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Dynamics of Anthracnose Disease of Chilli in Responses to Water and Nitrogen Management under Drip and Flood Irrigation

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ABSTRACT

Colletotrichum is one of the most important plant pathogens worldwide, causing the economically important disease anthracnose in a wide range of hosts including chilli (*Capsicum* spp.). A field experiment was conducted to investigate the extent and pattern of anthracnose disease (*Colletotrichum* sp.) in the influences of drip irrigation, spacing and nitrogen fertigation in chili (*Capsicum annuum* L.). The results revealed that drip irrigation reduced anthracnose disease infestation four times as compared to the flood irrigation method. Dripper spacing plays a significant role in reducing the disease incidence, least infestation (4.0%) was noticed in case of dripper placed at 60 cm apart as compared to closer spacing of dripper. Fertigation also reduces disease incidence more than three times as compared to top dressing apart from saving in labour and time. Fertigation resulted in maximum yield (1.20 Kg/m^2). The drip irrigation had significantly increased yield (1.50 Kg/m^2) and net income (60.30 %) as compared to flood irrigation.

Key words: Anthracnose, Chillies, Drip irrigation, Fertigation, Disease

INTRODUCTION

Anthracnose disease is one of the major economic constraints of chilli production worldwide, especially in tropical and subtropical regions. *Colletotrichum* is one of the most important plant pathogens worldwide, causing the economically important disease anthracnose in a wide range of hosts, including cereals, legumes, vegetables, perennial crops and tree fruits. Among these hosts, chilli (*Capsicum* spp.), an important economic crop is severely infected by anthracnose, which may cause yield losses of up to 50%. Typical anthracnose symptoms on chilli fruit include sunken necrotic tissues, with concentric rings of acervuli. Fruits showing blemishes have reduced marketability. Water and fertilizer are the two costliest inputs in agriculture. There is the need to develop efficient cultural practices for curbing plant disease in the climate change era (Singh *et al.*, 2013). Development of efficient water management techniques is one of the prominent options available among others. Apart from the economics consideration, it is also well known that the adverse effect of injudicious use of water and fertilizer on the environment can have far reaching implications (Singh *et al.*, 2012c). There is, therefore, a need for technological options, which will help in sustaining the precious resources and maximizing crop production without any detrimental impact on the environment. Micro-irrigation is the only option to replace the conventional irrigation method to achieve water-use efficiency (Pandey *et al*, 2013 and Singh *et al.*, 2012b). The area under drip irrigation, which was over 3.55 lakh ha in 2002, presently, adoption of drip irrigation in India, is increasing and about 6.0 lakh ha area is covered under drip irrigation under various crops. Among the various techniques developed for application of water, drip irrigation also referred to as trickle irrigation or micro-irrigation is gaining popularity as perhaps the most efficient method of water application (Bucks *et al.*, 1982). As water, labour and land preparation become costlier; this technique of water application is bound to replace conventional systems. Chowdhury (1992) reported that the irrigation water saving is by using recent micro-irrigation technique over conventional methods range from 40 to 70 percent.

Globally, India is a leading country in the context of the area covered in chilli production, making it's the most dominant player in the world chilli market. Water is an important input for growing this crop during the season. Pepper is most susceptible horticultural plants to

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drought stress because of the wide range of transpiring leaf surface, high stomatal conductance (Alvino *et al.*, 1994) and having a shallow root system (Dimitrov and Ovtcharrova, 1995). For higher yield, an adequate water supply and relatively moist soils are required during the entire growing season.. Low water availability prior to flowering of pepper reduced the number of flowers and retarded the occurrence of maximum flowering. The water deficit during the period between flowering and fruit development reduced final fruit production (Jaimez *et al.*, 2000 and Singh *et al.*, 2012a). Chilli crop requires good and precise amount of water for higher yield and quality. In this direction, drip irrigation offers great opportunity for precise application of water and nutrients to the crop. The system has proved its superiority over other conventional method of irrigation, especially in fruits and vegetable crops owing to precise and direct application of water in the root zone (Bhella, 1988; Raina *et al.*, 1998). Sivanappan and Padmakumari (1980) compared drip irrigation and furrow irrigation systems and found that 1/3rd to 1/5th of the normal quantity water was enough for the drip irrigated plots compared to normal quantity of water applied to plots under surface irrigation in vegetable crops.

