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Effect of Irrigation and Fertilization on Growth and Yield in Coriander: A Review

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ABSTRACT

Coriander is second most important seed spice crop grown for its seed as well as leaves. Among the major yield determining factors, NPK fertilization along with correct supply of water play an important role in the quality and yield aspects of coriander. Since coriander is grown mainly in arid and semi-arid areas, water is one of the main constraints in crop production as these growing areas are deficit in annual rainfall. Coriander grown particularly during winter season requires assured irrigation for successful production. Also, dumping of huge quantity of fertilizers in the soil becomes uneconomical besides polluting the environment. Therefore, application of optimum dose of fertilizers not only increases the yield but also improves the quality of the crop as well as soil. Extensive research work has been reported on irrigation and fertilizer requirement of coriander. Therefore, an attempt is been made to review the information available regarding the irrigation and fertilization studies and their impact on growth, yield and other attributing parameters of coriander.

Key words: Coriander, Fertilizers, Growth, Irrigation, Seed yield.

Coriander (*Coriandrum sativum* L.), also known as Chinese parsley, *cilantro*, or *dhania*, belonging to the Umbelliferae family is an important herbaceous annual spice crop and occupies a prime position in flavouring substances. It is native to Mediterranean region, but now a day, it is grown worldwide and is commercially produced in India, Morocco, Russia, East European countries, France, Central America, Mexico and USA. Coriander is cultivated for its high commercial value of stems, leaves and seeds and considered as natural source of essential oils, *i.e.*, petroselinic acid, geraniol, limonene and linalool, used in pharmaceutical and food industries (Carrubba, 2009; Hassan and Ali, 2013). It is appreciated worldwide as basic ingredient in many traditional food items, particularly curry powder because of its strong and typical aroma (Ramadan and Morsel, 2002; Mahendra and Bisht, 2011; Sahib *et al*., 2013). Coriander seeds are also used in preparation of *Ayurvedic* and *Unani* medicines (Sharma and Sharma, 2004). These characteristics qualify coriander as an important medicinal and aromatic spice. The new value-added products, volatile oil and oleoresins, obtained from coriander seeds are also in high demand in the international markets. India is the largest producer and acreage holder of this crop, covering 663 thousand hectares area and giving production of 609 thousand tonnes during the year 2016-17 (Anonymous, 2017). Although India is the largest producer of coriander in the world but the average productivity is very low as compared to European countries, *i.e.*, 9.18 q/ha. Low productivity of coriander may be ascribed to many reasons, of which, inadequate and imbalanced fertilization with limited moisture is the major factor. The requirement of water by the crop depends predominantly on the edapho-climatic conditions; however, the uniform and continuous supply of water is desirable (Thamburaj and Singh, 2004). In this context, inadequate irrigation management stands out among the limiting factors for the cultivation and production of this spice. Also, application of fertilizers (NPK) in right proportion and in optimum quantity according to soil and climatic conditions is essential to realize maximum potential of the crop and to get higher economic benefit since these are the indispensable plant nutrients required for growth, development and various physiological and biochemical processes. Coriander needs adequate moisture for its growth and development and responds greatly to applied nutrients, varying widely from place to place depending upon fertility level of the soil and other environmental conditions.

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Effect of irrigation

The survival of plant and its growth are closely associated with the availability of water since imbalance of water in plants will produce proportionately deleterious deviation in physiological activity, growth and production. The research information on the effect of irrigation has been reviewed below under the following headings:

Effect of irrigation on growth parameters

Irrigation at higher levels resulted in the highest vegetative growth in coriander compared to the lower levels (Osman and El-Feky, 2005). Also, it is possible to limit the number of irrigation up to pre-flowering stage but it is necessary to provide optimum irrigation to coriander crop at the time of flowering and seed setting stage as reported by Verma *et al*. (2015). Supplying irrigation at branching, flowering and seed formation stage gave the maximum value for number of branches per plant in coriander but it was at par with omitting irrigation at seed formation stage as observed by Kumar *et al*. (2008), whereas, Moniruzzaman *et al*. (2013) obtained maximum height of coriander plant along with maximum number of primary branches per plant by irrigating the crop at branching, flowering and seed filling stage. Hesami *et al*. (2012) observed improvement in plant height of coriander with the reduction in irrigation interval from 8 to 4 days. Application of irrigation at 25, 50, 75 and 100 days after sowing (DAS) gave higher values for growth characters *viz*., plant height and number of primary branches per plant in coriander over two irrigations (Singh *et al*., 2018). The plant height of coriander was gradually increased with the increase in the irrigation level and reached its maximum value with an irrigation treatment of 120% of potential evapotranspi--ration (ETP), though, there were no significant differences concerning the effect of different irrigation treatments on the number of branches per plant as obtained by Hassan and Ali (2013). The pronounced effect of irrigation on growth characters might be attributed to the beneficial effect of higher soil moisture status on absorption of water, uptake of nutrients, cell turgidity, cell elongation, net-assimilation rate and translocation of assimilates to the actively growing parts of plant.

