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Performance Evaluation of Leafy Vegetables in Naturally Ventilated Polyhouses

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Abstract: *The field experiment on the performance evaluation of five leafy vegetables in naturally ventilated polyhouse in randomized block design during the rainy season (June- August 2014) revealed coriander, palak and green Amaranthus to establish and grow well with higher biomass production compared to lettuce and red Amaranthus. The modified microclimate influenced the incidence of pests and diseases and the latter affected the growth and performance of red Amaranthus and palakin the polyhouse. Reduced pigmentation was also observed in red Amaranthus. Relative yields in terms of Amaranthus proved palak to be most advantageous followed by coriander*.

Keywords: *Amaranthus, coriander, leafy, palak, polyhouse, yield*

1. INTRODUCTION

The need to improve vegetable production in Kerala has led to the popularisation and adoption of the new technology of protected cultivation which is reported to be ideal for year round cultivation and better yields, in terms of quantity and quality. Vegetables grown under open field conditions are exposed to abiotic and biotic stresses which affect productivity and quality. In Kerala, the production of vegetables is low during the monsoon period due to heavy rainfall and unfavourable climatic conditions. Protected cultivation has the potential to reduce the stresses, offset the vagaries of weather and permitting year round cultivation to ensure regular supplies in the market (Singh *et al*., 2005). However, the profitability of protected cultivation depends upon the choice of structure, selection of crop, varieties, production technology and market price (Rajasekar *et al*., 2013). Until date studies on the cultivation of vegetables in polyhouses have been limited to fruit vegetables, although leafy vegetables are often more affected by the vagaries of weather elements in the open. Van Soest *et al*. (1997) have reported leafy vegetables to contribute significant amounts of vitamins and minerals to the human diet and are also excellent sources of protein, carotene (vitamin A), iron and ascorbic acid (vitamin C) and this group of vegetables are also referred to as "mines of minerals". It is in this backdrop that a field experiment was attempted to assess the performance of leafy vegetables under protected environment during rainy season

2. MATERIALS AND METHODS

The field experiment was laid out in naturally ventilated gable shaped polyhouses of side height 2.5m,centre height 4m, length 16 m and width 6 m established at Farming Systems Research Station Sadanandapuram. The average temperature within the polyhouse ranged from 27 to 34^0C, soil temperature 30 to 32^0C and relative humidity 75 to 88 % during the cropping period, June to August 2014. The initial soil analysis revealed acidic pH of 5.3, electrical conductivity of 0.16mmhos cm $^{-1}$, medium P 35kg ha-1 and high in available potassium 583.0 kgha-1. The leafy vegetables included in the study were Amaranthus red var. Arun (T1), Amaranthus green var. CO 1(T2), Palak (Beta vulgaris var. Benghalensis medium in available phosphorus)var. All Green (T3), Coriander (*Coriandrumsativum*) var. Surabhi (T_4)and Lettuce (*Lactuca sativa*) var. Great lakes (T_5). The treatments were replicated in the polyhouse in plots of 2.5m x 1.5 m. Amaranthus (red and green), coriander and lettuce were transplanted while palak seeds were sown directly. The recommended doses of NPK were applied basally and as top dressing with water soluble fertilisers. In addition, as leafy vegetables respond well to organic manure application, foliar sprays with supernatant solution of fermented neem cake- groundnut cake- farm yard manure and vermiwash were given at weekly

interval in addition to the chemical fertilisers. Irrigation was done daily using rose can, as closer spacing limited adoption of drip irrigation, and, prophylactic sprays of Pseudomonas were given thrice, at 10 days intervals. An open crop of the selected vegetables were also maintained, nevertheless, crop establishment was very poor and incidence of foliar diseases was wilt severely damaged the crops. The crops in the protected condition were harvested as and when they were ready for use as vegetable and observations on the days to 50 percent germination, plant height at different stages, days to first harvest, leaf area index, pest and disease incidence, per plant and plot yields were recorded. The yield data were converted to relative equivalent yields of Amaranthus for statistical analysis using the formula

$$\text{Relative equivalent yield (REYa)} = \frac{\text{Yield of crop x Market price/kg}}{\text{Market price of Amaranthus/kg}}$$

3. RESULTS AND DISCUSSION

The data on the growth of the five leafy vegetables in the polyhouse are presented in Table.1. Germination was rapid in Amaranthus varieties while it was slowest in coriander. It is understood that coriander seeds require seed treatment procedure to stimulate germination while these were not compulsory in the other crops included in the study. Palak too recorded slow germination. Initial growth was slow in coriander and lettuce while Amaranthus varieties and palak performed satisfactorily during the first month putting forth a good canopy. In the open field, crop establishment was very poor and could not be raised successfully due the heavy rains and growth characters of the leafy crops. Disease incidence was also severe. Plant height is an important parameter from crop management point of view. In the polyhouse crop, significant variations in plant height were observed with taller plants being observed in Amaranthus varieties.

