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Effect of Various Levels of Drip Irrigation on Growth and Yield Attributes of Sprouting Broccoli (*Brassica oleracea* var. italica) Cultivar Fiesta

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ABSTRACT

The field experiment was conducted in sandy loam soil of the Horticulture farm, Rajasthan Agricultural Research Institute, Durgapura (Jaipur-Rajasthan) during rabi 2013-14 and 2014-15. The experiment, comparising of 18 treatment combinations replicated four times, was laid out in split-plot design with three irrigation regimes ($I_{0.6}$, $I_{0.8}$ and $I_{1.0}$). The results of the study have clearly shown that application of irrigation regimes ($I_{0.8}$) significantly increased growth attributes (plant height, no. of leaves, leaf area etc.), yield attributes (volume of head, diameter of head, weight of main head and secondary head, total head yield per bed and per hectare and biological yield etc.).

Key words: *Drip irrigation, growth, yield, harvest and Broccoli*

INTRODUCTION

Broccoli belongs to Brassicaceae family, is commonly known as *Hari gobhi* in Hindi. The world "broccoli" is an Italian word taken from the Latin 'brachcum', meaning an arm or branch. Broccoli is a garden vegetable and closely resembles to cauliflower. Broccoli has thick clusters of flower buds that form edible "heads". To obtain increased yields of this upcoming vegetable, it is imperative that studies on fertility levels to be applied for optimum yield potential are necessary. Among all the important nutrients, nitrogen, phosphorus and potash stand out to be imperative. Generally excessive amount of inorganic fertilizers are applied to this vegetable in order to achieve higher yield and maximum growth[3,4]. Moreover, inorganic fertilizers are considered as major sources of plant nutrients[1,9]. However, the use of inorganic fertilizers alone may cause problem for human health and the environment[2].

Drip irrigating system (DIS) which is highly efficient for water application is also ideally suited for fertigation. In this, water soluble fertilizers at required concentration are conveyed via the irrigation network to the wetted volume of soil. Thus, the distribution of chemicals in the irrigation water will likely place these chemicals in the desired location near to root zone.

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Some potential advantages of fertigation are less fertilizer losses due to leaching, controlled nutrient application in soil, flexibility in timing of fertilizer application relation to crop demand based on development and physiological stages of crops. Fertigation reduces fluctuations of soil salinity due to fertilizers, thereby improving soil solution conditions particularly, for salt sensitive crops, conserves labour and energy.

The information about the various levels of drip irrigation, fertigation and biofertilizer in sprouting broccoli under sandy loam soils of agro-climatic conditions of Rajasthan is rather limited and sketchy.

MATERIAL AND METHODS

The experiment was laid out at Horticulture Farm, RARI, Durgapura, Jaipur (Rajasthan). The region falls under Agro-Climatic Zone III-A (Semi-Arid Eastern Plain). Durgapura is situated at 26.5º North latitude, 75.47º East longitude at an altitude of 390 meters above Mean Sea Level in Jaipur district of Rajasthan. The experiment was laid out in Split Plot Design (SPD) with 4 replications and 8 treatments. Randomization of the treatments was done with the help of random number table as advocated by Fisher and Yates[5].

Thirty-two pro-tray of 104 chambers were taken for raising seedlings. Each tray was prepared by filling coco-peat and vermicompost. Seeds were treated with 0.2 per cent Carbendazim to check the infection of damping off. Seeds were sown on 26th September, 2013 and 2014 in pro trays by placing the seeds at 1-2 cm depth. A thin layer of coco-peat was applied to cover the seed. Fertigation application in sub-plot as nitrogen (N) @ 120 kg ha^{-1}, phosphorus (P_2O_5) @ 80 kg ha^{-1} and potassium (K_2O) @ 60 kg ha^{-1} were applied. The fertigation was applied in five split doses after transplanting.

