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Effect of drip irrigation on yield, nutrient uptake and of bush pepper (*Piper nigrum*) intercropped in coconut garden

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ABSTRACT

An investigation on effect of different drip irrigation levels on growth, yield, nutrient uptake and dry matter partitioning of bush pepper grown in coconut garden was carried out. Six drip irrigation schedules were compared with daily pot irrigation at the rate of 10 l per plant (control). The treatment consists seven, drip irrigation 2 liters per day (October-May), drip irrigation 4 liters per day (October-May), drip irrigation 8 liters per day (October-May) ,drip irrigation 12 liters per day (October-May), drip irrigation 16 liters per day (October-May), drip irrigation 16 liters per day (October-March) and control. Among the treatments highest yield was recorded by the treatment drip irrigation 8 liters per day (October-May). The total yield and dry matter production was lesser at lower levels of drip irrigation. Dry weight of stem, leaves and total dry matter production were higher for the treatments drip 8, 12, 16 l/ plant from October-May compared to pot irrigation. Uptake of nutrients were significantly influenced by drip irrigation levels and maximum uptake was recorded by the treatment drip irrigation 8 l/ day followed by the treatment 16 l drip (October-May).

Key words: Bush pepper, drip, dry matter, nutrients, root, uptake.

INTRODUCTION

Black pepper known as king of spices is an important foreign exchange earner for the country. Black pepper can be propagated either by runners or by laterals. If laterals are used for propagation plant will be grown as bush and is called bush pepper. Bush pepper showed superior growth and yield under 50% shade [4]. Bush pepper suited to coconut garden [10, 13]. Earlier studies on root characters of bush pepper employing radioisotope P^{32} indicated that roots were distributed to a lateral distance of 30 cm from the plant [14]. Periodic water stress during December to May is regarded as the major constraint in increasing the productivity in black pepper [15]. Hence water saving irrigation methods should be followed in order to save water and to maximize yield. Rooting pattern of crop may affect water and nutrient uptake of the vine thereby enhancing the growth and yield. Investigation made by [2] shown that root system is not only a passage to the water and nutrients but also a major pathway for the input of carbon and nutrients to the soil. There has been a lot of interest showed by traditional pepper growers, both small and marginal farmers on bush pepper. Hence the study was conducted to find out best irrigation management and its influence on yield, nutrient uptake and dry matter production of bush pepper grown in coconut garden.

MATERIALS AND METHODS

Six month old bush pepper was planted in the yielding coconut garden, at a spacing of 2x1.85 m at Peruvannamuzhi farm of Indian Institute of Spices Research, Kozhikode, Kerala during the year 1997. The experimental site has typical tropical humid climate with bimodal monsoon rains, aggregating into three thousand mm per year. Majority of precipitation occurs between June- October. The soil was clay loam having pH 5.2, available nitrogen 400 kg ha^{-1}, available phosphorus 24 kg ha^{-1}, and available potash 72 kg ha^{-1}. The distance between two coconut trees was 7.5x7.5 m. The plants were maintained by providing

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supplementary irrigation under drip system. NPK fertilizer was applied at the rate of 10: 5: 20 gm plant^{-1} at bimonthly intervals. There were seven treatments including control (pot watering 10 l per plant). Different levels of drip irrigations were @ 2litres, 4 litres, 8 litres, 12 litres, 16 litres (Oct-May) and16 litres (Oct-March). Whole plot had 14 bush pepper plants and net plot had 3 bush pepper plants. All the plants except control were irrigated for one hour daily from Oct-May. To provide irrigation drip emitters were placed 10 cm away from the planting point. The experiment was laid out in RBD with three replications. Observations on yield of plants were recorded.

