Original Research Article

Effect of Irrigation and N-fertigation levels on broccoli performance in a Polynet house

Abstract

The purpose of this study is to see how the microclimate of the polynet house, irrigation, and fertigation levels affect broccoli output. The experiment was set up in a randomized block design within bounds beneath a polynet house with 320 m^2 floor area covered with 50% perforated green colour net. Plant height, dry matter production yield, and its attributes were found to be maximum in drip irrigation (1.0Epan) + 125 % N at all growth stages, as per effect of scheduled irrigation and fertigation levels on crop biometric performance. Drip irrigation (1.0Epan) + 125 % N resulted in a high higher yield (22.02 t ha^{-1}); while treatments drip irrigation (1.5 Epan) + 75 % N resulted as in lowest yield (18.02 t ha^{-1}).The treatment drip irrigation (1.0Epan) + 125 % N had a maximum NPK uptake.

Keywords: Broccoli, Nitrogen fertigation, irrigation, polynet house, yield and nutrient uptake.

1. Introduction

Broccoli (Brassica oleracea L var. italica) is a newly introduced exotic vegetable to India. The earliest sprouting broccoli selection was most likely made in pre-Christian Greece (Heywood, 1978) [1.]. Broccoli is a vegetable that is a cabbage-like edible green plant with a large blossoming head. Broccoli is one of the most nutritious cole crops since it is high in vitamins and minerals, and boiling broccoli lowers the quantities of anti-carcinogenic substances like sulforaphane. It contains the same amount of calcium as milk, making it a vital source of nourishment for persons suffering from osteoporosis or calcium deficiency (Nirmal *et al*. 2004) [2].

Comment [B1]: Scientific name with italic

Comment [B2]: Newly means last year? 10 years ago?

Polyhouse technology is an effective crop production intervention, especially under difficult climatic circumstances. In comparison to open field farming, it has the ability to provide year-round production of high-quality produce from modest landholdings. By maximizing productivity per unit area, it can address the challenge of year-round climatic variations as well as price variations and production. The theory behind a polyhouse is that crop output is controlled not only by genetics but also by the environment surrounding the plant. Temperature, light, relative humidity, air composition, and the nature of the root medium can all be regulated to give the plant the greatest possible environment for development. The purpose of this study is to see how varied irrigation and fertigation levels affect broccoli yield and characteristics in a polynet house in Central Telangana Zone.

2. Material Methods

The experimental polynet house is located at the College of Agricultural Engineering's Precision Farming Section in Kandi, Sangareddy district, Telangana. It is situated at a latitude of 17^{o}19 N and a longitude of 78^{o}28E, at a height of 535 meters above sea level. The climate

UNDER PEER REVIEW

in the area is semiarid tropical, with an average annual rainfall of 800 mm, with 66 percent of that falling between June and October.

2.1 Experimental Design and Details

The soil of the experimental site was sandy loam in texture, low in available nitrogen(243.2), high in available phosphorus (32.6 kg ha^{-1}**)** and low in available potassium K (243.2) K_2O kg ha^{-1}**).** The experiment was laid out in a randomized block design with plot size of 320 m^2 area. A total of nine irrigation accompanied fertigation levels were set out under poly net house condition. All the treatments were replicated thrice for assessing the level of significance and keeping the error degree of freedom in limits. The data on plant growth parameters *viz.*, plant height, dry matter accumulation at 30, 60, 90 DAT and at harvest were recorded. The data on yield and its attributes consisted of curd weight (gm) and broccoli yield (t ha^{-1}) was also recorded. In addition, nutrient analysis on the available nitrogen, phosphorus and potassium uptake at harvest with post harvest soil nutrient status pertaining to N, P and K was also performed.

Comment [B3]: Before use abbreviations, please explain what means

Comment [B4]: Please, tell the growing period, in which month was the experiment established?

