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Research Article

EFFECT OF FERTIGATION LEVELS ON GROWTH, QUALITY AND YIELD OF POLYHOUSE CUCUMBER (*Cucumis sativus*)

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Abstract- An experiment was carried out in Naturally Ventilated Polyhouse (NVP) with four fertigation levels *viz*.60%, 80%, 100%and120% of recommended dose of fertilizer (RDF) (150:70:160 kg of NPK/ha) to determine the suitable fertigation level for polyhouse cucumber in central Madhya Pradesh. The experiment was carried out in the month of August-December for two consecutive years2014 and 2015 with Gynoecious variety – Sandhya, F_1 hybrid. NPK (18:18:18), Urea and white Muriate of Potash was used as water soluble fertilizers. Fertigation levels significantly affected ($P<0.05$) cucumber plant height, No of fruits/plant and yield. Fruit length and girth were not affected by fertigation levels but fruit weight was affected. Highest plant height (431.3 cm) was achieved in 120% RDF treatment while maximum No of fruits/plant (14) and highest cucumber yield (54.43t/ha) was achieved in 100% RDF treatment. Therefore, it can be inferred that for cucumber grown inside NVP, the fertigation dose of 150:70:160 kg of NPK/ha may be recommended for the agro-climatic conditions of central Madhya Pradesh.

Keywords- Naturally ventilated polyhouse (NVP), Polyhouse cucumber, Fertigation, Water soluble fertilizer, Gynoecious variety, Protected cultivation, Cucumber yield.

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Introduction

The demand for non-food grains and non-crop commodities will increase much faster than the growth in population. In India before independence vegetable production was less than 20 million tonnes which has now increased to 163 million tonnes from an area of 9.4 million ha in 2013-14 [1]. It is anticipated that in the year 2025, to meet the domestic needs and export potential, on an average at the national level, the country should attain a per hectare yield of 21 tonnes for vegetables [2]. The productivity needs to be doubled for horticultural sector. This calls for a serious effort on the part of agricultural scientists and extension agencies to improve production. More than half of the required growth in yields must be meet from research efforts by developing appropriate technologies.

Vegetable cultivation occupies an important place in Indian agriculture by providing food, nutritional and economic security and more importantly, producing higher returns per unit area and time. Vegetables also have vast potential in gaining foreign exchange through export. Vegetable production in Indian agriculture has wider scope for increasing the income of marginal and small farmers due to labour intensive nature and sustainability of vegetable cultivation on small and marginal operational land holdings which leading to improved livelihood.

Among the vegetables, salad cucumber (*cucumis sativus*) is a crop of commercial importance. It belongs to the cucurbitaceae family and popularly called *Khira* in India. Gynoecious cucumber (parthenocarpic varieties) can be grown round the year in Naturally Ventilated Polyhouses (NVP), which produces dark green seedless cylindrical fruits. These fruits are mild in flavor and have a thin, tender skin that does not require peeling. Cucumber is very low calorie vegetable, provide just 15 calories per 100 g. It contains 95% water [3], which making cucumber an ideal hydrating and cooling food. It is a very good source of potassium, vitamin K and some unique anti-oxidants, which are good for brain, heart and urinary system of human body.

In India, Andhra Pradesh, Karnataka, Telangana and Assam are leading cucumber producing states. India produces 678.0 thousand tonnes of cucumber in 2013-14, in which Madhya Pradesh contributes 32.6thousand tonnes by an area of 2120 ha [1]. In Madhya Pradesh, cucumber is produce everywhere, but large amount of cucumber is produce in Jabalpur and adjoining areas. The cucumber growers are looking for new cultivation practices to harvest best quality cucumber fruits with higher yield and for early/off season cucumber production, and protected cultivation is an alternative for them.

Protected cultivation practices can be defined as a cropping technique wherein the environmental elements like temperature, relative humidity etc., just around the plant body is controlled partially/ fully as per plant need during their period of growth to maximize the yield and resource saving. The experience of greenhouse production, which emerged in northern Europe, stimulated development in other parts of the world areas including India with various rates and degrees of success. Adaptability of protected cultivation technology depends on local climatic conditions and the socio-economic environment.

