PERFORMANCE OF NUTRIENT SOURCES AND ITS LEVELS ON HYBRID BHENDI UNDER DRIP FERTIGATION SYSTEM

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ABSTRACT

Field experiment was carried out at AICRP- Water Management block, Agricultural College and Research Institute, Madurai during Kharif 2009 to study the effect of drip fertigation on growth, yield, quality and economics of hybrid bhendi (M-10). There were eight treatments replicated four times in Randomized Block Design. All the growth and yield parameters were substantially enhanced by drip fertigation treatments compared to surface irrigation with soil application of recommended dose of fertilizers. Drip fertigation of 100 per cent RDF as water soluble fertilizers (WSF) exhibited better plant height, number of branches, days taken for first flowering, root characteristics and dry matter production. As a consequence of better growth, yield attributing characters like number of pods per plant, pod length, pod girth and pod weight were increased under drip fertigation of 100 per cent RDF as WSF. Further, every increment in the level of nutrients by fertigation from 50 to 100 per cent recommended dose of fertilizers brought out corresponding increase in the above parameters. Drip fertigation of 100 per cent RDF as WSF registered significantly higher pod yield which amounted to 65 per cent yield increase over surface irrigation with soil application of recommended dose of fertilizers

The hybrid bhendi quality parameters *viz.,* crude protein, mucilage and ascorbic acid contents were significantly increased with increasing fertigation levels. Significantly lower crude fibre was noticed in the treatment with drip fertigation of 100 per cent RDF as WSF. The fertilizer dose with drip fertigation of 100 per cent RDF as WSF resulted in higher plant nutrient uptake and availability of soil nutrients at various growth stages of crop growth owing to easily available form of applied nutrients. Further, drip fertigation integrated with liquid biofertilizers and humic acid created favourable condition for multiplication of beneficial microorganisms in the rhizosphere region.

The nutrient mobility study revealed that fertigation treatments maintained higher concentration of available N and K around root zone of bhendi compared to surface irrigation with soil application of recommended dose of fertilizers where most of the nutrients moved to deeper layer due to leaching fraction of applied fertilizers. Fertigation of P at various levels also resulted in more available P at all soil layers compared to soil application of fertilizers. The resource use efficiency parameter *viz*., partial factor productivity declined with increasing levels of fertigation. The water use efficiency was higher under drip fertigation of 100 per cent RDF as WSF. Though the

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initial investment cost on drip fertigation system was more, drip fertigation of 100 per cent RDF as WSF resulted in higher net returns.
From the foregoing, it is concluded that drip fertigation of 100 per cent RDF as WSF at six days interval would be an ideal practice to achieve higher income as compared to traditional method of applying fertilizers with surface irrigation.

INTRODUCTION

Bhendi responds well to additional fertilizer applied and it is reported to be a heavy feeder of NPK (Patel *et al*., 2009). Drip irrigation is an effective way to supply water to bhendi plants and usually fertigation improves fertilizer use efficiency by the plants. It is well known that organic manures, inorganic fertilizers and biofertilizers are essential to increase the yield of vegetable crops. Day by day the cost of fertilizers has gone up and ultimately farmers receive only a marginal profit. Therefore, it is imperative that chemical fertilizers, organic manures as well as biofertilizers are utilized properly and effectively not only as source of the nutrients but also for increasing nutrient use efficiency without adversely disturbing the soil health.