Healthy seedlings were transplanted on 25th October, 2013 and 2014 when average height of seedlings was about 10-12 cm. The distance between row to row and plant to plant was kept as 45 cm × 45 cm. Plant height was recorded at 40, 60 DAT and at harvest. The number of leaves of five tagged plants were counted from each plot at 40, 60 DAT, the days were counted from the date of transplanting and average days to head initiation for the plant was calculated, The leaf area of five tagged plants were recorded from each plot at harvest by leaf area meter (LICOR-3100, Lincoln, USA), Volume of head was recorded by measuring the displaced water which was obtained by dipping the broccoli head in a measuring cylinder, The diameter of head was measured by dividing the circumference by 3.14 for five selected plants, Weight of main head and secondary head was taken from tagged plants after removing stem and leaves and average weight of main head and secondary head per plant was calculated, The total yield of central head and secondary head per bed was recorded by weighing with the help of single pan balance, The total yield per hectare in quintals was calculated on the basis of the total head yield per plot the tagged plants were weighed at the time of harvesting and average biological yield per plant was calculated.

RESULT AND DISCUSSION

Growth Parameters

The maximum mean plant height among all the treatments at 40 days after transplanting (24.69 cm), (36.61 cm) 60 DAT and Harvest time (48.83 cm) was recorded under $I_{1.0}$ irrigation regime on polled basis. It registered 49.09 and 12.89 per cent, 38.46 and 13.20 per cent and 63.97 and 21.26 per cent increase in plant height over $I_{0.6}$ and $I_{0.8}$ irrigation regimes, respectively.

The application of $I_{1.0}$ irrigation regime attained the maximum number of leaves per plant (12.90) at 40 DAT, and it registered 72.23 and 25.49 per cent, at 60 DAT (36.61 cm) and it registered 38.46 and 13.20 per cent and at harvest time leaves per plant (24.53) and it registered 55.94 and 17.37 per cent increase in leaves per plant over $I_{0.6}$ and $I_{0.8}$ irrigation regimes, respectively.

Among all the treatments application of $I_{1.0}$ attained the maximum number of days taken to head initation after transplanting of

broccoli though did not register significant differences with other irrigation regimes, fertigation levels and biofertilizer inoculation during both of the years of study and in pooled analysis.

Application of $I_{1.0}$ attained the maximum leaf area (1637.80 cm^2) among all the treatments and it registered 27.81 and 10.35 per cent increase in leaf area over $I_{0.6}$ and $I_{0.8}$ irrigation regimes, respectively. Application with treatment $I_{1.0}$ attained the maximum volume of head (84.05 cc) being at par with $I_{0.8}$ irrigation regime and it registered 45.26 and 3.65 per cent increase in volume of head as compared to $I_{0.6}$ and $I_{0.8}$ irrigation regimes, respectively.

The plant growth is a function of cell division and cell enlargement, which depends upon availability of inputs like nutrients and water. It is obvious that these parameters might have increased due to better nutritional environments in the root zone created with the application of water at $I_{1.0}$ volume which helped in growth and overall development of the plant in the soil which was otherwise poor at $I_{0.6}$ volumes. Further the production of dry matter is the outcome of growth and photosynthetic activity of the plant and their capacity to utilize available nutrients and is dependent on the balance between photosynthesis and respiration (P-R balance).

The application of water at $I_{1.0}$ volume might have increased water availability for longer duration which in turn might have helped in the rapid cell division and multiplication and resulted in expansion of leaf area with increased chlorophyll content thereby accelerating the photosynthetic rate and ultimately increased the supply of carbohydrates to the plants which in turn increased the vertical and lateral growth of the plants leading to the better plant height, number of leaves per plant and leaf area of sprouting broccoli during both the years as well as in pooled analysis. The findings of this investigation were in close conformity with those of Hegazi and ALSadon[7] and Gupta *et al*[6].

Yield Parameters

Application with treatment $I_{1.0}$ attained the maximum volume of head (84.05 cc) being at par with $I_{0.8}$ irrigation regime and it registered 45.26 and 3.65 per cent increase in volume of head as compared to $I_{0.6}$ and $I_{0.8}$ irrigation regimes, respectively.

Application with treatment $I_{1.0}$ irrigation regimes attained the maximum diameter of head (11.31 cm) as compared to all other treatments and it registered 43.71 and 4.63 per cent increase in diameter of head over $I_{0.6}$ and $I_{0.8}$ irrigation regimes, respectively. However, it remained at par with $I_{0.8.}$

The maximum average weight of main head 0.326 kg $head^{-1}$ was obtained at irrigation regime $I_{1.0,}$ being at par with $I_{0.8}$ which was 40.52 and 3.82 per cent higher in comparison to $I_{0.6}$ and $I_{0.8}$ volumes, respectively.