Effect of irrigation on seed yield and yield attributing parameters

While working on coriander, Tripathi *et al*. (2009) observed that the seed yield of coriander along with umblets/plant, umbel/plant, 1,000-seed weight and biomass production was significantly higher on the application of three irrigations at 20, 40 and 60 DAS, *i.e.*, (1.96 tonne/ha) and resulted in 38.31 per cent and 3.93 per cent increase in seed yield over two (at 20 and 40 DAS) and four irrigations (20, 40, 60 and 80 DAS), respectively. On the other hand, eight irrigations at 15 days interval recorded higher seed yield in coriander (Sharangi and Roy chowdhury, 2014; Hassan *et al*., 2012). Singh *et al*. (2018) obtained higher values for yield attributing characters, seed yield (16.48 q/ha) and biological yield (50.79 q/ha) in coriander with irrigation at 25, 50, 75 and 100 days after sowing (DAS) over two irrigations. Verma *et al*. (2015) and Lakpale *et al*. (2007) reported that deficit drip irrigation at vegetative stage (60% ETc) followed by optimum irrigation in reproductive and seed development stages (80% ETc) improved the yield attributes and seed yield in coriander. This helped in increase in root growth during initial stages and later it utilizes water effectively. However, increasing irrigation level up to 120% ET will increase the seed yield and oil percentage in coriander seeds as recorded by Hassan and Ali (2013). Highest seed yield in coriander was obtained with the application of irrigation at branching, flowering and seed formation stage but it was at par with omitting irrigation at the seed formation stage (Kumar *et al*., 2008) and seed yield of 2.1 t/ha was obtained with the application of irrigation at branching, flowering and seed filling stage (Moniruzzaman *et al*., 2013). The favourable effects of irrigation might be explained based on more plant height, which ultimately led to more number of primary branches per plant, and hence, increased the yield attributing characters, resulting in higher yield.

Effect of fertilizers

Among various factors, the application of fertilizers is one of the most important agronomic factors in stepping up the yield of coriander crop. The research information on the effect of fertilizers has been reviewed below under the following headings:

Effect of fertilizers on growth parameters

The application of fertilizers, *i.e.*, N_{60} and P_{50} kg/ha, registered higher plant growth (Singh *et al*., 2018), whereas, higher doses of water soluble fertilizer (125%) through fertigation in variety Co CR-4 resulted in better growth parameters, *i.e.*, increased plant height, number of branches, number of leaves and root length than that of other levels of fertigation as compared to variety CS 11 in coriander (Rajaraman *et al*., 2011). Lokhande *et al*. (2015) recorded maximum plant height, number of branches per plant, days for first flowering and days for 50% flowering with 60 kg nitrogen and 30 kg phosphorus followed by 30 kg nitrogen and 45 kg phosphorus as compared to control without application of fertilizers. This might be due to rapid conversion of carbohydrates into protein, which in turn might have increased the protoplasm and size of cell. Also, the optimum dose of nitrogen and phosphorus helped to increase the availability of other nutrients to the plants.

Effect of fertilizers on seed yield and yield attributing parameters

Kumar *et al*. (2013) stated that higher dose of nitrogen (N @ 100 kg/ha) and medium dose of phosphorus (P @ 30 kg/ ha) proved better in respect ofseed yield per hectare (18.84 q), seed weight (6.86 g) and straw weight per plant (24.33 g). On the other hand, application of N_{60} and P_{50} kg/ha, registered higher seed yield and its attributing characters in coriander (Singh *et al*., 2018). The application of nitrogen 80 kg/ha resulted in highest seed yield in coriander (Patel *et al*., 2013; Moniruzzaman and Rahman, 2015), whereas, application of nitrogen 75 kg/ha significantly increased the seed yield to the extent of 11.9, 32.7 and 84.3% over nitrogen 50, 25 kg/ha and control, respectively in coriander (Choudhary *et al*., 2014). Jan *et al*. (2011) obtained the maximum seed yield (1360.0 kg/ha) and test weight (10.32 g) with phosphorus 45 kg/ha in coriander, while Yousuf

et al. (2014) obtained highest seed yield (2.06 t/ha in 2008-09 and 2.09 t/ha in 2009-10) with moderate application of nitrogen, phosphorus, potassium and sulphur (70, 50, 30, and 20 kg/ha, respectively) but declining trend could be seen in yield with higher doses of these elements in coriander. Application of 60 kg nitrogen and 30 kg phosphorus resulted in higher fresh and dry biomass weight, number of umbels per plant, seed yield andgermination percent of primary as well as secondary umbels (Lokhande *et al*., 2015). The favourable effect of fertility levels might be explained based on more plant height, which ultimately led to more number of branches, hence, increased yield attributes, resulting in more yield.

Interaction effect of irrigation and fertilizers

Effect of irrigation and fertilizerson growth, seed yield and yield attributing parameters

The research information available in literature on the interactive effect of irrigation and fertilizers has been reviewed under:

The maximum growth is obtained by Angeli *et al*. (2016) with the application of nitrogen 105 kg/ha and irrigation depth of 121% of required real irrigation, whereas, nitrogen dose of 94 kg/ha and irrigation depth of 115% of required real irrigation promoted the greatest seed yield (29.0 t/ha) in coriander. Also an increase in seed yield from 35 to 45% due to the application of fertilizers and irrigation has been reported by different researchers (Prabhu *et al*., 2002; Lakpale *et al*., 2007; Tripathi, 2008). Tripathi *et al*. (2009) found the interaction effect of irrigation and fertility levels on seed yield of coriander significant and positive and recorded maximum yield (2.09 t/ha) with combined application of three irrigations and 100% recommended dose of fertilizer followed by three irrigation and 125% recommended dose of fertilizer (2.02 t/ha).

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