MATERIALS AND METHODS

Field investigation was conducted at AICRP-Water Management Block, Agricultural College and Research Institute, Madurai, Tamil Nadu, India during *Kharif* 2009 to elicit information on effect of drip fertigation on growth, yield, quality and economics of hybrid bhendi.
The experiment was laid out in Randomized Block Design (RBD) with four replications. Treatments consisted of T_1 – Surface irrigation with soil application of recommended dose of fertilizers (200:100:100 kg NPK ha^{-1}), T_2 -Drip fertigation of 100% RDF (N, P and K through drip system as water soluble fertilizers (WSF), T_3 - Drip fertigation of 50% RDF (50% NPK as basal +balance through drip as WSF), T_4 - Drip fertigation of 75% RDF (50% NPK as basal +balance through drip as WSF), T_5 – Drip fertigation of 100% RDF (50% NPK as basal +balance through drip as WSF), T_6 – Drip fertigation of 50% RDF (50% NPK as basal +balance through drip as WSF+LBF (Liquid Bio Fertilizers)+HA (Humic Acid)),T_7 – Drip fertigation of 75% RDF (50% NPK as basal +balance through drip as WSF+LBF+HA), T_8 – Drip fertigation of 100 % RDF (50% NPK as basal +balance through drip as WSF+LBF+HA). Hybrid bhendi (M-10) was used as the test crop. The recommended dose of fertilizer for hybrid bhendi is 200:100: 100 Kg NPK ha^{-1}. The drip irrigation was scheduled once in three days and fertigation was given once in six days as per the treatment schedule stating from 15 DAS upto 100 DAS. The observations on growth parameters at periodical intervals, yield attributes, yield and quality parameters were recorded. Further, resource use efficiency and economics were also calculated.

Results and Discussion

Growth attributes (Table 1)
Drip fertigation of 100 per cent RDF as WSF recorded the highest plant height followed drip fertigation of 100 per cent RDF (50% NPK as basal + balance through drip as WSF+LBF+HA). The lowest plant height was recorded in drip fertigation of 50 per cent RDF (50%NPK as basal + balance through drip as WSF) which was on par with surface irrigation with soil application of recommended dose of fertilizers. Similar

trend was also observed in number of branches per plant. The favourable moisture throughout the crop growth as well as adequate level of nutrients might have stimulated the physiological proves of cell elongation and cell division, which would have contributed to elongation of the stem and more number of branches. Similar results of better branching at recommended level of nutrients under drip irrigation system were reported by Tumbare *et al.* (1999) and Gulshan Mahajan *et al.* (2006) in Chilli an brinjal respectively.

Table 1. Effect of drip fertigation on growth attributes of hybrid bhendi

Treatments	Plant Height (cm)	No of branches at harvest stage	Days taken for first flowering
T_1	167.46	4.30	39
T_2	198.42	7.20	34
T_3	165.34	4.20	40
T_4	167.21	4.30	37
T_5	172.55	5.00	36
T_6	176.84	4.00	38
T_7	179.44	5.20	34
T_8	182.25	6.60	34
SEd	**3.80**	**0.11**	**0.83**
CD (P = 0.05)	**7.92**	**0.24**	**1.73**

Drip irrigation as well as fertigation levels significantly reduced the days taken for first flowering. The plants treated with drip fertigation of 100 per cent RDF as WSF came to flowering earlier. This was comparable with drip fertigation of 100 per cent RDF (50% NPK as basal + balance through drip as WSF+LBF+HA). The late flowering was observed under surface irrigation with soil application of recommended dose of fertilizers.

Yield parameters (Table 2)

Yield attributing characters like number of pods per plant, pod length, pod girth and pod weight were significantly higher under drip fertigation treatments. The maximum yield attributing characters were recorded under drip fertigation of 100 per cent RDF as WSF which was 26 per cent higher than surface irrigation with soil application of recommended dose of fertilizers. The increased number of pods under drip fertigation of 100 per cent RDF as WSF was mainly due to early vigour shown by the crop with its growth characters. This was also due to the availability of optimum plant nutrients along with sufficient moisture for early development of plant parts and rooting system, which might have enhanced more uptake of plant nutrients.

Table 2. Effect of drip fertigation on yield parameters of hybrid bhendi

Treatments	No of pods/plant	Pod length (cm)	Pod girth (cm)	Pod weight (g)
T_1	13.10	14.50	5.32	14.70
T_2	16.40	18.20	7.20	21.05
T_3	12.70	14.40	5.30	14.04
T_4	13.20	15.40	6.08	17.08
T_5	13.50	16.02	6.84	18.20
T_6	13.00	14.60	5.36	14.50
T_7	14.10	16.90	6.30	17.90
T_8	15.00	17.10	6.80	19.15
SEd	0.32	0.46	0.18	0.43
CD (P = 0.05)	0.68	0.97	0.37	0.91

Yield of bhendi (Table 3)