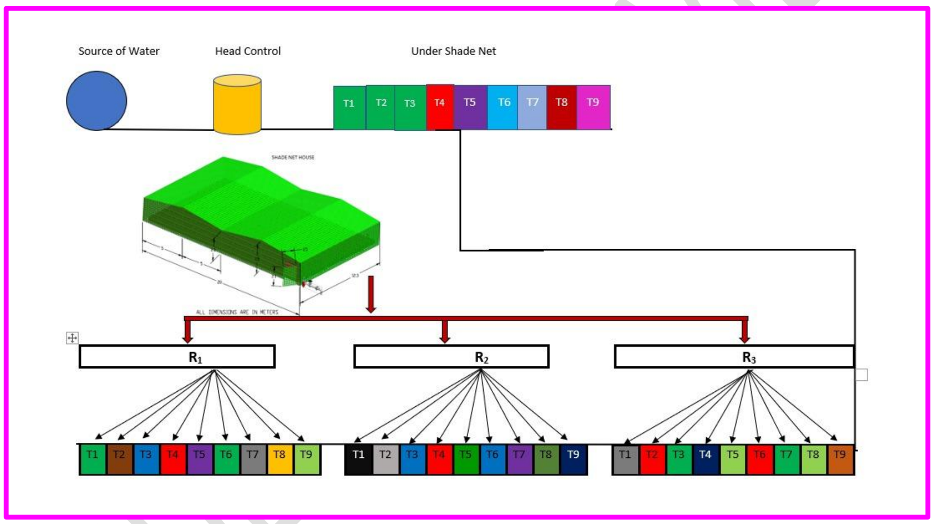

Fig. 1 Experimental layout of broccoli through drip irrigation in polynet house

3. Results and Discussion

3.1 Evaluation of broccoli crop biometric performance under semiarid tropical conditions

3.1.1 Plant height (cm)

Comment [B5]: The most important parameter is temperature. Please indicate the temperature, humidity, light intensity in growing period in correlation with morphological treats.

UNDER REVIEW

The main crop biometric growth factor i.e., plant height response for different irrigation and fertigation levels is presented in table 1.1. It has been observed that the crop height progressively increased with the age of the crop and up to harvest, irrespective of the treatments at 30, 60 and 90 DAT and at harvest. Plant height significantly varied with different dates of transplanting and an overview of the results indicated that significantly superior plant height (37.3) was observed in T6 (PNH+Drip fertigation of 1.0 Epan + 125% N) at all growth stages and at harvest followed by T5 (PNH + Drip fertigation of 1.0 Epan + 100% N) of 36.2 cm, which is comparable. Significantly lower plant height (32.8 cm) was recorded in T7 (PNH + Drip fertigation of 1.5 Epan+ 75% N, when compared with all the levels of irrigation and fertigation.

Comment [B6]: explain

The increased plant height in the treatment of PNH + Drip fertigation (1.0Epan) + 125% N treatment is due to maintenance of optimum soil moisture coupled with availability nutrients in the soil profile due to frequent irrigation favoring higher nutrient uptake, rapid cell division and cell enlargement. The decrease in plant height at harvest in all the treatments is due to senescence of plants. These results are in quite agreement with the findings of Locasio and Smajstrala (1996) [3] and Candido *et al*. (2000) [4].

Table 1.1: Plant height (cm) as influenced by different Irrigation and N-Fertigation levels

Treatments	Plant Height (cm)			
	30 DAT	60 DAT	90 DAT	At harvest
T_1- PNH + drip fertigation (0.50 Epan) + 75%N	20.8	29.6	35.8	34.0
T_2- PNH+drip fertigation (0.50 Epan) + 100%N	21.9	30.2	36.5	35.0
T_3- PNH + drip fertigation (0.50 Epan) + 125%N	22.1	31.0	36.9	35.2
T_4- PNH + drip fertigation (1.0Epan) + 75%N	21.5	30.0	36.2	34.2
T_5- PNH + drip fertigation (1.0 Epan) + 100%N	23.0	31.4	37.3	36.2
T_6- PNH + drip fertigation (1.0 Epan) + 125%N	24.1	32.0	38.2	37.3
T_7- PNH + drip fertigation (1.5Epan) + 75%N	19.1	27.9	34.8	32.8
T_8- PNH + drip fertigation (1.5 Epan) + 100%N	19.8	28.1	35.1	33.0
T_9- PNH + drip fertigation (1.5 Epan) + 125%N	20.0	28.9	35.5	33.5
SEm ±	0.14	0.13	0.14	0.12
CD @5%	0.42	0.86	0.39	0.35
CV (%)	1.17	0.76	0.64	0.60
	NS	**S**	**S**	**S**