In NVP, as a result of the shift from surface irrigation to drip method of irrigation, fertigation becomes the most common fertilization technique in the irrigated agriculture. Fertigation is the application of water soluble solid fertilizer or liquid fertilizer through drip irrigation system. Fertilizer needed is to be applied frequently and periodically in small amount with irrigation to ensure adequate supply of water and nutrient in the root zone of plant. The fertigation level for any crop is depends on soil type, crop, method of irrigation used, water quality, types of fertilizers

available, economic feasibility etc. In NVP, due to indeterminate nature of crop, vegetative and reproductive stage overlaps and the nutrients are required by plant even up to fruit ripening stage for better growth and fruit size, so, application method such as fertigation may be very effective in NVP. Since a very meager work has been carried out on fertigation of cucumber grown in NVP, the attempts are made in present investigation to find out the optimum fertigation level for polyhouse cucumber in central Madhya Pradesh.

MaterialsandMethods

An experiment was conducted in NVP at Hi-Tech Horticulture Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India during August to December, for two consecutive years 2014 and 2015. Two ridge and furrow type polyhouses, each covering a cultivable floor area of around 1000 m^2 with sidewall and roof ventilations, were used for the study. The polyhouse was oriented in north-south direction and constructed with G.I. pipes and covered with U.V. stabilized polythene film of 200 micron thickness as cladding material. The red soil (250 m^3), FYM (2 tonnes), rice husk (45 m^3) and gravel sand (10 m^3) were used as soil media for preparation of beds in 1000 m^2 greenhouse. The highly porous and well drained media was prepared for better root growth and penetration.

The drip system used for the study consisted of sand filter, screen filter, main, sub mains, in-line laterals, ventury injector with booster pump and other accessories required for drip irrigation and fertigation. A 5 horse power submersible type pump was used to lift water from the underground RCC tank and supply it to the drip irrigated plots. The underground main and sub main pipelines used for drip irrigation were made of PVC pipes of 75 mm and 63 mm diameter respectively. 16 mm diameter LLDPE laterals, provided with in-line drippers of 1 lph discharge at 20 cm spacing, were used. Operating duration of drip system was 15D minutes, where D was the depth of irrigation in mm. Ventury injector with booster pump was used for fertilizer mixing. The flow control valves were provided in the sub mains and at the head of each lateral.

Fresh, high-quality virus free seeds of cucumber (variety–Sandhya, F_1 hybrid) were used for nursery rising and 15 day old seedlings were transplanted on raised beds. Each bed, having 22 m length, 70 cm width and 25 cm height were prepared manually, maintaining 40 cm spacing in between the beds as working path. 40 cucumber seedlings were transplanted in a single row on each bed/treatment of 20 m^2, in zigzag pattern at 45 cm apart. Transplanting was done on 13 and 25 September in 2014 and 2015 respectively. All cultural operations, except irrigation and fertigation, were same to all the treatments and were attended regularly. Water requirement for cucumber in protected condition is very from 50 to 90 $m^3/1000m^2$, but in this experiment Irrigation water was applied on alternate day according to actual evaporation. In all 41 irrigation was applied in 2014 and 42 irrigation was applied in 2015 from transplanting to till last picking. First picking of cucumber fruits was done at 30 Days after Transplanting (DAT). The subsequent pickings were done at an interval of 5 to 7 days. Last (9^{th}) picking was done on 4 and 18 December in 2014 and 2015 respectively.

The sixteen treatment combinations, consisting of four irrigation levels and four fertigation levels were laid out in Factorial Randomized Block Design (FRBD) and replicated thrice under protected condition in naturally ventilated polyhouse. Recommended dose of fertilizer (RDF) for cucumber in protected condition was considered as 150:70:160 kg of NPK/ha [4]. The four fertigation levels (treatments) were 60% RDF, 80% RDF, 100% RDF and 120% RDF. Nutrients were supplied to the crop in 10 equal parts by fertigation. First fertigation was done with 3^{rd} Irrigation and then next fertigations were carried out after 8-10 days intervals. The last 10^{th} fertigation was applied with 38^{th} irrigation. Water soluble fertilizers NPK (18:18:18), Urea and white Muriate of Potash (MoP) were used in fertigation process. The quantity of nutrients applied in different treatments is given in [Table-1].

