where they reported 1.10mg/g and 1.16mg/g of coriander sample respectively

Conclusion

From the conclusion of the present study revealed that, the significant variations were observed in growth and yield parameters of different coriander genotypes. Among the promising leafy coriander genotypes CO Acc-2 recorded the highest leaf yield of 9.97 t/ha followed by CO Acc -11and CO Acc-6 were also recorded the higher herbage yield under coconut shade during *Kharif* month. These three genotypes like CO Acc-2, CO Acc-11 and CO Acc-6 also required further evaluation for ensuing season.

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