The highest yield with drip fertigation of 100 per cent RDF as WSF may be attributed mainly owing to good vegetative growth in terms of higher plant height, more branches, more pods and higher pod weight than with surface irrigation with soil application of recommended dose of fertilizers. In the present study, it was also observed that there was no significant difference in crop yields between drip fertigation of 50% RDF (50% NPK as basal +balance through drip as WSF) and surface irrigation with soil application of recommended dose of fertilizers and these treatments recorded the lowest yield. This indicated that fertigation saved fertilizers to the tune of 50 per cent as compared to 100% RDF to maintain the same yield. Savings in the consumption of fertilizers upto 50 per cent by fertigation compared to soil application have been reported by Satyendra kumar *et al.* (2008) in onion and Soumya *et al*. (2008) in tomato.

Table 3. Effect of drip fertigation on yield of hybrid bhendi

Treatments	**Pod Yield (t ha^{-1})**
T_1	10.87
T_2	17.96
T_3	9.89
T_4	12.37
T_5	13.84
T_6	10.57
T_7	13.97
T_8	15.54
SEd	**0.48**
CD (P = 0.05)	**1.00**

Quality parameters (Table 4)

The quality parameters of hybrid bhendi like crude protein, crude fibre, ascorbic acid and mucilage contents were higher in drip fertigation of 100 per cent RDF as WSF. This was comparable with drip fertigation of 100 per cent RDF (50% NPK as basal + balance through drip as WSF+LBF+HA. Surface irrigation with soil application of recommended dose of fertilizers was found to record lower quality parameters. The increasing quality parameters in the recommended level of nutrients applied in combination with liquid biofertilizers and humic acid favoured by intense protein synthesis and its efficient storage in the presence of sufficient amount of available nitrogen from drip fertigation and supplementation from *Azospirillum*. These findings are in conformity with Prabhu *et al*. (2002) and Patel *et al*. (2009).

Table 4. Effect of drip fertigation on quality parameters of hybrid bhendi

Treatment	Crude protein (%)	Crude fibre (%)	Ascorbic acid (mg/100g)	Mucilage content (%)
T_1	15.18	13.66	13.33	1.27
T_2	18.37	10.38	19.65	1.85
T_3	15.37	12.30	14.13	1.32
T_4	15.75	12.87	15.24	1.48
T_5	18.00	11.01	16.01	1.78
T_6	16.00	11.83	16.82	1.61
T_7	16.93	12.18	17.45	1.72
T_8	18.25	10.74	18.52	1.82
SEd	0.40	0.33	0.65	0.06
CD (P = 0.05)	0.84	0.70	1.36	0.14

Nutrient mobility (Fig.)

The mobility of nutrients was well pronounced under drip fertigation system. The maximum concentration of nitrogen was noticed under drip fertigation of 100 per cent RDF as WSF. As the dose of fertilizer reduced, the availability of nutrient also decreased in the root zone. In general, fertigation treatments maintained higher concentration of available N (Figure 1) around root zone of bhendi upto a depth of 0-30 cm soil layer compared to surface irrigation with soil application of 100 per cent recommended dose of fertilizers, where most of the N moved to deeper soil layer (30-45cm).

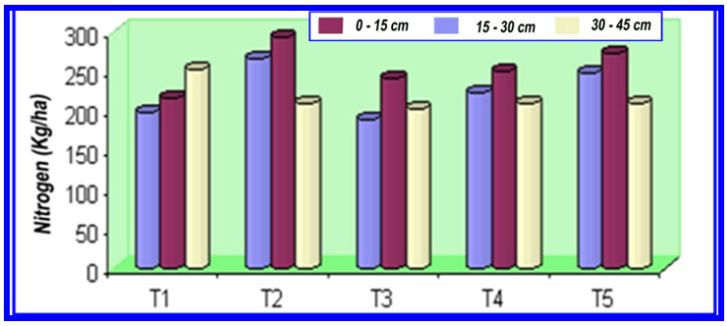

Figure 1. *Concentration of N in Soil (0-15 cm along lateral) as influenced by method of fertilizer application and fertigation levels*

