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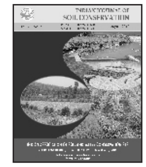

Effect of drip fertigation and polyethylene mulching on growth, yield and input use efficiency of pointed gourd in eastern coastal plain zone of Odisha

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ABSTRACT

Field experiments were conducted during 2015-17 at Precision Farming Development Centre, Bhubaneswar to study the effect of drip fertigation and polyethylene mulching on pointed gourd (*Trichosanthes dioica*) *cv. Swarna Aloukik*. The experiment was laid out in randomized block design with seven treatments and three replications. The treatments T_1, T_2, T_3 comprised of 100, 80 and 60% levels of fertigation and T_4, T_5 and T_6 refers to 100, 80 and 60% levels of fertigation with polyethylene mulching, respectively. The treatment T_7 was taken as control with drip irrigation and basal application of recommended dose of fertilizer. The recorded data on the growth parameters and yield of pointed gourd revealed that the plant height, canopy development and other plant growth parameters were higher in the treatment with 100% fertigation of NPK with polyethylene mulch (T_4) when compared to other treatments. Similarly, the yield attributing character *viz.*, fruit weight, fruit length, fruit girth were recorded maximum values of 28.3, 9.25, 9.28 cm, respectively in T_4 and the lowest values were recorded in control. Hence pointed gourd yield subsequently recorded highest value in T_4 followed by T_5 which are significantly higher than T_7. Likewise superior water use efficiency (WUE) and nutrient use efficiency were observed in all the polyethylene mulch combination treatments when compared with other treatments without mulch. The study emphasized that adoption of drip fertigation with polyethylene mulching increases the productivity in pointed gourd, besides ensuring the higher efficiency of water and nutrients. Pooled data of 2015-16 and 2016-17 indicated that drip fertigation with mulching resulted 26% and 27% increase in yield and irrigation water use efficiency (IWUE), respectively over drip irrigation with soil application of fertilizers.

1. INTRODUCTION

India with its large population is facing unique challenges of water scarcity due to diverse geographical, climatic and geo-environmental conditions apart from unequal spatio-temporal distribution of fresh water resources. Therefore efficient and effective water management strategies are essential for meeting the increasing water needs of agricultural, domestic, industrial and environmental sectors. Considering the current water resources problems and rapid increase in its demand, the importance of effective utilization of water resources cannot be underestimated if India has to remain self-reliant in food production. Water supply is major constraint to crop production and efficient use of water in any irrigation system is becoming important particularly in arid and semiarid region where water is a precious source. Now-a-days, the world is facing very serious global warming problem and to overcome this problem precision farming is the only way to produce more yield from limited resources *viz.* land, water and fertilizer.

Precision farming is about doing the right thing, in the right place, in the right way, at the right time. The intent of precision farming is to match agricultural inputs and practices as per crop and agro-climatic conditions to improve the accuracy of their applications. The conventional methods of water conveyance and irrigation, being highly inefficient, has led not only to wastage of water but also to several ecological problems like water logging, salinization and soil degradation making productive agricultural lands unproductive. It has been recognized that use of modern irrigation methods like drip and sprinkler irrigation is the only alternative for efficient use of surface as well as ground water resources. Drip irrigation is an advanced system through which water can be applied precisely, judiciously and uniformly with the help of regulatory system directly to the root zone of the crop and it saver water significantly over surface irrigation practices (Kumar *et al.,* 2012). At the same time, adequate fertigation (fertilizer application through irrigation water) to maintain optimum nutrient supply for better growth and development of the crop are also equally important towards the higher productivity. The primary advantage of this system is that fertilizer can be injected through irrigation water. Drip irrigation improves the WUE, nutrient uptake and quality of the produce, increase plant growth and development, higher yield and improved quality and its flexibility in scheduling water application. Application of water soluble fertilizer through drip irrigation system is gaining importance in present day agriculture to boost the production and productivity of various crops. Fertilizer through drip irrigation system can efficiently place nutrients in wetted zone where in the roots are at the highest concentration. In fertigation, nutrient use efficiency could be as high as 90% compared to 40-60% in conventional methods. The amount of fertilizer lost through leaching can be as low as 10% in fertigation, whereas it is 50% in the traditional system. The shrinking land: man and water: man ratios, increasing fertilizer prices, haunting energy crisis, wide spread pollution and fast degradation of natural resource further emphasise the need for improved water and fertilizer use efficiency (FUE). Drip fertigation optimize the use of water and fertilizer enabling to harness high crop yield, simultaneously ensuring a healthy soil and environment. The drip fertigation technology encompasses the application of solid or liquid mineral fertilizers through drip irrigation systems thus supplying a nutrient containing irrigation water to crops. It can be used to apply any water soluble fertilizer or chemical and water in precise amounts, as and when required to match the plant needs or any other agronomic management.