Furthermore, there is good potential for adoption of drip irrigation and use of water soluble fertilizers with drip system, *i.e.* fertigation technique for achieving better productivity and quality in different crops. The micro-irrigation also enables use of fertilizers, pesticides and other soluble chemicals along with the irrigation water more economically and thus enhancing the quality of produce and yield (Pandey *et al.*, 2013, Singh *et al.*, 2000).

Micro-irrigation is a highly efficient method of water application to crops, which substantially saves water and fertilizer, increases yield besides improving the quality of produce and reducing labours. In the recent years there has been a serious concern of global shortage of water. It is estimated that in India by 2025, 33 per cent of India's population will be live under severe scarcity conditions (Chauhan, 2005)**.** Low temperature and frost injury during winter season are the limiting factors for growing high value vegetables, like chilli. Chilli (*Capsicum annuum* L.) is an important spice cum vegetable crop cultivated extensively in India. India contributes one fourth of world's production of chilli with an average annual production of 12.89 lakh tonnes in an area of 7.59 lakh ha (Anonymus, 2005).

Diseases caused by fungi, bacteria and viruses are a major constraint to production chilli. Anthracnose disease caused by *Colletotrichum* species is major disease of chilli may cause yield losses up to 50% (Pakdeevaraporn *et al.*, 2005). Typical symptoms of chilli fruit include sunken necrotic areas with concentric rings over necrotic area. Fruits showing blemishes or discoloured due to infection have reduced marketability (Manandhar *et al.*, 1995). Predominanantly diseased fruits act as a source of inoculums allowing the disease to spread plant to plant with in the fields. During warm and wet periods, conidia from acervuli and micro-sclerotia are splashed by rain or irrigation water from diseased to healthy fruit and foliage. Considering all these factors, present experiment was conducted to find out the minimum use of water, optimum spacing and use of nutrients for maximum yield and return through drip irrigation.

MATERIALS AND METHODS

Field trials of chilli crop were conducted under farmer's participatory research project in the farmer's field at Bihta, Patna district of Bihar, on sandy loam soil having pH 7.3, E.C. 0.18 ds/m. The experiment was conducted in' FRBD design with two irrigation treatments (drip and flood irrigation methods) and three dripper/ plant along with maintaining spacing (plant to plant, 30, 45, 60 cm and row to row, fixed 60 cm) and two nitrogen application methods, i.e. through fertigation and top dressing. The variety 'California Wonder' was planted in the first week of October during each year. Seedlings were grown in small bags (8 cm x 4 cm size). Four weeks old seedlings were used for transplanting in randomized plots with appropriate treatment. The crop was fertilized with recommended dose of FYM (2 kg/m^2) and inorganic fertilizers- phosphate (200 kg/ ha) given as SSP and potash (250 kg/ ha) given as MOP. The full dose of FYM and half dosages of inorganic fertilizers were applied as basal dose in all treatments during land preparation (at 15 days before planting). Rest amount of fertilizers was applied in split dosages at every 25 day intervals during crop season. Insecticides and fungicides were used as per crop requirement.

The drip system consists of filters (sand and screen), venture attachment for fertigation, pipeline (PVC main supply pipe, size 30 mm, sub main LDPE laterals size 12 mm), and dripper size 0.6 PEE with the water discharge capacity of 2 l/h. The sub-main laterals were fixed at 60 cm apart and drippers were fixed at 30, 45 and 60 cm along the laterals. All sub-main laterals were controlled by the gate valve system. Nitrogen was provided by ventury system of fertigation. The drip system was operated at alternate days or at two

days interval for 10 min. Flood irrigation was provided by using plastic pipes (2 cm size) as per need or moisture content. The data were recorded and calculated on the basis of randomly selected 3-5 plants in each plot. Considering all these factors, present experiment was conducted to find out minimum use of water, optimum spacing and compact use of nutrients for maximum yield and returns through drip Irrigation.

