International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 1531-1534

Received: 22-03-2018
Accepted: 24-04-2018

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Effect of water soluble fertilizers on growth parameters and economics of coriander (*Coriandrum sativum* L.)

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Abstract
An experiment entitled "Effect of water soluble fertilizers on growth parameters and economics of coriander (*Coriandrum sativum* L.)" was carried out under medium black clayey soil and slightly alkaline soil in reaction with pH 7.9 and EC 0.49 dSm^{-1} during *rabi* season of 2016-17 at the Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh. The experiment consisting of 10 treatment combinations, comprising (T_1) control, (T_2) RDF + water spray, (T_3) RDF + WSF (19:19:19), (T_4) RDF + WSF (13:40:13), (T_5) RDF + WSF (12:61:00), (T_6) RDF + WSF (00:52:34), (T_7) RDF + WSF (28:28:00), (T_8) RDF + WSF (00:00:50:17.5 S), (T_9) RDF + Urea and (T_{10}) RDF + KNO_3. Foliar spray of water soluble fertilizers (WSF), urea and KNO_3 was done @ 2 per cent at 30, 45 and 60 days after sowing. Recommended dose of fertilizers was applied at the time of sowing. These treatments were evaluated under randomized block design with 3 replications. The results of experiment indicated that growth parameters *viz*., plant height and branches per plant at harvest, dry matter accumulation at 60, 90 DAS and at harvest increased significantly with the application of RDF 20:10 kg NP ha^{-1} + foliar application of WSF (19:19:19) @ 2 per cent at 30, 45 and 60 days after sowing and also gave significantly higher gross return of ₹114335, net return of ₹82641 ha^{-1} and benefit cost ratio (3.61) over control.

Keywords: Water soluble fertilizer, growth, economics and coriander

Introduction
The seed spices are a group which denotes all those annual whose dried fruits or seeds used as spices. The seed spices mostly used in pulverized state, primarily for seasoning or garnishing food and beverages. They are characterized by pungency, strong odour, sweet or bitter taste. Spices play an important role in human dietary because of their agreeable flavour and aroma to food and add greatly to the pleasure of eating (Ayaduraj, 1966) [5]. India is the world's largest producers, consumers and exporter of seed spices. Gujarat and Rajasthan together contribute more than 80 per cent of the total seed spices production in the country and thus, both the states together are known as "seed spices bowl" of India (Meena *et al.* 2017) [10].
Coriander (*Coriandrum sativum* L.) Is one of the earliest spices and used by mankind (Luaza *et al.* 1996) [9]. Coriander belongs to family *Apiaceae* (*Umbelliferae*) and possess 2n=22 chromosomes with cross-pollination as mode of reproduction. The seed type is dicot and having epigeal germination. The term coriander came from the Greek word, koris, meaning bedbug because the leaves and green fruit of this plant have an odour similar to bedbugs. It is commonly known as "Dhania" or "Dhana". It is an important spice crop having a prime position in flavouring food. Besides the essential oil, the seed contains 16.1% fatty oil, 14.1% protein, 21.6% carbohydrate, 32.6% fibres, 11.2% moisture and 4.4% mineral matters and coriander leaves are very rich in vitamin A and vitamin C (Singh *et al.* 2017) [14]. The whole plant including stem, leaves and seeds have pleasant aromatic odour. The crop is grown both for tender leaves and seeds; tender leaves are extensively used for flavouring curries, soups, chutneys, sauce and garnishing several food preparations. The seed has been immensely used as condiment in the preparation of curry powder, soups, pickling, sausages and for flavoring cakes, cookies and liquor, for preparing value added products such as coriander powder, dhana dal, besides used in several medicinal preparations. Coriander oil is a valuable ingredient in perfume industry as well as oleoresin extraction. The fruits and the oil are used as a flavouring agent to cover the test or correct the nauseating or gripping quality of other medicines. They are used medicinally for a number of purposes, particularly to relieve flatulence (Bhuiyan *et al.*

2009) [6]. the aromatic odour and taste of coriander fruits is due to presence of essential oil called 'coriandrol' (Pruthi, 1976) [13].