3.1.2 Number of leaves

Table 1.2 shows the crop's biometric performance in terms of leaf number. Among the various irrigation and fertigation optimization treatments applied to broccoli, treatment T6, i.e., PNH + Drip fertigation at 1.0 Epan+ 125 percent N at harvest, resulted in a greater number of leaves (32 per plant). T5 of PNH + Drip fertigation at 1.0 Epan) + 100 percent N, on the other hand, produced a comparable number of leaves (29 per plant). The treatment T7, i.e., PNH + Drip fertigation at 1.5 Epan+ 75 percent N (17 per plant), has the fewest leaves per plant, which is significantly inferior. The increase in vegetative growth parameters in broccoli is due to

UNDER PEER REVIEW

increased nutrient availability and fertigation, which results in better nutrient uptake and utilization in plant organ growth and development. (Biradar *et al*. 2018) [5] reported similar results in a broccoli crop that are in line with the current study's findings.

Table 1.2: Number of leaves of broccoli as influenced by different Irrigation and N-Fertigation levels

Treatments	No. of Leaves			
	30 DAT	60 DAT	90 DAT	At harvest
T_1-PNH + drip fertigation (0.50 Epan) + 75%N	10.0	16.0	27.0	22.0
T_2-PNH + drip fertigation (0.50 Epan) + 100%N	10.0	18.0	30.0	25.0
T_3-PNH + drip fertigation (0.50 Epan) + 125%N	10.0	20.0	31.0	26.0
T_4-PNH + drip fertigation (1.0 Epan) + 75%N	9.0	18.0	28.0	23.0
T_5-PNH + drip fertigation (1.0 Epan) + 100%N	11.0	21.0	33.0	29.0
T_6-PNH + drip fertigation (1.0 Epan) + 125%N	13.0	23.0	35.0	32.0
T_7-PNH + drip fertigation (1.5Epan) + 75%N	9.0	12.0	21.0	17.0
T_8-PNH + drip fertigation (1.5 Epan) + 100%N	8.0	14.0	23.0	19.0
T_9-PNH + drip fertigation (1.5 Epan) + 125%N	9.0	15.0	25.0	20.0
SEm ±	0.12	0.16	0.15	0.05
CD @5%	0.37	0.47	0.44	0.16
CV (%)	2.26	1.61	0.94	0.42
	S	**S**	**S**	**S**

3.1.3 Yield and Yield Attributes

Data pertaining to broccoli yield (t ha^{-1}) at all levels of irrigation and fertigation, as well as at all growth stages, had been significantly influenced, and the results are presented in Table.1.3. Among the various levels of irrigation and fertigation, the treatment of PNH + Drip fertigation (1.0 Epan) +125 percent N (22.02 t ha-1) produced the highest yield of 22.02kg/ha, which was found to be significantly superior to all other treatments. PNH + Drip fertigation (1.5 Epan) +75 percent N had the lowest yield (18.02 t ha-1). PNH + Drip fertigation (1.5 Epan) +75 percent N yields were lowered. The higher head yield obtained at 1.0 Epan with 125% RDN of water-soluble fertigation might be due to increased nutrient dynamics in the root zone and in plants under drip fertigation. Similar results were also reported by (Erdem *et al.* 2010) [6] and Vasu and Reddy (2013) [7] which are in quite agreement.