The maximum average weight of secondary head of 0.197 kg $head^{-1}$ was obtained at irrigation regime $I_{1.0}$ which was 51.54 and 3.14 per cent higher in comparison to $I_{0.6}$ and $I_{0.8}$ volumes, respectively. However, it remained at par with $I_{0.8}$ irrigation regimes.

The maximum total yield per bed of 9.05 kg $head^{-1}$ was obtained at irrigation regime $I_{1.0}$ which was 44.80 and 3.67 per cent higher in comparison to $I_{0.6}$ and $I_{0.8}$ volumes, respectively.

The maximum total head yield of 258.46 q ha^{-1} was obtained at $I_{1.0}$ level which was 44.80 and 3.57 per cent higher in comparison to $I_{0.6}$ and $I_{0.8}$ volumes, respectively.

The maximum value regarding biological yield of 3.33 kg was also obtained $I_{1.0}$ level which was 50.68 and 4.06 per cent higher in comparison to $I_{0.6}$ and $I_{0.8}$ volumes, respectively.

This might be due to increased availability of nutrients to the crop in the presence of ample moisture which might have helped in the increased synthesis of growth substances and naturally occurring phytohormones probably the auxin which ultimately helped in increased secondary heads per plant. Further, the increased availability might have enjoyed by the plants at the flower

primordial initiation stage which might have helped in flower formation resulting into higher average weight of main head. The increase in biological yield might be on account of better growth and development of plant in terms of plant height and dry matter. This is further supported by the fact that the water is involved in nutrients uptake in the plants from the soil. The increased nutrient supply because of more availability of water and its uptake by the plant along with nutrients brought significant increase in plant height, number of leaves per plant and leaf area which ultimately contributed to the significant increase in biological yield. These findings are in accordance with the earlier findings of Kadam and Magar[8], Raina *et al*[10]., and Gupta *et al*[6].

Table 1: Effect of various levels of drip irrigation on growth attributes of sprouting broccoli (*Brassica oleracea* var. italica) Cultivar Fiesta

Plant Height				**Number of Leaves per Plant**			**Days taken to head initiation**	**Leaf area (cm^2)**
Treatment	At 40 DAT	At 60 DAT	At Harvest	At 40 DAT	At 60 DAT	At Harvest		
Irrigation regimes	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
$I_{0.6}$	16.56	26.44	29.78	7.49	11.66	15.73	51.96	1281.39
$I_{0.8}$	21.87	32.34	40.27	10.28	15.14	20.90	52.34	1484.21
$I_{1.0}$	24.69	36.61	48.83	12.90	18.07	24.53	52.48	1637.80
SEm±	0.24	0.42	0.66	0.19	0.17	0.35	0.78	27.73
CD (p = 0.05)	0.75	1.31	2.04	0.57	0.54	1.06	NS	85.44
CV (%)	8.03	9.25	11.57	12.58	8.10	11.74	10.37	13.09

Table 2: Effect of various levels of drip irrigation on yield attributes of sprouting broccoli (*Brassica oleracea* var. italica) Cultivar Fiesta

Treatment	**Volume of head (cc)**	**Diameter of head (cm)**	**Average weight of main head per plant (kg)**	**Average weight of secondary head per plant (kg)**	**Total head yield per bed (kg)**	**Total head yield q ha^{-1}**	**Biological yield per plant (kg)**
Irrigation regimes	Mean	Mean	Mean	Mean	Mean	Mean	Mean
$I_{0.6}$	57.86	7.87	0.314	0.191	6.25	178.49	2.21
$I_{0.8}$	81.09	10.81	0.326	0.197	8.73	249.56	3.20
$I_{1.0}$	84.05	11.31	0.004	0.002	9.05	258.46	3.33
SEm±	1.06	0.16	0.013	0.007	0.11	3.53	0.05
CD (p = 0.05)	3.25	0.51	9.90	9.48	0.34	10.89	0.15
CV (%)	9.84	11.39	0.232	0.130	9.63	10.70	11.27

*Data based on pooled mean of 2 years (2013-14 & 2014-15)

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