Coriander is native of Mediterranean Region and commercial grown in India, Morrocco, Russia, Hungary, Poland, Romania, Mexico, Turkey and USA. In India, coriander is mainly grown in the states of Rajasthan, Gujarat, Tamil Nadu, Madhya Pradesh, Andhra Pradesh, Uttar Pradesh and Haryana. Total area under the crop in India is about 674 thousand hectares with an annual production of 883 thousand MT having the productivity of 1310.09 kg/ha (Anonymous, 2016-17a) [3]. In Gujarat, it occupies an area of 121199 hectares and production of 189518.03 tonnes with average productivity of 1563.69 kg/ha (Anonymous, 2016-17b) [4].

Foliar nutrition is designed to eliminate the above problems particularly with respect to macro nutrients. Now a day's application of N, P and K in different ratios through foliar sprays is being recognized as an important method of fertilization in modern agriculture. Application of nutrients through foliar spray at appropriate stages of growth becomes important for their utilization and better performance of the crop (Anandhakrishnaveni *et al*. 2004) [1]. Foliar application of nutrients is an important crop management strategy in maximizing crop yields. It can supplement soil fertilization. In case of foliar application, the nutrients penetrate the cuticle of the leaf or the stomata and then enter the cells facilitating easy and rapid utilization of nutrients. Hence, crop response occurs in short time in foliar application compared to soil application. Foliar fertilization is the application of foliar sprays of one or more mineral nutrients to plants to supplement traditional soil applications of fertilizers. Foliar fertilization is used as a means of supplying supplemental doses of macro and micro-nutrients, plant hormones, stimulants and other beneficial substances. It is also determined that during crop growth supplementary foliar fertilization increase plants mineral status and improve crop yields (Kolota and Osinska, 2001) [8]. Foliar application could be considered one of the most common methods, which used to deliver the needed nutrients to plants in adequate concentrations and improve plant nutritional status as well as increase the crop yield and its quality (Smoleń, 2012) [15]. Foliar fertilization has the ability to improve the efficiency and rapidity of utilization of a nutrient urgently required by the plant for maximum growth and yield (Oosterhuis, 1999) [12].

Materials and Methods

An experiment was conducted at instructional farm, Junagadh Agricultural University, during *rabi* seasons of 2016-17. The experiment site is situated in South Saurashtra Agro-climatic region of Gujarat. The soil was medium clayey in texture and slightly alkaline in reaction with pH (7.9) and EC (0.49 dSm^{-1}), low in available N was carried out with Alkaline $KMnO_4$ method by Subbaiah and Asija, 1956 (242.60 kg ha^{-1}), medium in available P (34.70 kg ha^{-1}) and available K (269.00 kg ha^{-1}). The available P and K were carried out with Olsen's method and Flame Photometric method by Olsen *et al.* 1954 and Jackson, 1974. The experiment were laid out in randomized block design with three replications and consisting of 10 treatment combinations, comprising (T_1) control, (T_2) RDF + water spray, (T_3) RDF + WSF (19:19:19), (T_4) RDF + WSF (13:40:13), (T_5) RDF + WSF (12:61:00), (T_6) RDF + WSF (00:52:34), (T_7) RDF + WSF (28:28:00), (T_8) RDF + WSF (00:00:50:17.5 S), (T_9) RDF + Urea and (T_{10}) RDF + KNO_3. Foliar spray of water soluble fertilizers (WSF), urea and KNO_3 was done @ 2 per cent at 30, 45 and 60 days after sowing. Recommended dose of fertilizers was applied at the time of sowing. The coriander variety 'Gujarat Coriander-2' was sown at 30 cm row to row and 10 cm plant to plant spacing.45-15 cm paired rows. The crop was fertilized with recommended dose of fertilizers 20-10-0 kg N-P_2O_5-K_2O ha^{-1}. The crop was raised as per the recommended package of practices.