RESULTS AND DISCUSSION

Effect of Irrigation on Disease Incidence

The result revealed that the method of drip irrigation had significantly increased yield (10.50 kg/m^2) and net income (60.30 Rs/m^2) of chilli as compared to flood irrigation in all the years. The crop yield improved by 60.30 % in chilli when the crop was irrigated through drip irrigation. Drip irrigation system saved the maximum water and total time engaged in irrigation as well as, minimized weeds and anthracnose disease incidence. However, flood irrigation had no water saving, more occurrence of weeds, high disease incidence and total time. The results corroborated by the findings of Khan, 2000, Mahajan and Singh, 2005, Singh *et al.*, 2000 and Thiyagarajan *et al.*, 2005.

Effect of dripper spacing on disease incidence

The dripper spacing of 30 cm recorded significantly positive effect on yield and net returns as compared to 45 cm spacing. The yield was higher (58.77 %) in chilli at 30 cm wide dippers spacing as compared to the flood irrigation method. However, wider dripper spacing (60 cm) saved more water, total irrigation time, minimized the anthracnose disease and weed incidence as compared to closer dripper spacing in each year (Table 1). This improvement might be due to the fact that closer spacing accommodates higher plant population, resulted more number of fruits which increases total yield and net returns. These findings are in agreement with those of Singh *et al.*, 2004, Singh and Naik, 1990 and Chauhan, 2005.

Effect of Nitrogen on Disease Incidence

The maximum yield in chilli (10.20 kg/m^2), net income, weed incidence, minimal diseases and saved water and total irrigation time as compared to top dressing method during each year (Table 1) resulted due to fertigation. All the yield components were significantly influenced due to nitrogen fertigation. Fertigation with nitrogen had recorded 34.46 % higher yield as compared to top dressing method. The results are in agreement with those reported by Chauhan, 2005, Khan, 2000 and Jade, 2005. Higher weed density and weed growth were observed at higher levels of nitrogen. Similar results

Table 1: Influence of drip irrigation, dripper spacing and fertigation on various parameters

Treatment	Yield (Kg/m^2)	Income (Rs/m^2)	Yield increased by drip irrigation against flood irrigation (%)	Disease incidence (%)	Weed incidence (%)	Saving of water (%)	Time of total irrigation (hr)
Irrigation method							
Drip	1.050	67.00	60.30	05.00	32.40	40	10
Flood	0.655	11.70	----	20.00	100.00	----	40
CD (P = 0.05)	0.137	07.31		03.24	11.93		4.62
Dripper spacing							
30 cm	1.040	65.60	58.77	08.00	35.60	30	10
45 cm	0.920	48.80	40.45	05.00	32.30	35	10
60 cm	0.822	35.08	25.49	04.00	22.70	40	10
CD (P = 0.05)	0.104	05.48	5.87	03.15	09.13	11.0	-
Nitrogen							
Fertigation	1.020	62.80	55.72	04.50	16.40	35	10
Top dressing	0.770	27.80	17.55	15.50	31.50	30	10
CD (P = 0.05)	0.115	06.13	6.15	05.65	12.43	7.0	-

Av. Selling price: Rs 14/Kg; Total cost of cultivation: Rs 80/m^2

were reported by Narda and Lubana (2002). Increase in yield with higher level of nitrogen fertilizer might be due to higher amount of nitrogen available for promotion of better carbohydrate utilization to form more protoplasm and cell and also due to readily available nitrogen in the vicinity of the root zone due to fertigation resulting in more efficient utilization of applied nitrogen than placement method. Similar results were reported by Veeranna *et al.*, 2001.