Table-1 *Quantity of nutrient applied in different treatments (kg/ha)*

	60% RDF	80% RDF	100% RDF	120% RDF
Nitrogen (N)	90	120	150	180
Phosphorous (P)	42	56	70	84
Potassium (K)	96	128	160	192
Total (N+P+K)	**228**	**304**	**380**	**456**

Observations on plant height and flower appearance (as growth parameters), length, girth and weight of fruits (as quality parameters), No of fruits/ plant along with fruit yield/plant and fruit yield/ha (as yield parameters) were recorded using standard procedures. Statistical analysis of the individual year data was performed using FRBD with three replications. Pooled analysis of data over years was also performed to identify the average effect of fertigation over years. The level of the significant difference (LSD at $P < 0.05$) was used in the ANOVA to test the effect of fertigation treatments on different response variables.

Results and Discussions

Fertigation levels affect the cucumber plant height in NVP. Data of 2014 and 2015 reveal that the plant height of cucumber grown inside polyhouse showed significant improvement according to fertigation levels [Table-2]. Highest plant height (431.3 cm) was found in 120% RDF, which was at-par with 100% RDF (414.8 cm) and significantly higher over 60% and 80% RDF (334.5 and 356.0 cm respectively) at the time of last picking [Fig-1a]. Similar findings have been reported by Sumathi [5].

Table-2 *Plant height (at harvest) and flower appearance of cucumber as influenced by fertigation levels inside NVP*

		60% RDF	80% RDF	100% RDF	120% RDF	CD (0.05)
Plant height (cm)	**2014**	345.8	363.4	422.3	440.7	49.95
	2015	323.1	348.5	407.3	421.9	42.28
	Pooled Mean	334.5	356.0	414.8	431.3	S
Flower appearance (Days After Transplanting)	**2014**	21.8	21.3	21.4	20.6	1.59
	2015	21.4	21.5	20.8	22.2	2.00
	Pooled Mean	21.6	21.4	21.1	21.4	NS

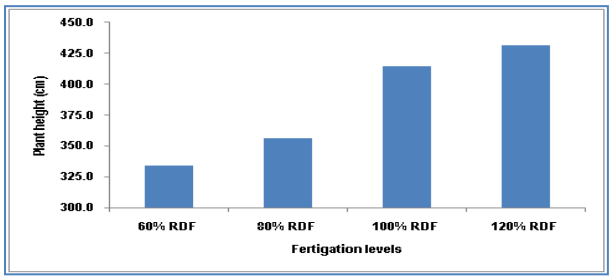
S - Significant, NS - Non Significant

Table-3 *Length, girth and weight of cucumber fruits as influenced by fertigation levels inside NVP*

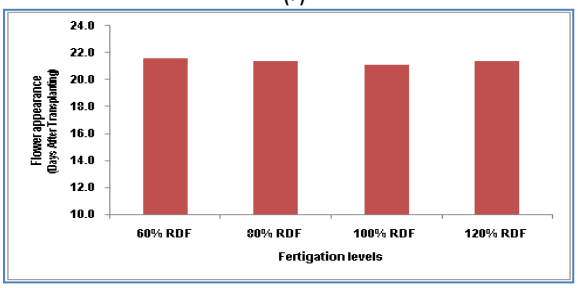
		60% RDF	80% RDF	100% RDF	120% RDF	CD (0.05)
Fruit length (cm)	**2014**	14.5	14.7	15.1	15.0	1.07
	2015	14.4	14.6	15.0	14.9	0.99
	Pooled Mean	14.4	14.6	15.0	15.0	NS
Fruit girth (cm)	**2014**	14.0	14.2	14.2	14.3	0.92
	2015	14.2	14.6	14.4	14.5	0.84
	Pooled Mean	14.1	14.4	14.3	14.4	NS
Weight of 5 fruits (kg)	**2014**	1.01	1.03	1.03	1.07	0.05
	2015	1.02	1.04	1.10	1.10	0.06
	Pooled Mean	1.02	1.04	1.07	1.08	S

S - Significant, NS - Non Significant

Flower appearance was unaffected by fertigation levels [Table-2], probably because it is predominantly a varietal characteristic. The earliest flower appearance was observed in 100% RDF treatment at 21 days after transplanting (DAT) and the lasts flower appearance was observed in 60% RDF treatment at 22 DAT [Fig-1b].