Polyethylene mulch can be used: (i) to modify soil temperature, which may promote faster growth early in the season and generally lead to earlier harvest, (ii) for effective weed control, (iii) to prevent nutrient losses by leaching, (iv) to prevent fruit contact with soil, and (v) to reduce soil water loss by decreasing evaporation from the soil surface (Fritz, 2012). The use of impermeable plastic mulch in bell pepper cultivation affects water fluxes and may change crop water use and distribution compared to open-field conditions (Allen *et al*., 1998; Amayreh and Al-Abed, 2005) reducing soil evaporation (Deng *et al*., 2006), as it acts as a moisture barrier which diminishes the surface area of soil evaporation. Plastic mulch affects the micro-climate around the crop by modifying the radiation budget of the surface and by decreasing the soil water loss. Colour affects the surface temperature of the mulch cover and consequently the underlying soil temperature. In India pointed gourd is grown in an area of 16000 ha land and the productivity is 15.18 t ha^{-1} and in Odisha state it is grown in an area of 1743 ha land having the productivity 14.13 t ha^{-1} (Anonymous, 2016).

Hence, evaluating the effect of precision farming technologies *viz.,* drip irrigation, fertigation and polythene mulching on plant growth and yield of pointed gourd is imperative. However, very little research data is available on the performance of pointed gourd under drip fertigation alongwith polyethytene mulch. Some fertigation studies have been conducted in different parts of the country with only nitrogenous fertilizers, Nitrogenous and potassic fertilizers and very less study on N, P, K fertigation. Hence, the study was undertaken to evaluate the effect of drip fertigation on growth, yield, IWUE and

FUE of pointed gourd at different levels of fertilizer dose with and without polyethylene mulching.

2. MATERIALS AND METHODS

Field Experiment

Experiments were carried out for two years *viz.*, 2015-16 and 2016-17 with growing season from 3rd week of December to 1st week of November. The field experiment consisted of design of drip irrigation system, installation of system, transplanting of pointed gourd, irrigation scheduling, fertigation scheduling, recording of observations and analysis of data.

Experimental Site

Experiment was conducted at Precision Farming Development Centre, OUAT, Bhubaneswar located between 20°31'15"N latitudes and 85°47'24"E longitudes. The soil was texturally classified as sandy loam, having a pH of 4.7, EC of 0.07 dS m^{-1} and organic content of 0.37%. The soil was characterized to be low in available nitrogen, high in available phosphorus and low in available potassium (kg ha^{-1}) and also low in available Sulphur (kg ha^{-1}), Boron (mg kg^{-1}), Zinc (mg kg^{-1}). The field capacity and permanent wilting point of soil at experimental site was 18.9 and 3%, respectively on volume basis. The bulk density of soil was 1.52 g cc^{-1}.

Experimental Design

The experiment was laid out in Randomized block design with three replications and seven treatments *viz.*, T_1, T_2 and T_3 refers to 100, 80 and 60% levels of fertigation and T_4, T_5 and T_6 relates to 100, 80 and 60% levels of fertigation with polyethylene mulch, respectively. The treatment T_7 involves drip irrigation with soil application of 100% recommended dose of fertilizer and treated as control.

The field preparation was done followed by application of farm yard manure at 20 t ha^{-1}. There were 21 plots having gross size of 6 x 5 m each, which were laid out in the field in three replications. The five broad beds of 1m width were made within each plot. The 16 mm laterals of drip irrigation were laid at a spacing of 1.2 m and fixing of online drippers of 4 lph was done at a spacing of 1 m. PVC pipes of 63 and 50 mm diameter was used for main and sub-main lines, respectively. The water from the tube well had to passed through the hydrocyclone and screen filters. The system was operated at a constant pressure of 1.0 kg cm^{-2}.

Meteorological data were collected from OUAT observatory station which included daily precipitation, air temperatures (maximum, minimum and average), humidity, wind speed, and bright sunshine hours. From collected data daily reference evapotranspiration rates were then calculated by using DSS_ET approach. The crop coefficient (K_c) approach was used in which crop evapotranspiration is calculated by multiplying ET_0 by K_c-Crop coefficient and the length of each phase (in days) were used as per recommendations of Allen *et al*. (1998) for three different growing stages of pointed gourd *i.e.* initial (Kc-0.5), mid-season (Kc-1.0), and late season (Kc-0.9).

