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EFFECT OF BIOREGULATORS AND THEIR TIME OF APPLICATION ON GROWTH AND YIELD OF CUMIN

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ABSTRACT

The effect of bioregulators and their time of application on growth and yield of cumin were studied during rabi seasons of 2007-09 on a loamy sand soil at Jobner, Rajasthan. Bioregulators used were NAA @ 50 ppm and Triacontanol (@ 0.5 ml and 1.0 ml L^{-1}) with three levels of spray viz., one (40 DAS), two (40 and 60 DAS) and three (40, 60 and 80 DAS) along with one absolute control. The treatments were laid out in factorial randomized block design with three replications. Results revealed that growth and yield of cumin increased significantly with the application of growth regulators. NAA @ 50 ppm recorded maximum plant height, number of branches/plant and umbels/plant during 2008-09 and umbellets/umbel, seeds/umbel, seed yield (503 and 511 kg ha^{-1}) and net returns (Rs 41364 and 47124 ha^{-1}) during both the years which was comparable with Triacontanol @ 1.0 ml L^{-1}. The growth regulators did not affect straw and biological yields in 2007-08 but during 2008-09, the highest straw (1366 kg ha^{-1}) and biological yields (1910 kg ha^{-1}) was recorded with Triacontanol @ 1.0 ml L^{-1} which was comparable with application of NAA @ 50 ppm and Triacontanol @ 0.5 ml L^{-1}. Growth regulators did not cause any significant influence on test weight and volatile oil content of seed. The number of sprays had no significant effect on growth and yield during both the years but during 2008-09, the net returns significantly increased with two sprays (40 and 60 DAS) over single spray (40 DAS).

Key words: Cumin, bioregulator, NAA, Triacontanol, growth, yield, economics

INTRODUCTION

Cumin (*Cuminum cyminum* L.), an important commercial seed spice crop of arid and semi-arid regions of India belonging to the Umbellifereae family, is valued for its aroma, medicinal and therapeutic properties. In India, it is mainly cultivated in Rajasthan, Gujarat, Karnataka and Orissa. There is a lot of potential for cumin seed spices in our country because of the export potential and daily internal consumption as it finds place in almost all the Indian dishes. Crushed cumin seeds are used as a condiment in a variety of dishes. Cumin seeds contain volatile oil (2% – 5%) that imparts the characteristic aroma to the seeds. The oil is used in perfumery and for flavouring liquors and cordials. In indigenous medicine, cumin seeds have long been considered as a stimulant, carminative and are used for therapeutic purposes. They are also used in veterinary medicines. They are used as an essential ingredient in mixed soups, sausages, pickles, cheese and meat dishes, and for seasoning breads, cakes and candies. The productivity of the crop is below potential due to variety of reasons including environment. Bioregulators present a new possibility to break yield barrier, particularly imposed by the environment (Witter, 1971). Use of plant growth regulators can have a greater impact in increasing yield and quality. The bioregulators act as chemical catalysts in plants and improve physiological and reproductive efficiency in the plants. The bioregulators possibly improve the gene expression for efficient sucrose transport and increase dry matter partitioning for seed production. Application of Triacontanol and Naphthalene Acetic Acid induce higher physiological efficiency including photosynthetic ability of plants. It leads to better growth and yield of several vegetables and agronomic crops without substantial increase in the cost of production (Sumeriya *et al.*, 2000). These increase ethylene formation in plants, which facilitates the efficient translocation of photosynthates from source to sink. Foliar application of Triacontanol is known to enhance dry matter accumulation resulting in higher seed yield in maize. Application of NAA is known to induce higher physiological efficiency including photosynthetic ability of plants. Information regarding the use of plant growth regulators and their time of application suitable for cumin is not available. Keeping this in view the field experiment was conducted to study the effect of bioregulators and their time of application on growth and yield of cumin.

MATERIALS AND METHODS

The field experiment was conducted during winter seasons (*Rabi*) of 2007-08 to 2008-09 on a