Root production and dry matter partitioning study

Root production was studied during 2002 at the end of the experiment, using the technique suggested by Hoffmann and Kammeron 1978 [5]. Two plants were taken from each treatment, replication wise to study the root production. A circular trench having 30 cm width and 100 cm depth was taken around the plant. The soil was then washed from the trench towards the base of the plants by gentle spraying of water exposing the roots. Entire plant was uprooted; exposed roots were cut and collected separately for different treatments. Similarly stem and leaves were separately collected washed and dried in an oven at 70^{0}C. Dry weight of roots, stem and leaves were recorded after drying. Dry weight of different parts was added to obtain total dry matter. The samples were mixed together, powdered treatment wise and analyzed for major, secondary and micronutrients as per standard procedure [12] and nutrient uptake was computed based on total dry matter. Data was analyzed for variance using the procedure suggested by [8].

RESULTS AND DISCUSSION

Variation in dry matter production

Dry matter production in bush pepper plants varied significantly with respect to various irrigation levels (Table 1). Dry weight of stem varies from 121.2 g to 190 g and maximum recorded by the treatment 8 l drip that was on par with 12 and 16 liters of drip. Leaf dry weight was higher in the treatment 16 l/drip that were on par with 8 liters of drip. Significantly higher total dry matter production (313.5 g) was recorded by the treatment 16 l drip (Oct-May) followed by 8 litres of drip (311.9 g). Among various parts, stem contributed more towards dry matter production compared to leaves and roots. This result was in agreement with the findings of [11] in grapes (*Vitis vinifera*). Lowest dry matter was recorded by the treatment 2 l drip followed by the treatment 161 drip (Oct-March).

Yield was significantly influenced by various drip irrigation levels. Yield was less during first year, gradual increase was observed in subsequent years and maximum yield was recorded during 4th year. Mean of 5 years yield indicated that maximum being in 8 l drip that was on par with 16 l drip Oct-May. Yield was less in the case of treatment 2 and 4 liters of drip.

Yield obtained in 8 l drip was more than other drip irrigation treatments. Favorable soil moisture levels and uniform water distribution in the rhizosphere of bush pepper would have resulted production of more root biomass and nutrient uptake (Tables 1, 3 & 4), better photosynthesis and yield. For three year old bush pepper it was noticed that higher yield in the treatment 8 l drip per plant from Oct- May [13]. Preliminary irrigation experiments conducted on vine pepper from Indian Institute of Spices Research (IISR) showed that irrigation at the rate of 7 l per day through drip during October-May was better than October- March (IISR 1998). For vine pepper 10-12 liters of water per day is required conventially for irrigation [9], only 8 liters is required by adopting drip irrigation in bush pepper. This accounts for saving of 25% irrigation water. Similar results of saving water and enhancing yield in cotton by drip irrigation were reported [7].

In the present experiment the yield obtained was less in 16 litres drip (Oct-May) because of partitioning of more photosynthate to vegetative parts especially leaves as evident from the Table 1. This is in agreement with the findings of [10]. Partitioning of dry matter between vegetative and reproductive parts is an important process that causes variations in yield [2, 3]. The yield was less from the plants irrigated with 2 l drip. This was mainly due to less dry matter production (Table 1) and less nutrient uptake (Tables 3 and 4).

Table 1. Influence of drip irrigation on stem, leaf and dry matter production of bush pepper plants

Quantity of drip irrigation l/day/plant	Stem (g)	Leaves (g)	Root (g)	Total dry matter (g)
2	121.2 (73.4)	21.6 (13.1)	22.2 (13.5)	165.0
4	140.0 (63.1)	50.0 (22.5)	31.8 (14.3)	221.8
8	190.0 (63.0)	78.0 (26.0)	31.8 (10.0)	311.9
12	177.0 (61.0)	69.2 (24.0)	43.9 (14.8)	289.0
16	167.0 (53.3)	106.7 (34.0)	42.6 (12.7)	313.5
16 (Oct-Mar)	128.3 (65.0)	45.8 (23.0)	39.8 (12.1)	197.9
10 l (control)	133.0 (57.5)	74.7 (32.3)	23.8 (10.3)	231.5
CD (0.05)	28.4 (55.8)	30.1 (31.3)	30.7 (NS)	30.0