Then pointed gourd rooted cuttings were planted in line at 120 x 100 cm spacing during 3rd week of December in both years *viz.*, 2015 and 2016. Crop was raised by following the recommended package of practices for pointed gourd. The plants were mulched with 100 micron bi-colour (silver and black) low density polyethylene film under treatments T_4, T_5 and T_6. Irrigation was applied through drip irrigation system on alternate days to all plants.

This experiment uses venturi injector with manifold as fertigation unit. The water soluble fertilizers chosen for the experiments are urea (46:0:0), urea phosphate (18:18:18) and sulphate of potash (0:0:50) to meet the soil test based recommend dose of fertilizer *i.e.* 188:60:100::N:P:K. The venturi injector was used for application of fertilizers in drip irrigation system. The different levels of fertigation were applied at monthly interval as per schedule. Crop growth parameters and yield were recorded throughout the growing season for all treatments.

T_3 1.2x1.0 m (RxP)	T_5	T_1	T_4	T_6	T_2	T_7
T_7 1.2x1.0 m (RxP)	T_2	T_3	T_5	T_1	T_4	T_6
T_5 1.2x1.0 m (RxP)	T_7	T_4	T_6	T_2	T_3	T_1

S E W N

5 m

6 m

Layout of Experiment Plot

Irrigation Water Use Efficiency (IWUE)

IWUE is generally defined as crop yield per unit water used to produce the yield. (Howell, 1996). Thus IWUE, were determined using the following the equation (Cetin and Uygan, 2008):

$$IWUE = (E_y/I)$$

Where, IWUE = irrigation water use efficiency (kg m^{-3}); E_y = yield, (kg ha^{-1}); I = applied irrigation water amount (m^3).

Fertilizer Use Efficiency (FUE)

FUE is defined as the crop yield per kg of fertilizer used. (Rajan *et al.*, 2014). Thus FUE was calculated as fresh fruit weight (kg) obtained per unit weight of fertilizer used (kg).

Statistical Analysis

The data on various parameters studied during the course of investigation were statistically analysed, applying the technique of analysis of variance suggested by Panse and Sukhatme (1985). The treatment differences were found significant when the critical difference is worked out at 5% probability level found to be less and the treatments with difference less than critical difference were not significant.

3. RESULTS AND DISCUSSION

Biometric Observation

The biometric observations *viz.*, vine length, stem girth, leaf area and number of primary branches were recorded at 15 days intervals. The pooled data at 120 DAP were taken into consideration for statistical analysis and tabulated in Table 1.

The treatments of drip fertigation with polyethylene mulching showed better length of vine as compared to treatments without mulching. The 100% fertigation through drip and mulching recorded maximum vine length of 4.05 m which is at par with 80% fertigation with mulching but 53% higher growth over control. Similarly the stem girth of pointed gourd gave maximum value of 2.91 cm in case of T_4 and is significantly better over other treatments. The leaf area was recorded the maximum value of 113.59 sq cm which is significantly higher than other treatments and 33% higher than control. Plants under mulching treatments indicated 6.85% more leaf area than plants without mulching. The number of primary branches are higher in case of T_4 and at par with T_5 but significantly higher than other treatments. This improved growth could be attributed to regular and timely supply of required water and nutrients through drip fertigation which must have enhanced the uptake of the nutrients (Srinivas *et al.*, 1997). The maintenance of favourable soil moisture and ease of availability of nutrients in the active root zone increased growth parameters of pointed gourd with drip fertigation system. Similar result *i.e.* better growth of biometric parameters in case of tomato at 100% N and K fertigation was observed by Brahma *et al.* (2010).

Influence of drip fertigation levels on yield and yield attributing characters

The pooled data of two years were analysed for variance. All drip fertigation treatments with mulching recorded 16% higher fruit weight over non mulch treatments. The average fruit weight is maximum *i.e.* 28.3 gm in case of 100% fertigation with mulch (T_4) which was significantly higher than other treatments. Similarly, the average fruit length recorded 10.3% higher values in case of $T_{4,}$ T_5 and T_6 as compared to non mulch treatments but 41.5% over control. The fruit length was longer in case of T4 (9.25 cm) but at par with T_5 (8.4 cm). Likewise average fruit girth for drip fertigated treatments with mulching recorded 5.9% higher values as compared to only drip fertigated treatments. The fruit girth recorded

Table: 1
Growth parameters of pointed gourd as influenced by different treatments