Table 1.3: Broccoli head weight, yield per plot and yield (t/ha) as influenced by irrigation and N-fertigation levels

Treatments	Average	Head	Yield

UNDER PEER REVIEW

	head weight(g)	Yield per plot (Kg)	(t/ha)
T_1-PNH + drip fertigation (0.50 Epan) + 75%N	399.00	1.97	19.70
T_2-PNH + drip fertigation (0.50 Epan) + 100%N	411.90	2.03	20.34
T_3-PNH + drip fertigation (0.50 Epan) + 125%N	421.60	2.08	20.82
T_4-PNH + drip fertigation (1.0 Epan) + 75%N	404.80	2.00	19.99
T_5-PNH + drip fertigation (1.0 Epan) + 100%N	430.00	2.12	21.23
T_6-PNH + drip fertigation (1.0 Epan) + 125%N	446.00	2.20	22.02
T_7-PNH+ drip fertigation (1.5Epan) + 75%N	365.00	1.80	18.02
T_8-PNH + drip fertigation (1.5 Epan) + 100%N	378.00	1.87	18.67
T_9-PNH + drip fertigation (1.5 Epan) + 125%N	389.00	1.92	19.21
SEm ±	0.12	0.06	0.02
CD @5%	0.36	0.19	0.05
CV (%)	0.05	5.00	0.14
	S	S	S

3.2 Plant Nutrient Content and Uptake of Nutrients

Nutrient content of the plant parts needs to be optimum for normal functioning of the plant. The level of nutrient uptake is better indicated by the nutrient content of the plant parts particularly leaves and dry matter production. The results obtained during the process of experiment on the nutrient content of the wrapper leaves in broccoli at harvest are presented in Table.1.4. The amount of nitrogen, phosphorus, and potassium in the leaf, as well as absorption, were all affected by fertigation. The treatment of PNH + Drip fertigation (1.0 Epan) + 125 percent N had the greatest N, P, and K content in leaf and uptake of 2.63 percent, 118.04 Kg ha-1, 0.67 percent and 30.11 Kg ha-1, and 3.12 percent and 140.36 Kg ha-1, respectively, at harvest.

Nutrient uptake is a function of dry matter production, available nutrient status of the soil. The right combination of water and nutrients are essential for obtaining higher yields along with quality. The method of fertilizer application is also important in improving the use efficiency of the nutrients. Drip fertigation method enables the adequate supplies of water and nutrients with precise timing and uniform distribution to meet the crop nutrient demand (Patel and Rajput, 2000; Narda and Chawla, 2002) [8][9]. Better uptake of N, P and K under PHC + Drip irrigation (1.0 Epan) + 125% N might be due to higher dry matter production. This could be attributed to the synergistic effects of higher water content and available nutrients in the soil and crop growth. These results are conformity with the findings of (Gupta *et al*. 2010) [10].

Table 1.4: N, P and K uptake (kg ha^{-1}) of the broccoli leaves excluding head as influenced by irrigation and N-fertigation levels

Treatments	% N	N	% P	P	% K	K

UNDER PEER REVIEW

	in leaves	uptake (Kg/ha)	in leaves	uptake (Kg/ha)	in leaves	uptake (Kg/ha)
T$_1$-PNH + drip fertigation (0.50 Epan) + 75%N	1.88	66.94	0.45	16.14	2.65	94.48
T$_2$-PNH+ drip fertigation (0.50 Epan) + 100%N	2.01	75.53	0.52	19.63	2.86	107.17
T$_3$-PNH+ drip fertigation (0.50 Epan) + 125%N	2.13	82.77	0.59	22.96	2.90	112.99
T$_4$-PNH + drip fertigation (1.0 Epan) + 75%N	1.88	67.64	0.47	17.06	2.79	102.13
T$_5$-PNH + drip fertigation (1.0 Epan) + 100%N	2.32	99.22	0.65	27.90	2.96	126.40
T$_6$-PNH + drip fertigation (1.0 Epan) + 125%N	2.63	118.04	0.67	30.11	3.12	140.36
T$_7$-PNH+ drip fertigation (1.5Epan) + 75%N	1.85	58.84	0.44	14.07	2.45	77.89
T$_8$-PNH + drip fertigation (1.5 Epan) + 100%N	1.95	62.41	0.50	16.13	2.63	84.21
T$_9$-PNH + drip fertigation (1.5 Epan) + 125%N	1.96	66.56	0.55	18.67	3.05	105.24
SEm ±	0.01	0.45	0.09	0.40	0.09	3.31
CD @5%	0.03	1.31	0.02	1.18	0.27	9.00
CV (%)	1.14	1.05	3.13	3.49	5.00	5.00