Value in parenthesis is percentage of total dry matter

Uptake of nutrients

Uptake of nutrients was significantly influenced by various drip irrigation levels (Table 3). In general, uptake was higher in drip irrigated plants with higher quantities of water applied. Among the treatments, maximum uptake of nitrogen and phosphorus was recorded by 8 l drip followed by 16 l drip (Oct-May). Uptake of nitrogen, phosphorus and potash were comparatively higher in 16 l drip (Oct-March) compared to the treatment 2 and 4 liters of drip.

Table 2. Effect of drip irrigation levels on berry yield (dry) of bush pepper for five years

Quantity of drip irrigation (l)	Dry berry yield (gm/pl)					
	1998	1999	2000	2001	2002	Mean
2	22.2	40.2	88.0	98.5	81.3	66.1
4	33.5	51.7	127.0	131.4	91.7	87.1
8	95.0	173.3	230.0	322.1	159.0	195.9
12	61.7	118.3	162.2	186.7	80.0	121.8
16	65.0	119.7	263.4	295.1	83.9	165.4
16 (Oct-Mar)	72.2	122.7	71.7	101.1	60.0	85.5
10l (control)	28.3	47.7	112.6	117.1	91.1	79.4
CD(0.05)	6.7	66.0	75.8	54.2	40.8	41.8

Table 3. Effect of different irrigation levels on uptake of major and secondary nutrients in bush pepper plants

Drip irrigation levels	N (g/pl)	P (g/pl)	K (g/pl)	Ca (g/pl)	Mg (g/pl)
2	2.8	0.19	1.8	3.0	0.5
4	3.9	0.33	2.8	3.3	0.8
8	6.5	0.60	4.5	4.0	1.3
12	4.6	0.36	4.1	2.3	1.0
16	6.2	0.53	5.3	3.3	1.1
16(Oct-Mar)	4.3	0.32	3.4	3.0	0.6
10 l (control)	5.1	0.45	4.2	3.9	1.0
CD(0.05)	1.3	0.16	0.9	1.2	0.2

Table 4. Effect of different irrigation levels on uptake of micro nutrients in bush pepper plants

Drip irrigation levels	Fe (mg/pl)	Mn (mg/pl)	Zn (mg/pl)	Cu (mg/pl)
2	183.0	21.0	7.1	4.3
4	341.0	34.4	10.4	4.7
8	541.0	89.1	21.6	11.7
12	395.0	40.2	12.9	7.8
16	514.0	86.0	18.6	11.0
16 (Oct-Mar)	319.0	35.1	10.7	6.1
10 l (control)	406.0	51.9	15.0	8.8
CD(0.05)	79.4	17.5	3.0	1.9

Lower availability of soil moisture reduced the uptake of nutrients as evident from Tables 3 and 4. The result corroborate the finding of Sujatha *et al.*, who observed less biomass production in chilli plants irrigated with less quantities of water by drip [10].

Effect of different irrigation levels on secondary and micronutrient uptake of bush pepper plant was significant (Table 4). Maximum uptake of calcium,

magnesium, iron, manganese, zinc and copper was observed in 8 l drip followed by 16 l drip (Oct-May). Uptake was lesser in the treatments 2, 4 liters drip and 16 l drip (Oct-March).

CONCLUSION

From the present study it was inferred that providing irrigation @ 8 l/plant through drip found to be best for getting maximum yield in bush pepper inter cropped in coconut garden and saved 25 % irrigation water compared to control (Pot watering 10 l/ plant). Yield was less in the treatment drip 16 l per plant (Oct-May) due to poor partitioning of dry matter to berries. Nutrient uptake, total dry matter production was higher for the treatment drip 8 l per plant and lesser in the treatment in which less quantity of water was applied (2 l drip and 4 l drip) which resulted in less yield. Among various parts stem contributed more towards total dry matter production.

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