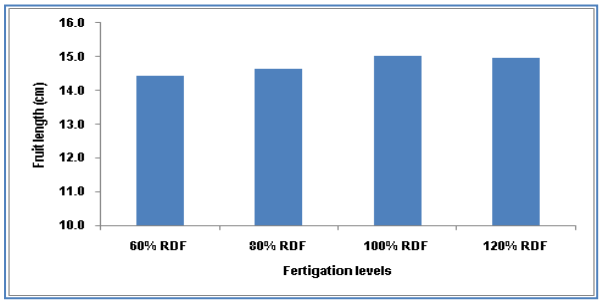
1(a)



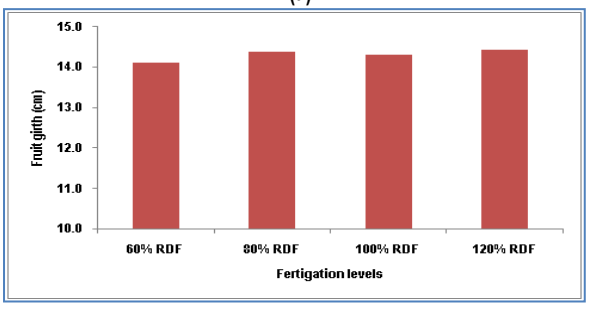
1(b)

Fig-1(a, b) Effect of fertigation levels on growth parameters of cucumber plant

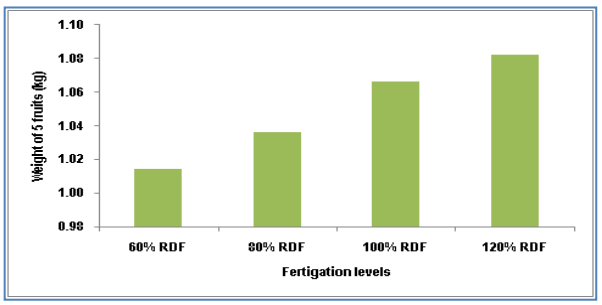
Data related with size and weight of cucumber fruits were collected and analysed at 2nd, 5th and 8th pickings. At 5th picking stage, fruit length and girth was found almost similar for all fertigation levels i.e. not affected by fertigation levels [Table-3]. The same result was observed at 2nd and 8th pickings. Highest fruit length (15.0 cm) was found in 120% and 100% RDF, which was at-par with other two treatments at 5th picking [Fig-2a]. Similarly highest fruit girth (14.4 cm) was found in 120% and 80% RDF, which was at-par with other two treatments at 5th picking [Table-3], [Fig-2b]. At 5th picking stage, weight of 5 fruits was found highest (1.08 kg) in 120% RDF, which is significantly superior over 60% RDF and at par with other levels [Table-3], but at 2nd and 8th picking, this was also found non-significant. The effect of fertigation levels on fruit weight is illustrated in [Fig-2c].



2(a)



2(b)

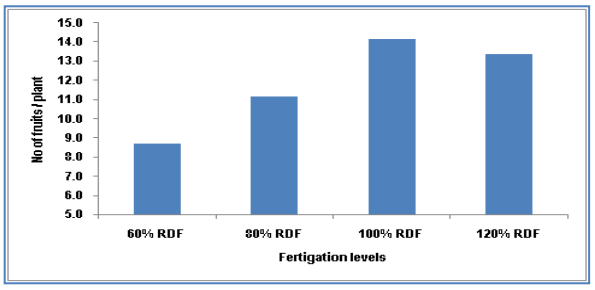


2(c)

