



CONSUMPTIVE USE, WATER USE EFFICIENCY AND WATER PRODUCTIVITY IN LONG PEPPER AS INFLUENCED BY PRECISION FARMING TECHNIQUES UNDER PROTECTED CULTIVATION

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ABSTRACT

The experiment on Precision farming techniques in long pepper (*Piper longum* Linn.) under protected cultivation” was carried out at the College of Agriculture, Padannakkad, Kasaragod, Kerala Agricultural University during 2013-2014 to develop cost effective agro techniques for improving the productivity and profitability of long pepper. The experiment consisting of 14 treatments replicated twice was laid out in RBD in the interspaces of coconut garden. The treatments were, T1 - Planting in trenches filled with enriched rooting medium + Staking + Fertigation through drip system; T2- Planting in trenches filled with enriched rooting medium + Staking + Fertigation through micro sprinkler; T3- Planting in trenches filled with enriched rooting medium + Without Staking + Fertigation through drip system; T4- Planting in trenches filled with enriched rooting medium + Without Staking + Fertigation through micro sprinkler; T5 - T1 + Planting in hanging pots and fertigation through mist; T6 - T2 + Planting in hanging pots and fertigation through mist; T7 - T3 + Planting in hanging pots and fertigation through mist; T8 -T4 + Planting in hanging pots and fertigation through mist; T9 - Planting in trenches filled with potting mixture + Without staking + Life saving irrigation (Control); T10 - T1 Under partial shade; T11- T2 Under partial shade; T12- T3 Under partial shade, T13- T4 Under partial shade; T14- Planting in trenches filled with potting mixture + Without staking + Life saving irrigation under partial shade (control). The treatments effects had significant influence on soil moisture content after irrigation and the values ranged from 18.85 - 20.85 per cent. The per cent increase in soil moisture in T5 was 11.03 compared to the control T14. However, soil moisture estimation prior to irrigation revealed no significant difference due to treatment effects. Seasonal consumptive use and mean daily consumptive use also showed significant variation due to treatment effects. Except the two control treatments, T9 and T14; all the other 12 treatments where micro irrigation systems were installed were on par. Except the two control treatments where life saving irrigation was practiced, all other treatments were on par with respect to seasonal consumptive use and mean daily consumptive use. All the treatments which received micro irrigation were on par in relation to water productivity.

KEY WORDS: Precision farming, consumptive use, water use efficiency, water productivity.

INTRODUCTION

Long pepper is an economically important medicinal plant widely recommended for commercial mediculture among the progressive farmers of the state. It requires specific habitats for satisfactory growth and production. The microclimatic requirements of long pepper match very well with the agro climatic conditions prevailing in the interspaces of middle aged coconut palms of the humid tropics. Hence it is ideally suited for intercropping in irrigated coconut gardens. Commercial mediculture with long pepper by adopting precision farming techniques under protected cultivation in coconut garden yield rich dividends. Low cost poly cum shade house constructed in the interspaces of coconut gardens / homesteads can be successfully used for commercial growing of long pepper. Adequate supply of soil moisture can maintain optimum turgor potential which opens the stomatal aperture for gaseous exchange and leads to higher photosynthetic rate and ultimately increases plant growth characters and yield. This was confirmed with no stress condition (1.0 CPE), which provided adequate moisture for growth and development of long pepper (Manjunath *et al.*, 2007).

Trickle irrigation operates on the basis of a constantly maintained wetted zone around plant roots and wetted area under a point source (driper) which is greatly affected by the application rate and duration of irrigation. With lower application rate of 5 l hr⁻¹ for longer time (2 hrs per day), the depth of wetting was more when compared to higher application rate of 30 l hr⁻¹ for shorter time (20 minutes per day) (Rekha and Mahavishnan, 2008). Hachum *et al.* (1976) reported that under an isolate dripper, the vertical component of wetted zone becomes larger and the horizontal component becomes smaller with decrease in discharge rate, the extent of wetted zone is determined by the emitter spacing (Keller and Karmeli, 1975). Protected cultivation techniques are widely used for crop production under controlled / partially controlled environment in temperate region and even in arid climates on a commercial basis. They can play vital role in developing countries like India for increasing agricultural production and productivity. Water scarcity, high temperature and low humidity are prevailing during summer in India. These conditions make crop production quite difficult. Plastic films made of low-density polyethylene (LDPE) are

commonly used in agriculture as coverings for increasing the yield and quality of agricultural products (Panwar *et al.*, 2009). There is good scope for adoption of drip irrigation and use of water soluble fertilizers with drip system, *i.e.*, fertigation technique for achieving better productivity and quality in different crops like long pepper. With this background, an experiment was carried out to find out the consumptive use, water use efficiency and water productivity in long pepper as influenced by precision farming techniques under protected cultivation.