Table1. *Growth characters of leafy vegetables grown in polyhouses*

Treatments	Days to 50% germination	Plant height (cm)		No. of leaves/plant	Days to first harvest	LAI
		at first cut	at final harvest			
Palak	13	31.13	30.80	30.5	39.0	6.01
Coriander	15	20.76	33.63	99.0	50.0	2.41
Lettuce	5.75	21.23	21.93	15.9	32.8	1.38
Green Amaranthus	2.75	50.90	47.30	35.0	30.5	4.97
Red Amaranthus	2.5	47.38	34.03	32.2	31.0	4.10
SE	0.661	2.28	2.52	1.74	9.34	0.53
CD	1.53	7.56	5.82	4.02	21.53	1.23

The lower values recorded in the plant heights at final harvest compared to that at first cut in all crops except coriander is because it is the re-growth that is being recorded in these crops.

The days to first harvest in the multicut species ranged from 30.5 to 39 and in coriander owing to the market preference for whole plants the crop was harvested after 50 days, when canopy development was satisfactory. Harvesting interval in the different species varied significantly (Table 2) with rapid re-growth being observed in lettuce followed by Palak. In both these crops foliage development was a dense rosette of succulent leaves on a short stem, whereas in Amaranthus elongation of internodes was more pronounced (5.3 to 8cm) compared to the normal growth in open conditions, this interfering with leaf production, as a result of which the days for subsequent harvest was extended. In protected environments, shoots tend to elongate and intermodal length increases compared to the open conditions (Ramesh and Arumugam 2010). The highest leaf area index was recorded in palak (6.01) and it may be attributed to the leaf physiology, increased number of stomatoes and photosynthesis and hence accumulation of more photosynthates during the cropping period. The results agree with that observed by Papadopoulos and Ormrod (1991) in tomato. Significant variation recorded in the average number of leaves per harvest is due the higher number of leaves in the biomass of coriander as this was harvested in a single operation unlike in the other multicut crops.

The per plant and plot yields are depicted in Table. 2. The results on yields are presented on plot basis, as within the polyhouse the experiment is conducted in small sized plots ($3.75m^2$) and conversion to per hectare would lead to high degree of extrapolation of the yield data. The data on the leaf yields are presented as relative equivalent yields in terms of red Amaranthus, it being the most popular vegetable in Kerala. Palak was found to be most advantageous in term of relative yields

followed by coriander. Green Amaranthus recorded lower values for relative yields despite highest yields owing to the lower market price, while in lettuce, leaf yields were low. Marketable yields in red Amaranthus showed 24.6 per cent decrease than the actual harvested yield due to the presence of white spots on the leaves making them unsuitable for sale.

Table2. *Yield, yield attributes of leafy vegetables in polyhouse*

Treatments	No. of harvests	Harvest interval(days)	No. of leaves harvest^{-1}	Yield plant^{-1}(g)	Yield plot^{-1} (3.75 m^2) kg	Marketable yield plot^{-1} (3.75 m^2)kg	REY$_A$ plot^{-1} (3.75 m^2)
Palak	3	12	9.83	80.9	3.94	3.94	15.567
Coriander	1	-	99.0	47.81	1.66	1.66	4.112
Lettuce	3	7	5.0	23.39	0.70	0.70	0.979
Green Amaranthus	4	14	8.43	69.33	5.37	5.37	3.637
Red Amaranthus	4	16	8.08	74.98	3.98	3.00	3.930
SE	-		9.34	4.05	0.281	-	0.73
CD	NS	-	21.54	9.35	0.65	-	1.69

**Price of palak : Rs 60/kg Coriander : Rs. 40/kg Lettuce: Rs.20/kg*

Green Amaranthus: Rs 10/kg Red Amaranthus : Rs.15/kg

On an average four cuttings were possible in Amaranthus and three each in lettuce and palak. Coriander crop was harvested by uprooting considering the market preferences for whole plants.

Incidence/ infestations of pathogens and insect pests within the polyhouse are depicted in Table 3 and red Amaranthus was found to be susceptible to the fungal disease, leaf spot while in palak wilt incidence was noticed. This could be attributed to the high humidity within the polyhouse and poor air circulation during the months of crop growth as this coincided with the south west monsoon season of the state. Krishnakumary and Rajan (2006) have reported that environmental factors play a pivotal role in disease development. The incidence of leaf spot in Amaranthus is severe during the month of July due to the prevailing low temperature, high humidity and rainfall as recorded in this study also. Thrips, leaf miners and mealy bugs were the pests observed. The symptoms necessitated organic and mild chemical spot applications for control and checking further spread.

Table3. *Pest and disease incidence in leafy vegetables in polyhouse*

Crops	Leaf miners	Thrips	Aphids	Mealy bugs	Wilt	Leaf spot
Palak	X	X	X	√	√	X
Coriander	X	X	X	X	X	X
Lettuce	X	√	X	X	X	X
Green Amaranthus	√	X	X	√	X	X
Red Amaranthus	X	X	X	√	X	√

The results of the study reveal the feasibility of growing leafy vegetables under protected environments during the rainy season which is not possible under open conditions as experienced in the experiment during this cropping season. Among the five crops tried, green Amaranthus, Palak and coriander prove to be ideal, red Amaranthus is susceptible to disease and all the vegetable crops under protected conditions require a higher dose of nutrients compared to the recommended package for open cultivation.

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