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Evaluation of stress mitigating chemicals and their response on productivity, profitability and plant nutrient status of coriander (*Coriandrum sativum* L.)

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Abstract
A field experiment was conducted during *rabi* of 2016-17 at Agronomy farm, S.K.N. College of Agriculture, Jobner (Jaipur) to study the effect of stress mitigating chemicals on coriander varieties (*Coriandrum sativum* L.) grown on irrigated loamy sand soil of semi-arid eastern plain zone of Rajasthan. The experiment consisting of four varieties (RCr-435, RCr-728, RCr-436 and RCr-41) and six stress mitigating chemicals (water sprayed control, salicylic acid @ 100 ppm, thiourea @ 500 ppm, kinetin @ 30 ppm, DMSO @ 78 g ha^{-1} and TGA @ 100 ppm at 40 and 60 DAS) making 24 treatment combinations. The variety RCr-728 significantly increased seed, straw and biological yields (14.82, 42.03 and 56.85 q ha^{-1}), total nitrogen, phosphorus and potassium uptake and higher net returns (Rs 45240 ha^{-1}) over RCr-41, RCr-435 and RCr-436. Foliar application of thiourea 500 ppm produced significantly higher seed (15.19 q ha^{-1}) and straw yield (42.22 q ha^{-1}), total uptake of nitrogen, phosphorus and potassium and also obtained significantly highest net returns (Rs 47376 ha^{-1}) as compared to water spray and other stress mitigating chemicals.

Keywords: Productivity, profitability, nutrient status, coriander, stress mitigating chemicals

Introduction
Coriander (*Coriandrum sativum* L.) is an annual spice and condiment that is mostly used for its pleasant aromatic odour. It is an important seed spice grown in Rajasthan during *rabi* season for grain purpose under rain fed vertisols. The major contributing states are Rajasthan, Gujarat, Andhra Pradesh, Tamil Nadu and Madhya Pradesh. The crop has to survive under residual soil moisture throughout the cropping period and generally experiences terminal moisture stress which results in poor yield, which is the major constraint in production. It was felt necessary to look for the use of PGRs to break the yield stagnation of important varieties and its differential effect in term of yield and quality under normal and late sown conditions. Thus, for exploitation of genetic yield potential of the crop to the economic maxima with low cost technology, time of sowing, varieties and application of plant growth regulators are the important deciding factors. However, a measure research work on the agronomical manipulation of the crop involving these factors has been done. Plant growth regulators (PGRs) have great potential in in-creasing agricultural production and help in removing many of the barriers imposed by genetics and environment. Stress mitigating chemicals play an important role in mitigating stress and increasing flower set. Exogenous application of stress mitigating chemicals has been reported to improve the yield and nutrient status of various crops. Keeping this in view, the present field experiment was conducted to study the effect of PGRs on growth, seed yield, quality and economics of coriander.

Materials and Methods
A field experiment comprising twenty four treatment combinations replicated three times, was conducted in Randomized Block Design with four coriander varieties [RCr-435, RCr-728, RCr-436, RCr-41] and six treatments of stress mitigating chemicals (Water spray (Control), Salicylic acid @ 100 ppm spray twice at 40 and 60 DAS, Thiourea @ 500 ppm spray twice at 40 and 60 DAS, Kinetin @ 30 ppm spray twice at 40 and 60 DAS, DMSO @ 78 g ha^{-1} spray twice at 40 and 60 DAS and TGA @ 100 ppm spray twice at 40 and 60 DAS) during *Rabi*, 2016-17 at S. K. N. College of Agriculture, Jobner (Rajasthan).

The soil of experimental field was loamy sand in texture, alkaline in reaction (pH 8.2), low in organic carbon (0.14%), available nitrogen (130 kg ha^{-1}), available phosphorus (18.8 kg P_2O_5 ha^{-1}) and medium in potassium (175.6 kg K_2O ha^{-1}) content. The crop was sown on 5th November 2016 in lines 30 cm apart for sole crops with recommended package of practices. A basal dose of 30 kg N ha^{-1} and full dose of phosphorus and potassium was drilled about 5-7 cm deep through Urea, DAP and MOP at sowing. Remaining dose of nitrogen through urea was applied in two equal splits with irrigation. To workout the most profitable treatment, the economics of treatments was calculated on the basis of prevailing market rates in terms of net return (Rs ha^{-1}) and B C ratio. The uptake of N, P and K by coriander was worked out by multiplying their content in seed/straw with yield, respectively and the total uptake was computed by summing up the uptakes by seed and straw. Data obtained were statistically analyzed in factorial randomized block design using the standard techniques of analysis of variance.