MATERIALS & METHODS

Investigations on “Precision farming techniques in long pepper (*Piper longum* L.) under protected cultivation” was carried out at the College of Agriculture, Padannakkad, Kerala Agricultural University during 2013-2014 to develop cost effective agro techniques for improving the productivity and profitability of long pepper. *Piper longum* L. variety ‘Viswam’ released from Kerala Agriculture University was used for the study. The experiment laid out in RBD and replicated twice consisted of 14 treatments. The treatments were, T1 - Planting in trenches filled with enriched rooting medium + Staking + Fertigation through drip system; T2- Planting in trenches filled with enriched rooting medium + Staking + Fertigation through micro sprinkler; T3- Planting in trenches filled with enriched rooting medium + Without Staking + Fertigation through drip system; T4- Planting in trenches filled with enriched rooting medium + Without Staking + Fertigation through micro sprinkler; T5 - T1 + Planting in hanging pots and fertigation through mist; T6 - T2 + Planting in hanging pots and fertigation through mist; T7 - T3 + Planting in hanging pots and fertigation through mist; T8 - T4 + Planting in hanging pots and fertigation through mist; T9 - Planting in trenches filled with potting mixture + Without staking + Life saving irrigation (Control); T10 - T1 Under partial shade; T11- T2 Under partial shade; T12- T3 Under partial shade, T13- T4 Under partial shade; T14- Planting in trenches filled with potting mixture + Without staking + Life saving irrigation under partial shade (control). Long pepper vines were cut into pieces of 20 cm length and planted in polythene bags filled with potting mixture (1:1:1 mixture of sand: soil: cowdung). Polythene bags were kept under partial shade for two months and watered once in two days. Saplings attained four leaf stages at the time of planting in the main field. Trenches of 3.6 m length, 30 cm width and 45 cm depth were taken, mulched the bottom with dry leaves to a height of 10 cm, filled with enriched growth medium and mixed with surface soil. Long pepper saplings were planted in the trenches at a spacing of 60 x 40 cm @ one sapling per hill. A cassava stem of one metre length was erected at a distance of 15 cm from the base of each long pepper plant and the growing vine was trailed on to it. Cassava was defoliated at fortnightly intervals to avoid competition with long pepper. A shade house was erected in the interspaces of two rows of coconut palms standing at row distance 7.5 m and plant to plant distance of 7.5 m. 50 per cent shade net was used to ensure proper shade for the crop. A fertilizer applicator was installed in the system to discharge liquid organic manures, such as vermiwash, panchagavya and jeevamrutha was effected. The procedure outlined under

SAS package was followed for the conduct of statistical analysis (Hatcher, 2003). Soil sampling was done using a screw auger at a distance of 15 cm away from the base of the plant to a depth of 20 cm just before and after irrigation and the soil moisture worked out gravimetrically. Irrigation requirement was estimated by directly adding the quantity of water used for irrigation in each treatment.

Consumptive use

$$Cu = \sum_1^n (Ep \times 0.6) + \sum_1^n \frac{(Mai - Mbi)}{100} \times Asi \times Di \times ER$$

Where Cu= Consumptive use of water in mm

Ep = Pan evaporation from USWB class an open pan evaporimeter from the date of irrigation to the date of soil sampling after irrigation.

0.6 = A constant used for obtaining ET value from the pan evaporation value for the given period of time.

Mai = Percentage of soil moisture (W/W) of the ith layer of soil at the time of sampling after irrigation.

Mbi = Percentage of soil moisture (W/W) of the ith layer of soil at the time of sampling before irrigation.

Asi = Apparent specific gravity of ith layer of soil, gcc^{-1} .

Di = Depth of ith layer of soil, gcc^{-1} .

ER = Effective rainfall within the season

n = Number of soil layer

N= Number of days between irrigation and post irrigation soil sampling.

Water use efficiency

Crop water use efficiency (CWUE) and field water use efficiency (FWUE) were worked out using the following formula and expressed as $g M^{-3}$.

$$CWUE = \frac{\text{Yield}}{\text{Consumptive use}}$$

$$FWUE = \frac{\text{Yield}}{\text{Total water requirement}}$$

Water productivity (WP)

Water productivity was estimated using the formula proposed by Kijne *et al.*, (2003) and expressed as $g M^{-3}$.

$$WP = \frac{\text{Total biomass}}{\text{Total water depleted}}$$

Crop Coefficient (Kc)

Crop coefficient was worked out by dividing the consumptive use during a given period by pan evaporation value during that period.

RESULTS & DISCUSSION

Mean data on moisture content of the soil before and after irrigation, seasonal consumptive use, mean daily cu, crop coefficient, crop water use efficiency, field water use

efficiency and water productivity as influenced by precision farming techniques under protected cultivation are furnished in Table 1. The treatments effects had

significant influence on soil moisture content after irrigation and the values ranged from 18.85 - 20.85 per cent.