Vegetative Growth and Yield Parameters

The plant height and branches/plant responded significantly higher in drip as compared to flood method of irrigation. The highest plant height (61.20 cm) was recorded with drip irrigation, while the lowest (52.7 cm) with flood method of irrigation (Table 2). More branches/plant (6.90) was recorded with drip irrigation than flood method of irrigation. There was a significant increase in size (length) and weight of fruits in the plots irrigated through drippers as compared to surface irrigated plots. The maximum fruit weight (2.89 g) was observed under drip irrigation followed by flood irrigation (2.49 g).

The plant height and number of branches increased the new nodes for appearance of flower and fruit development, resulting in the increase of the total yield of chilli. These results are in conformity with Antony and Singandhupe (2004), Manjunatha *et al.* (2001), Cetin and Bilgel (2002) and Tiwari *et al.* (2003) who also reported beneficial effects of drip irrigation on growth and yield of different vegetables. The flood method of irrigation not only resulted in wastage of water in deep percolation below the root zone, but also sets a chain of undesirable reaction such as leaching of available plant nutrients and consequently development of soil problem and poor aeration resulting in reduced crop yield. These results are in conformity with Gutal *et al.* (1990), who observed higher red pepper yield under drip irrigation as compared to surface irrigation.

The data on root length (Table 2) revealed that, the root length in flood method of irrigation was found minimum (18.3 m). Drip irrigated plants received water once in two days, whereas water applied at larger intervals in surface irrigated crops. Osmatic adjustment and prolonging root expansion (Sharp *et al.*, 1990) had been described as a cause for increased root length in mildly stressed plants than well watered plants. So at drip irrigation, root length was maximum (36.2 m), because, though the crop received water once in two days, the amount of water applied was less. In surface irrigation, due to the larger interval between two irrigations, this treatment suffered maximum water stress as compared to other treatments. This severe water stress has stopped the root elongation, as evident from less root length in the data.

The results lead to conclude that drip irrigation enhanced the net income and fruit yield; save the time in irrigation, reduced weeds and anthracnose disease infestation in chill crop. In drip irrigation water is used judiciously that suppressed the emergence of weeds and disease incidence. Fertigation in drip irrigation are utilized efficiently by the plant as compare to top dressing. In top dressing rest unutilized nitrogenous fertilizers induce the weed growth and make plant more succulent that can be congenial for foliage and fruit disease development like anthracnose. The dripper spacing (30 cm) also improved the net-income and higher yield. Whereas, wider spacing (60 cm) saved the maximum water, minimized weed and disease incidence. Wider spacing can reduce moisture and increases the light trapping between the rows, therefore, water available for spore germination and spreads of inoculums can be hindrance; and infestation of disease is low. The application of irrigation at an alternate day

Table 2: Effect of treatments on different parameters of chilli*

Treatments	Plant Height(cm)	Branches/plant	Length of fruit (cm)	Weight of fruit (g)	Root length (m)
Irrigation Treatments					
Drip	61.20	6.90	6.70	2.88	36.2
Flood	52.70	5.11	6.18	2.49	18.3
CD (P = 0.05)	0.76	0.61	0.05	0.03	5.4
Nitrogen doses					
Drip	55.82	8.50	6.31	2.75	26.8
Flood	49.50	6.11	5.92	2.62	22.2
CD (P = 0.05)	1.48	0.62	0.09	0.03	NS

*Data based on mean of two years

was effective in vegetable crops. The drip irrigation is more effective to get more fruits and fruit weight/plant and yield of the vegetable crops compared with the traditional method of irrigation. This type of study can also be carried out in other vegetable crops to arrive at some concrete decisions for making recommendations for use of drip irrigation in vegetable crops.

CONCLUSION

Fertigation is a very important activity to be undertaken with micro-irrigation system to harvest quality produce at competitive price to boost up the export and promote hi-tech horticulture. The farmers should be trained to adopt these technologies as per scientific recommendations to produce a quality product. Thus drip irrigation is beneficial for chilli in term of yield, better morphological characters, *viz*, plant height, number of branches, root length, weight of fruits along with 58.6 % saving of irrigation water over flood method of irrigation.

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