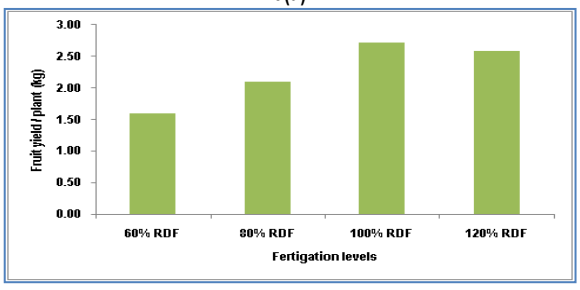
Fig-2 (a, b, c) – Effect of fertigation levels on size and weight of cucumber fruits

Effect of fertigation levels on cucumber yield was huge. Among all the fertigation levels, 100% RDF and 120% RDF fertigation levels showed great impact on yield parameters, with respect to other fertigation levels. 100% RDF fertigation level was found significantly superior over 60% and 80% RDF, and at-par with 120% RDF for all yield parameters. No of fruits/plant was found maximum in 100% RDF (14fruits)#, which was significantly higher over 60% RDF (7 fruits) # and 80% RDF (11fruits) #, and at-par with 120% RDF (13 fruits) # [Table-4], [Fig-3a].

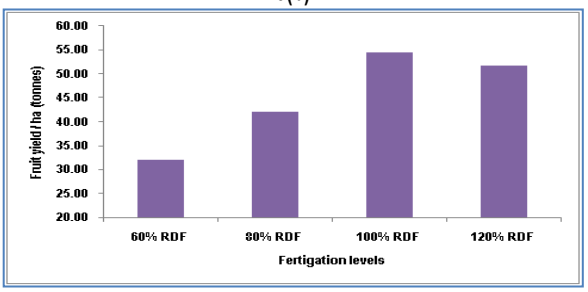
Fruit yield/plant was found maximum in 100% RDF (2.72 kg), which was significantly higher over 60% RDF (1.60 kg) and 80% RDF (2.10 kg), and at-par with 120% RDF (2.59 kg) [Table-4], [Fig-3b]. Similarly fruit yield/ha was found maximum in 100% RDF (54.43 tonnes), which was significantly higher over 60% RDF (32.03 tonnes) and 80% RDF (42.07 tonnes), and at-par with 120% RDF (51.72 tonnes) [Table-4], [Fig-3c]. The results are in conformity with the findings of experiment held at Centre for Protected Cultivation Technology (CPCT), IARI [6], in which Kian variety of cucumber produced highest fruit yield (2.08 kg/plant and 74.90 tonnes/ha) under NVP in rainy season.



3(a)



3(b)



3(c)

Fig-3(a, b) – Effect of fertigation levels on yield of cucumber in NVP cultivation

Table-4 *No of fruits/plant, fruit yield/plant and fruit yield/ha of cucumber as influenced by irrigation levels inside NVP*

		60% RDF	80% RDF	100% RDF	120% RDF	CD (0.05)
No of fruits/plant	2014	8.27	11.01	13.64	12.90	1.53
	2015	9.11	11.31	14.69	13.81	1.41
	Pooled Mean	8.69	11.16	14.17	13.36	S
Fruit yield/plant (kg)	2014	1.54	2.04	2.59	2.44	0.28
	2015	1.67	2.16	2.86	2.73	0.26
	Pooled Mean	1.60	2.10	2.72	2.59	S
Fruit yield/ha (tonnes)	2014	30.75	40.89	51.75	48.88	5.65
	2015	33.31	43.26	57.10	54.55	5.09
	Pooled Mean	32.03	42.07	54.43	51.72	S

S - Significant, NS - Non Significant

Cucumber yield was also affected by irrigation levels, but interaction of fertigation and irrigation was found non-significant at every time. This research article is mainly focused on effect of fertigation on cucumber only.

Conclusion

Fertilizer management is important for achieving higher cucumber yield, especially in protected cultivation. In NVP cultivation, we can not only maintain optimal features of cucumber growth, but also maintain cucumber yield and improve fruit quality. Based on the results of the present study, it can be concluded that, the 150:70:160 kg per hectare application of N:P:K is the best fertigation dose recommendation for polyhouse grown cucumber in order to get higher yield and uniform fruit size for the agro-climatic conditions of central Madhya Pradesh.

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Conflict of Interest: None declared

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#Flower appearance and No of fruits/plant values are rounded off in Text.