Treatments	Vine length (cm)	Stem girth (cm)	Leaf area (sq. cm)	No. of primary branches
T_1 (100% RDF through fertigation)	397.88	2.78	111.42	7.25
T_2 (80% RDF through fertigation)	376.30	2.72	102.41	7.03
T_3 (60% RDF through fertigation)	316.47	2.55	89.48	6.22
T_4 (100% RDF through fertigation with LDPE mulch)	405.50	2.91	113.59	7.88
T_5 (80% RDF through fertigation with LDPE mulch)	396.28	2.79	111.65	7.48
T_6 (60% RDF through fertigation with LDPE mulch)	327.12	2.65	98.78	6.67
T_7 (Drip irrigation with RDF in soil application)	264.12	2.47	85.29	6. 02
Sem(±)	15.22	0.03	0.55	0.20
CD (0.05)	47.42	0.10	1.71	0.62

Table: 2
Effect of drip fertigation on yield and yield attributes of pointed gourd (2015-16 and 2016-17)

Treatments	Fruit weight (gm)	Fruit length (cm)	Fruit girth (cm)	Yield t ha^{-1}
T_1 (100% RDF through fertigation)	23.92	8.01	8.52	14.41
T_2 (80% RDF through fertigation)	22.95	7.76	8.22	13.97
T_3 (60% RDF through fertigation)	19.80	6.87	7.49	13.06
T_4 (100% RDF through fertigation with LDPE mulch)	28.29	9.25	9.28	15.81
T_5 (80% RDF through fertigation with LDPE mulch)	27.25	8.44	8.71	15.49
T_6 (60% RDF through fertigation with LDPE mulch)	21.72	7.28	7.70	13.72
T_7 (drip irrigation with RDF in soil application)	18.10	6.48	7.24	12.51
Sem (±)	0.30	0.16	0.26	0.19
CD (0.05)	0.94	0.48	0.82	0.60

maximum value of 9.28 cm for T_4 which was at par with T_5 and 19.5% higher values over control. The highest yield of 15.8 t ha^{-1} was recorded in case of T_4 which was also at par with T_5 (14.4 t ha^{-1}), but increased upto 26.3% over control. Also drip fertigated treatments with mulching recorded 8.6% higher yield over non mulched treatments (Table 2). Similarly the maximum yield of tomato were reported by researchers in case of 100% fertigation (Hebbar *et al.*, 2004; Pawar *et al.*, 2013). Furthermore, the highest yield of pointed gourd was reported by Rani *et al.* (2012) under 100% NPK drip fertigation and plastic mulching. Results were corroborated by the findings of Kapoor et al. (2014) and Jeelani et al. (2017) in cauliflower and broccoli, respectively.

Irrigation water use efficiency (IWUE) and fertilizer use efficiency (FUE)

Greater reduction in total water used for the production of pointed gourd was observed in drip irrigation over surface irrigation. The pooled data of IWUE showed maximum value of water 3.5 kg m^{-3} (T_4) which is at par with T_5 (3.4 kg m^{-3} of water) but 26.6% higher value than control. All treatments of drip fertigation with mulch showed 8.5% higher IWUE as compared to non-mulch treatments. FUE was found to increase with decrease of fertigation levels. The maximum FUE of 65.6 kg kg^{-1} of NPK was recorded in case 60% fertigation with mulch (T_6) followed by T_3 (62.5 kg kg^{-1} of NPK) .The results showed that there exist a inverse relationship between fertigation level and FUE (Table 3). It is also confirmed that there was saving of fertiliser as compared to T_7, where water and nutrient were delivered frequently to the plants root zone directly.

4. CONCLUSIONS

The use of hi-tech horticulture technologies *viz.*, drip fertigation and polyethelene mulching in pointed gourd grown under sandy loam soils of PFDC farm resulted better growth, yield and input use efficiency. The growth parameters of pointed gourd in treatment combinations of 100% drip fertigation of NPK and mulching showed an increase of vine length by 53%, stem girth by 16%, leaf area by 33% and number of primary branches by 31.6% as compared to 100% basal application of fertilizer and drip irrigation (control).