TABLE 1: Soil moisture, seasonal consumptive use, water use efficiency and water productivity as influenced by precision farming techniques under protected cultivation

Treatments	Soil moisture (%)		Seasonal Cu (mm)	Mean daily Cu (mm)	CWUE (g m ⁻³)	KC	FWUE (gm ⁻³)	Water Productivity (gm ⁻³)
	After	Before						
T1	19.65	15.10	506.49	1.38	915.57	0.678	8.00	1018.42
T2	19.65	15.00	515.07	1.40	817.4	0.687	7.26	1001.53
T3	20.00	14.99	490.62	1.33	846.055	0.65	7.11	1042.08
T4	19.4	14.65	523.51	1.43	779.1	0.70	7.01	986.85
T5	20.85	15.80	548.84	1.50	982.795	0.73	7.26	834.00
T6	20.85	15.30	536.17	1.46	937.385	0.71	6.83	818.89
T7	20.35	15.65	519.29	1.41	1012.33	0.69	7.02	734.34
T8	20.45	14.80	599.49	1.64	812.265	0.79	6.68	707.82
T9	19.8	14.45	179.99	0.48	2284.96	0.23	46.37	5722.35
T10	19.05	14.60	498.18	1.36	755.735	0.66	6.44	819.94
T11	19.00	14.10	531.95	1.45	698.58	0.70	6.38	792.68
T12	19.85	14.35	553.05	1.51	661.015	0.74	6.22	808.085
T13	20.10	14.20	565.72	1.54	590.13	0.75	5.74	807.01
T14	18.85	14.05	174.36	0.47	1563.77	0.24	30.50	4860.49
SE	0.49	0.10	64.10	0.17	131.87	0.08	0.44	158.22
CD	1.074	NS	138.64	0.37	284.850	0.18	0.96	341.77

The treatment T5 recorded the highest moisture content after irrigation and it was on par with T6, T8, T7, T13, T3, T12 and T9. The per cent increase in soil moisture in T5 was 11.03 compared to the control T14. However, soil moisture estimation prior to irrigation revealed no significant difference due to treatment effects. Seasonal consumptive use and mean daily consumptive use also showed significant variation due to treatment effects. Except the two control treatments, T9 and T14; all the other 12 treatments where micro irrigation systems were installed were on par. The highest seasonal cu of 599.49 mm was recorded by T8 and it was 70.95 per cent higher compared to T14. The same treatment T8 recorded the highest mean daily cu of 1.64 mm which was 71.34 per cent compared to T14. The two control treatments, T9 and T14, which received life saving irrigation showed higher crop water use efficiency and FWUE. The highest CWUE of 2284.96 g m⁻³ was recorded by the control treatment T9 which was significantly different from all other treatments. The same treatment T9 also showed the highest FWUE and showed significant superiority over all other treatments. All the treatments which received micro irrigation were on par in relation to water productivity. The control treatments T9 and T14 registered the highest water productivity of 572.44 g m⁻³ which differed significantly from all other treatments. Precision farming techniques on long pepper under protected cultivation influenced moisture content of the soil before and after irrigation, seasonal consumptive use, mean daily cu, crop coefficient, crop water use efficiency, field water use efficiency and water productivity. Except the two control treatments where life saving irrigation was practiced, all other treatments were on par with respect to seasonal consumptive use and mean daily consumptive use. The highest seasonal cu of 599 mm was recorded when long pepper was planted in trenches filled with enriched growth medium + without staking + fertigation through micro

sprinkler + planting in hanging pots + fertigation. The increase in seasonal consumptive use was to the tune of 70 per cent compared to the control. The highest mean daily cu of 1.64 mm was recorded by the above treatment which was 71 per cent higher compared to the control. The two control treatments which received life saving irrigation showed higher crop water use efficiency and FWUE. The highest CWUE of 2284 g M⁻³ was recorded when long pepper was planted in trenches filled with potting mixture and allowed to creep on the land surface and provided with life saving irrigation. The same treatment also showed the highest FWUE and showed significant superiority over all other treatments. All the treatments which received micro irrigation were on par in relation to water productivity.

REFERENCES

- Hachum, A.Y., Alfaro, J.F. & Willardson, L.S. (1976) Water movement in soil from trickle source. *J. Irrig. Drain. Div.* **102**: 179-192.
- Hatcher, L. (2003) Step by Step Basic Statistics Using SAS: Exercises. SAS Institute INC., Cary, NC, USA. *J. Ecol.* **91**(1): 147-167.
- Karmeli, D. and Keller, J. (1975) Trickle Irrigation Design. Rain Bird Sprinkler Manufacturing Corporation, Glendora, California, 133pp.
- Kijne, J.W., Barker, R. & Molden, D. (2003) Water Productivity in Agriculture: limits and opportunities for improvement. CABI Publ.
- Manjunatha, H.M., Sreeramu, B.S., Raviraja, S.G., Vasundhara, M. & Chandre, G.M. (2007) Influence of irrigation regimes and fertility levels on growth of long pepper (*Piper longum* L.). *Biomed.* **2**(3): 272-277.

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Panwar, N.L., Kothari, S. & Rathore, N.S. (2009) Protected Cultivation of Medicinal Plant in Composite Climate of Indian State Rajasthan. *American-Eurasian J. Agric. Environ. Sci.* **5** (5): 633-637.

Rekha, K.B. & Mahavishnan, K. (2008) Drip fertigation in vegetable crops with emphasis on lady's finger (*Abelmoschus esculentus* (L.) Moench)– A review. *Agricultural Reviews.* **29**(4): 298:305.