Results and Discussion

Performance of Varieties

Due to more number of seeds by virtue of increased number of umbels $plant^{-1}$, seeds $umbel^{-1}$ and higher accumulation of biomass and nutrients as well as yield components in varieties RCr-728 led to significant increase in seed yield. Among the varieties, variety RCr-728, being at par with RCr-436, showed significantly higher nitrogen, phosphorus and potassium concentration in seed and straw over RCr-41 and RCr-435. The higher nitrogen, phosphorus and potassium concentration in RCr-728 may be due to its genetic milieu. Further, nutrient uptake is dependent on concentration and dry matter production, hence, inspite of marginal improvement in nitrogen, phosphorus and potassium concentration, significantly higher nitrogen, phosphorus and potassium uptake was observed due to higher seed and straw yield production under RCr-728. The results of the present investigation indicate differential behavior of coriander varieties with respect to nutrient concentration and its uptake is in close conformity with findings of other workers (AICRPS, 2008, 2011 and Balai and Keshwa, 2011) [6]. Results indicated that variety RCr-728 obtained significantly higher net returns of Rs 45240 ha^{-1} over RCr-41, RCr-435 and RCr-436. These results also support to the findings of Balai and Keshwa (2010) [4]. Despite the same cost of cultivation for these varieties, the higher seed yield recorded under variety RCr-728 have led to increased net returns.

Stress mitigating chemicals

Results revealed that foliar application of stress mitigating chemicals significantly enhanced seed, straw and biological yield of coriander. The favourable hormonal balance maintained at cellular levels due to application of stress mitigating chemicals may have greater photosynthetic efficiency and enzymatic activities through the production of endogenous auxins Balai (2005) [3] in coriander. The increase in yield due to application of thiourea may be due to stimulatory effect of growth regulators which induce large number of reproductive sink leading to greater activity of carboxylating enzymes thus resulting in higher photosynthetic rates with greater translocation and accumulation of metabolites in sink and ultimately higher seed yield Meena *et al*. (2014) [6]. Foliar application of all stress mitigating chemicals significantly increased the nitrogen, phosphorus and potassium concentration in seed and straw and their uptake comparison to water spray. Among the stress mitigating chemicals, foliar spray of thiourea recorded maximum nitrogen, phosphorus and potassium concentration and total uptake in seed and straw over all stress mitigating chemicals. Thiourea application might have helped in improvement of metabolic processes of plants and better growth and development, leading to greater absorption of nutrients from rhizosphere. Solanki (2002) [9] while working at Bikaner also reported that thiourea being a sulphydryl compound significantly improved the root growth. It might be due to metabolic role of SH-group in root physiology and biochemistry. Thiourea creates better microbial population in soil which are responsible to mobilize essential nutrients. Foliar spray of thiourea gave maximum net returns (47376 Rs ha^{-1}) over water spray, kinetin, dimethyl sulfoxide and thioglycolic acid. The cost of thiourea was low in comparison to added output. Thus, the increased seed yield led to higher net returns. These results are in close conformity with the findings of Singh (2007) [8] and Meena *et al.* (2011) [6].

Table 1: Effect of varieties and stress mitigating chemicals on yield, total nutrient uptake and economics of coriander

Treatment	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Total N uptake (kg ha^{-1})	Total P uptake (kg ha^{-1})	Total K uptake (kg ha^{-1})	Net returns (Rs ha^{-1})	B-C ratio
Varieties							
RCr-435	13.60	38.85	52.45	18.98	45.11	39136	2.36
RCr-728	14.82	42.03	56.85	21.68	51.50	45240	2.57
RCr-436	13.84	39.00	52.84	19.35	45.94	40339	2.40
RCr-41	12.53	36.61	49.14	16.48	38.69	33787	2.18
S.Em+	0.27	0.77	1.04	0.30	0.70	1354	0.05
CD (P=0.05)	0.78	2.22	3.00	0.85	2.01	3854	0.13
Stress Mitigating Chemicals							
Control	11.63	34.90	66.62	14.83	36.39	30294	2.09
Salicylic acid (100 ppm)	14.29	40.48	91.33	20.37	47.64	43438	2.55
Thiourea (500 ppm)	15.19	42.22	101.73	22.76	53.08	47376	2.66
Kinetin (30 ppm)	13.65	38.98	83.30	18.73	44.85	35895	2.11
DMSO (78 g ha^{-1})	13.43	38.69	81.51	18.46	43.83	39133	2.40
TGA (100 ppm)	13.97	39.49	85.78	19.60	46.08	41616	2.47
S.Em+	0.33	0.94	1.60	0.36	0.85	1658	0.06
CD (P=0.05)	0.96	2.72	4.63	1.04	2.46	4721	0.16
CV (%)	8.39	8.34	6.53	6.55	6.51	15	8.34

Conclusion

Based on the results of one year experimentation, it may be concluded that coriander variety RCr-728 gave maximum seed yield (14.82 q ha^{-1}), net returns (Rs 45240 ha^{-1}) and B-C ratio (2.57) and proved superior to other varieties. Foliar spray of 500 ppm thiourea at 40 and 60 DAS gave the maximum seed yield (15.19 q ha^{-1}), net returns (Rs 47376 ha^{-1}) and B:C ratio (2.66) and was found significantly superior to water sprayed control and rest of the stress mitigating chemicals.

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