Table: 3
Irrigation Water Use Efficiency (IWUE) and Fertilizer Use Efficiency (FUE) as affected by fertigation levels and mulching (2015-16 and 2016-17)

Treatments	Yield t ha^{-1}	IWUE (kg yield m^{-3} of water use)	FUE (kg yield/kg of NPK fertilizer)
T_1 (100% RDF through fertigation)	14.41	3.20	41.39
T_2 (80% RDF through fertigation)	13.97	3.11	50.26
T_3 (60% RDF through fertigation)	13.06	2.90	62.50
T_4 (100% RDF through fertigation with LDPE mulch)	15.81	3.52	45.42
T_5 (80% RDF through fertigation with LDPE mulch)	15.49	3.44	55.74
T_6 (60% RDF through fertigation with LDPE mulch)	13.72	3.05	65.62
T_7 (drip irrigation with RDF in soil application)	12.51	2.78	35.94
Sem (±)	0.19	0.05	0.69
CD (0.05)	0.60	0.14	2.15

Similarly maximum yield and IWUE was observed in case of 100% fertigation with mulching and recorded 26 and 27% higher value, respectively over the control. However, the FUE found to increase with decrease of fertigation level and indicated maximum value in case of 60% fertigation with mulching. The mulched treatment on an average showed 8.2% higher FUE as compared to non-mulched treatments.

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REFERENCES

Anonymous. Agricultural Statistics at a glance. 2016. Government of India, Ministry of Agriculture and Farmers' Welfare Department of Agriculture, Cooperation and Farmers' Welfare.

Allen, R.G., Pereira, L.S., Raes, D. and Smith, M. 1998. Crop Evapotranspiration : Guide-lines for Computing Crop Water Requirements. *FAO Irrigation and Drainage.* Paper 56, Rome, Italy.

Amayreh, J. and Al-Abed, N. 2005. Developing crop coefficients for field-grown tomato (*Lycopersicon esculentum* Mill) under drip irrigation with black plastic mulch. *Agric. Water Manage.*, 73: 247-254.

Brahma, S., Phookan, D.B., Barua, P. and Saikia, L. 2010. Effect of drip fertigation on performance of tomato under Assam condition. *Indian J. Horti.,* 67(1): 56-60.

Cetin, O. and Uygan, D. 2008.The effect of dripline spacing, irrigation regimes and planting geometry of tomato on yield, irrigation, water use efficiency and net return. *Agric. Water Manage.,* 95: 949-958.

Deng, X., Shan, L., Zhang, H. and Turner, N.C. 2006. Improving agricultural water use efficiency in arid and semiarid areas of China. *Agric. Water Manage.,* 97(8): 1102-1116.

Fritz, V.A. 2012. Plastic mulches: benefits, types, and sources. In: *Minnesota High Tunnel Production Manual for Commercial Growers*. 2nd ed. Regents of the University of Minnesota. http://hightunnels.cfans.umn.edu.

Howell, T.A. 1996. Irrigation Scheduling Research and Its Impact on Water Use. *Proc. of the International Conference on Evapotranspiration and Irrigation Scheduling*, pp 21-33.

Hebbar, S.S., Ramachandrappa, B.K., Nanjappa, H.V. and Prabhakar, M. 2004.Studies on NPK drip fertigation in field grown tomato. *Europ. J. Agron*., 21: 117-127.

Jeelani, J., Katoch, K.K. and Sandal, S.K. 2017. Effect of drip fertigation levels on soil dynamics,water use efficiency, yield and quality parameters of broccoli in wet temperate zone of Himachal Pradesh. *Indian J. Soil Cons.*, 45(1): 96-104.

Kapoor, R., Sandal, S.K., Sharma, S.K., Kumar, A. and Saroch, K. 2014. Effect of Varying drip irrigation levels and NPK fertigation on soil water dynamics, productivity and water use efficiency of cauliflower (*Brassica oleracea var.* botrytis) in wet temperate zone of Himachal Pradesh. *Indian J. of Soil Cons.*, 42(3): 249-254.

Kumar, Ambrish, Kwatra, J., Sharma, H.C., Sharma, A.K. and Singh, A.K. 2012. Feasibility study of gravity fed irrigation system on hilly terrace land in mid-Himalayan regions. *Indian J. Soil Cons.,* 40(3): 102-106.

Panse, V.G. and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers. *Indian Council of Agricultural Research Publication*, pp 87-89.

Pawar, D.D., Dingre, S.K., Kale, K.D. and Surve, U.S. 2013. Economic feasibility of water soluble fertiliser in drip fertigated tomato. *Indian J. Agril. Sci.,* 83(7): 703-707.

Rani, R., Nirala, S.K. and Suresh, R. 2012. Effect of fertigation and mulch on yield of Pointed gourd in calcareous soil of North Bihar. *Environ. Ecol.,* 30(3A): 641-645.

Rajan, K., Haris, A.A., Prasad, L.K. and Shivani. 2014. Efficacy of conventional, solid soluble and liquid fertilizers applied through drip fertigation on tomato. *Indian J. Horti.,* 71(2): 217-221.

Srinivas, K. 1997. Growth, yield and quality of banana in relation to nitrogen fertilization. *Trop. Agric*., 74: 260-262.