Results and Discussion

Effect on growth parameters

An assessment of data (Table 1) indicated that application of RDF 20:10 kg NP ha^{-1} + foliar application of WSF (19:19:19) @ 2 per cent thrice at 30, 45 and 60 days after sowing (T_3) recorded significantly the highest dry matter accumulation per plant at 60 DAS (2.25 g/plant), 90 DAS (6.85 g/plant) and at harvest (8.25 g/plant) over the control (T_1) but remained at par with treatment (T_4) RDF + WSF 13:40:13, (T_5) RDF + WSF 12:61:00, (T_6) RDF + WSF 00:52:34, (T_7) RDF + WSF 28:28:00 and (T_9) RDF + urea at 60 DAS and 90 DAS and further remain at par with treatment (T_4) RDF + WSF 13:40:13, (T_7) RDF + WSF 28:28:00 and (T_9) RDF + urea at harvest. Application of RDF 20:10 kg NP ha^{-1} + foliar application of WSF (19:19:19) at 30, 45 and 60 DAS (T_3) also significantly increased the number of branches per plant (22.14) and plant height (63.71 cm) over control (T_1) and remained at par with treatments (T_4) RDF + 13:40:13 (20.87) and (T_9) RDF + urea (19.71). This might be due to positive effect of N, P, K which enhances the higher plant growth and canopy due to augment cell division and cell expansion. This increased growth attributes may be the result of additional and adequate supply of N, P and K through foliar application which might have increased nutrient uptake and better translocation of nutrients. In addition nitrogen being chief constituent of protein and protoplasm has enhanced the synthesis of chlorophyll content of the leaves and cell division thus resulted in more number of leaves attribute towards more leaf area and dry matter accumulation. These results are in confirmation with the findings of Anbumani *et al.* (2003) where he reported that application of foliar nutrients facilitated more availability and less interference in the absorption of nutrients. This paves way for the production of more biomass leading to higher dry matter production.

Table 1: Effect of different water soluble fertilizers on dry matter accumulation

Treatments	Dry matter accumulation (g/plant)			Branches per plant at harvest	Plant height at harvest (cm)
	60 DAS	90 DAS	At harvest		
T_1- Control	1.74	5.28	6.57	15.85	45.60
T_2-RDF + water spray	1.81	5.35	6.67	16.77	49.56
T_3-RDF + WSF (19:19:19)	2.25	6.85	8.25	22.14	63.71
T_4-RDF + WSF (13:40:13)	2.22	6.65	8.20	20.87	57.43
T_5-RDF + WSF (12:61:00)	2.15	6.24	7.05	17.92	54.51
T_6-RDF + WSF (00:52:34)	2.07	6.13	7.04	18.46	54.48
T_7-RDF + WSF (28:28:00)	2.20	6.54	8.08	17.92	50.46
T_8-RDF + WSF (00:00:50:17.5 S)	1.92	5.78	7.00	18.02	54.44
T_9-RDF + Urea	2.17	6.40	7.98	19.71	59.22
T_{10}-RDF + KNO_3	1.90	5.96	7.02	17.00	54.50
S. Em ±	0.11	0.29	0.40	0.94	3.09
CD (P=0.05)	0.32	0.88	1.19	2.79	9.18
CV (%)	9.00	8.34	9.40	8.80	9.84

Effect on economics

The details of gross return, net return and benefit cost ratio (BCR) for individual treatment is presented in Table 2 indicate that significantly the highest gross returns of ₹ 114335/ha, net returns of ₹82641/ha and benefit cost ratio of (3.61) were secured with the application of RDF 20:10 NP kg ha^{-1} + foliar application of WSF (19:19:19) @ 2 per cent (T_3) over control. This might be attributed to higher seed and stover yields obtained with comparatively less cost than additional income under these treatments.

Table 2: Effect of different water soluble fertilizers on economics of coriander

Treatments	Gross return (₹/ha)	Cost of cultivation (₹/ha)	Net return (₹/ha)	B:C ratio
T_1- Control	73013	27527	45486	2.65
T_2- RDF + water spray	86244	28966	57278	2.98
T_3- RDF + WSF (19:19:19)	114335	31694	82641	3.61
T_4- RDF + WSF (13:40:13)	99555	31694	67861	3.14
T_5- RDF + WSF (12:61:00)	97952	32306	65646	3.03
T_6- RDF + WSF (00:52:34)	97758	33224	64534	2.94
T_7- RDF + WSF (28:28:00)	99378	32544	66834	3.05
T_8- RDF + WSF (00:00:50:17.5 S)	93109	31660	61449	2.94
T_9- RDF + Urea	92099	29365	62734	3.14
T_{10}- RDF + KNO_3	94050	32408	61642	2.90
S. Em ±	4899	-	4899	0.16
CD (P = 0.05)	14556	-	14556	0.46
CV (%)	8.96	-	13.34	8.86

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