Drip fertigation caused both horizontal and vertical moment of applied P and maximum concentration was observed at all layers of soil (Figure 2) compared to soil application of recommended dose of fertilizers. Available P distribution in soil at all layers was at higher level in drip fertigated treatments when compared to surface irrigation with soil application of recommended dose of fertilizers. The accumulation of available P at 0-15 and 15-30 cm was tended to be higher in drip fertigation of 100 per cent RDF as WSF (29.3 Kg ha^{1}) because of complete solubility of phosphorus source (Poly feed – 13:40:13) and frequent and small application rates through drip system. Phosphate transport in soil applied treatment was too slow for the average rate of root growth into the soil, since P fertilizers are prone to fixation at the point of application. Most of the applied P may be turned to non-soluble form in a short time after its application and the observed concentrations build up in the upper soil layer could affect root growth and create unfavourable conditions for P uptake. This suggested higher response to P fertigation compared to soil application in traditional method. Research has shown that the mobility of P can be increased when they are applied via fertigation

Distribution of K varied both vertically and horizontally from the emitting point after fertigation. The accumulation of K in soil application of recommended dose of fertilizers was lower at 0-15 and 15-30cm depth and the reverse was true at 30-45cm depth where entire K fertilizer was three times soil applied, indicating potential leaching risk. In this sandy clay loam with low CEC and K fixation, potassium ions move along with water and thus, it will be prudent to apply K fertilizers through drip irrigation in more splits to achieve maximum nutrient use efficiency (Figure 3). This suggested that split application of K fertilizers through drip would be a better option for bhendi than soil application with surface irrigation. It was also observed that the drip fertigation has the potential to minimize leaching loss and to improve the available K status in root zone for efficient use by the crop. Hence frequent supplementation of nutrients through drip irrigation increased availability of NPK in the root zone and which in turn increased the yield and quality of bhendi.

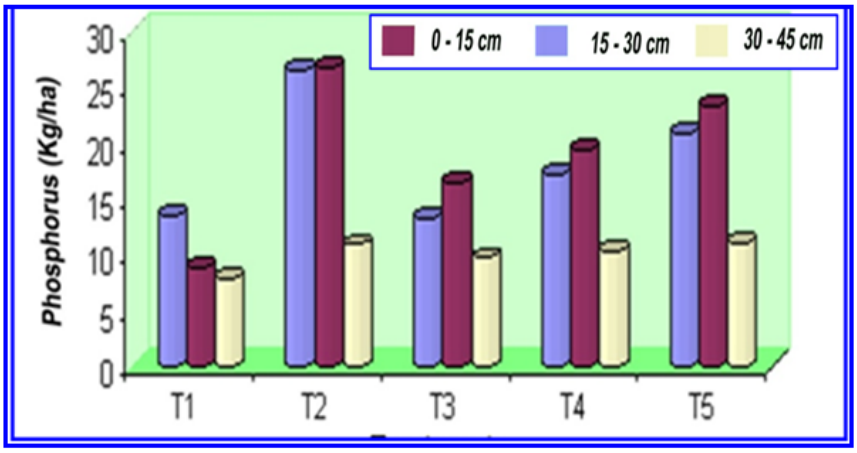

Figure 2. *Concentration of P in Soil (0-15 cm along lateral) as influenced by method of fertilizer application and fertigation levels*

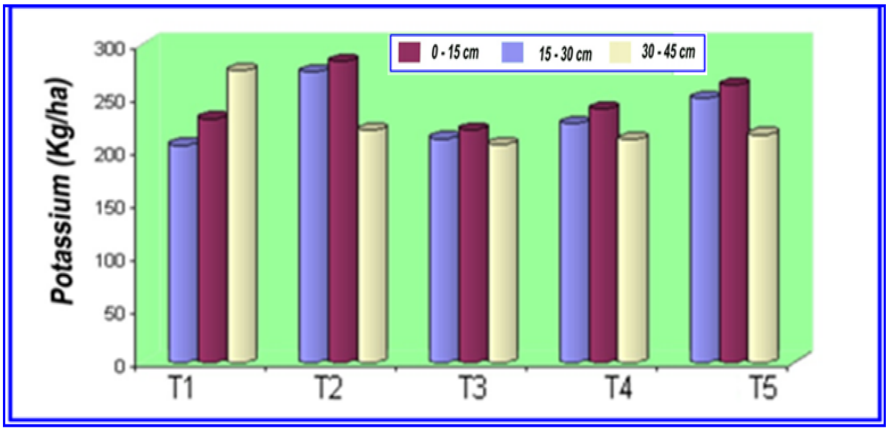

Figure 3. *Concentration of K in Soil (0-15 cm along lateral) as influenced by method of fertilizer application and fertigation levels*