UNDER PEER REVIEW

4. Conclusion

Optimizing the irrigation and fertigation levels for highly nitrous and medicinal crop like broccoli under poly net house will improve the production potential and thereby improving the living standards of individuals. Growth parameters *viz*., plant height (at 30, 60 and 90 DAT) and dry matter accumulation (at 30, 60, 90 DAT and at harvest) were significantly higher with the SNHC + Drip irrigation (1.0 x Epan) + 125% N at all the growth stages. Significantly lower yields have been observed in 22.02 t/ha and Curd weight 446 grams and yield 22.02 t ha^{-1} were significantly higher with PNH + drip fertigation (1.0 Epan) + 125%N. Drip irrigation scheduled at 1.0 E pan with 125% N in the poly net house is recommended for broccoli production in central Telangana agro-climatic conditions as it maintained high yield.

Comment [B7]: you haven't any data about climatic condition. Semiarid tropical condition means nothing without daily registration about temperature, humidity and light intensity in Poly net house where the experiments where conducted!

Reference

1. Heywood VH. Flowering plant of the world. Mayflower Books, New York, 1978, 2-3.

2. Nirmal D, Singh KP, Benerjee MK, Rai M. Exotic Vegetables-Technical Bulletin Indian Institute of Vegetable Research, Varanasi, India. 2004; 2(1):4-6.

3. Locasio, S.J and smajastrala, A.G. 1996.Water application scheduling by pan evaporation for dry irrigated tomato.*Journal of American Society of Horticultural Science.*121(1): 63-68.

4. Candido, V., Miccolis, V and Perniola, M. 2000.Effects of irrigation regime on yield and quality of processing tomato (*Lycopersiconesculentum*Mill.) cultivars.III International Symposium on Irrigation of Horticultural Crops.*Acta Horticulture.*537: 779-788.

5. Biradar, M. S., Mantur, S. M., &Dhotre, M. (2018). Influence of fertigation on growth and

yield of broccoli and red cabbage under net house conditions. *Acta Horticulturae*, (1227), 485–490. doi:10.17660/actahortic.2018.1227.61.

6. Erdem T, Arın L, Erdem Y, Polat S, Deveci M, Okursoy H and Gultas HT. 2010. Yield and quality response of drip irrigated broccoli (*Brassica oleracea* L. var. *italica*) under different irrigation regimes, nitrogen applications and cultivation periods. *Agricultural Water Management* 97: 681-688.

7. Vasu, D., and Reddy, M.S. (2013). Effect of fertigation on yield, quality, nutrient uptake, fertilizer and water use efficiency in cabbage (*Brassica oleracea*).Agropedology (Nagpur) *23* (*2*), 106–112.

8. Patel, N. and Rajput, T.B.S. (2000). Effect of fertigation on growth and yield of onion. In: Micro Irrigation, CBIP publication no. 282: 451-454.

9. Narda, N.K. and Chawla, J.K. 2002. A simple nitrate sub-model for trickle fertigated potatoes. *Irrigation and Drainage*. 51: 361-371.

10. Gupta, A.J., Ahmed, N and Lal Singh. 2010. Response of lettuce to drip irrigation and fertigation. *Indian Journal of Fertilizers*. 6(5):12-16.

UNDER PEER REVIEW