Water use studies (Table 5)

Drip irrigation is an efficient method to deliver water and nutrients to the plants because water is directly applied to the effective root zone of crop plants. The loss of water was minimum and that resulted in the lower water requirement in drip irrigation system compared to surface irrigation. In the present study, the total water used by the crop was 22 percent higher in surface irrigation compared to drip irrigation. Increased efficiency of water due to drip irrigation was earlier reported by Sankar et al. (2008).

Water use efficiency can be increased either by increasing the yield or by reducing the quantity of water applied. Among the treatments, drip fertigation of 100 per cent RDF as WSF resulted in higher water use efficiency and water productivity followed by drip fertigation of 100 % RDF (50% NPK as basal + balance through drip as WSF+LBF+HA). Surface irrigation with soil application of recommended dose of fertilizers recorded lower water use efficiency and productivity. The increased efficiency of water usage under drip irrigation was due to increased pod yield and less water consumption compared to surface method of irrigation. This is in confirmation with the findings of Soumya *et al*. (2008).

Table 5. Effect of drip fertigation on water use efficiency and water productivity in hybrid bhendi

Treatment	Total water use (mm)	WUE (kg ha^{-1} mm^{-1})	Water productivity (Rs. ha^{-1} mm^{-1})
T_1	655	16.60	132.76
T_2	512	35.08	280.63
T_3	512	19.32	154.53
T_4	512	24.16	193.28
T_5	512	27.03	216.25
T_6	512	20.64	165.16
T_7	512	27.29	218.28
T_8	512	30.35	242.81

Conclusions

Generally, drip irrigation cum drip fertigation improved the performance of hybrid bhendi with higher yield attributes. Drip fertigation of 100 per cent RDF as WSF was the best in improving many of the growth attributes and yield. Based on the growth, yield and quality parameters drip fertigation of 100 per cent RDF as WSF was superior followed by drip fertigation of 100 per cent RDF (50% NPK as basal + balance through drip as WSF+LBF+HA). Drip fertigation of 100 per cent RDF as WSF recorded the highest net return. Hence, it is concluded that drip fertigation of 100 per cent RDF as WSF at six days interval is an ideal practice to achieve higher income as compared to traditional method of applying fertilizers with surface irrigation.

References

1. Gulshan Mahajan, Rakesh Sharda and K.G. Singh. 2006. Effect of planting method and drip irrigation on yield and water use efficiency of brinjal. Agronomy Digest. 6.
2. Patel, A.P., Tandel, Y.N., Patel. C.R. Patel M.A. and Patel, P.B.2009. Effect of combined application of organic manures with inorganic fertilizers on growth and yield okra CV. Parbhani Kranti. The Asian J.Hort. 4(1): 78-81.
3. Prabhu, T, Narwadkar, P.R, Sajindranath, A.K. and Bhore, M.R.2002. Effect of INM on yield and quality of okra. Gujarat J. Applied Hort. 2(2):28-33.
4. Satyendra kumar, Imtiyar, M.and Kumar, A.2008. Variable irrigation and fertigation on seed quality and seed yield of okra Parbhani Kranti J.Maharashtra Agric. Univ. 31(1): 130-131.
5. Soumya, T.M., Ramachandrappa, B.K. and Nanjappa H.V. 2008. Effect of fertigation with different sources and levels of fertilizer on growth and yield of tomato. Mysore J.Agric.Sci., 43(1): 80-84
6. Tumbare, A.D. B.N. Shinde and B.U., Bhoite. 1999. Effect of liquid fertilizers through drip irrigation on growth of yield of okra. Indian J. Agron., 44(1) : 176-178.