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loamy sand soil at Agronomy farm, SKN College of Agriculture, Jobner (Rajasthan). The soil of experimental plot was low in organic carbon (2.2 g kg^{-1}), available nitrogen (133.3 kg ha^{-1}), phosphorus (7.5 kg ha^{-1}), medium in potassium (160.6 kg ha^{-1}) and alkaline in reaction (pH 8.2). The treatments were laid out in factorial randomized block design with 3 replications. The experiment comprised of thirteen treatment combinations consisting of sprays of bioregulators as one factor (Triacontanol @ 0.5 and 1.0 ml L^{-1}, NAA @ 50 ppm and water spray) and number of sprays as another factor (spraying once at 40 DAS, twice at 40 and 60 DAS and thrice at 40, 60 and 80 DAS) along with one absolute control. Cumin RZ 223 was sown directly using seed rate of 14 kg ha^{-1} in 4.0 m x 2.7 m size plots at a spacing of 30 cm. A general recommended dose of 30 kg N and 20 kg P_2O_5 ha^{-1} were applied through diammonium phosphate and urea. Nitrogen was applied in two splits at sowing and at the time of first irrigation and whole phosphorus at the time of sowing. Need based cultural and plant protection operations were taken up to harvest good crop. Five random plants were selected from each plot for taking observations on growth and yield attributes and for yield, the net plots (3.0 m x 2.1 m) were harvested. Economics was worked out on the basis of prevailing market prices of inputs and outputs. The volatile oil was estimated by using Clevenger's apparatus (AOAC, 1988). The data collected for two years were subjected to statistical analysis individually year wise.

RESULTS AND DISCUSSION

Growth and yield attributes

Growth regulators significantly influenced the plant growth viz., plant height and number of branches/plant of cumin during 2008-09 over water spray (Tables 1). Among the different growth regulators used under present investigation, NAA @ 50 ppm recorded maximum plant height (41.5 cm) and number of branches/plant (5.6) which was on par with Triacontanol @ 1.0 and 0.5 ml L^{-1} for plant height and Triacontanol @ 1.0 ml L^{-1} for branches/plant. There was no significant influence of number of sprays on plant growth during both the years. The increase in vegetative growth might be due to stimulation of cell division and cell elongation, while increasing plasticity of cell wall. The primary physiological effect of plant growth regulators is to stimulate the elongation of cells due to increased enzymatic activities, permeability of cell wall and formation of energy rich phosphates. Another possible explanation for better growth might be due to the increased osmotic uptake of water and nutrients under the influence of plant growth regulators and in turn improving nutrient metabolism of plant system. These observations are quite in line with those of Parmar *et al*. (2012) in green gram and Singh *et al.* (2012) in coriander. Number of umbels/plant during 2008-09 (19.1), umbellets/umbel (4.73) and seeds/umbel (23.0) during 2007-08 were highest with NAA @ 50 ppm which was on par with Triacontanol @ 1.0 and 0.5 ml L^{-1} but significant over water spray. The maximum umbellets/umbel (5.13) and seeds/umbel (33.6) were recorded with application of NAA @ 50 ppm which was comparable with application of Triacontanol @ 1.0 ml L^{-1} but significant to Triacontanol @ 0.5 ml L^{-1} and water spray during 2008-09.

Table 1: Effect of bioregulators on growth and yield attributes of cumin

Treatments	Plant height (cm)		Branches/plant		Umbels/plant		Umbellets/umbel		Seeds/umbel		Test weight (g)	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
Bioregulators												
Triacontanol @ 0.5ml L^{-1}	42.4	41.0	4.62	5.3	22.0	17.6	4.53	4.78	22.3	30.9	4.80	4.85
Triacontanol @ 1.0 ml L^{-1}	42.4	41.2	4.80	5.6	23.1	18.5	4.75	4.87	22.3	31.9	4.97	4.98
NAA @ 50 ppm	42.6	41.5	4.71	5.6	23.1	19.1	4.73	5.13	23.0	33.6	5.57	5.46
Water spray	41.6	39.6	4.49	4.9	20.8	14.8	4.24	4.62	20.0	29.7	4.73	4.76
CD (P = 0.05)	NS	1.0	NS	0.3	NS	2.0	0.26	0.22	1.8	2.7	NS	NS
Time of application												
One (40 DAS)	42.0	40.5	4.62	5.3	21.9	16.8	4.47	4.78	21.4	31.5	4.86	4.88
Two (40 & 60 DAS)	42.3	41.0	4.67	5.4	22.5	17.7	4.60	4.87	21.9	31.6	5.29	5.23
Three (40, 60 & 80 DAS)	42.4	40.9	4.68	5.4	22.3	17.9	4.62	4.90	22.5	31.6	4.90	4.92
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control vs. rest												
Control	41.4	39.0	4.40	5.6	18.9	14.5	4.13	4.40	19.4	28.1	4.47	4.51
Rest	42.2	40.8	4.66	5.4	22.2	17.5	4.56	4.85	21.9	31.5	5.02	4.97
CD (P= 0.05)	NS	1.2	NS	0.4	NS	2.4	0.32	0.27	1.9	3.3	NS	NS

Growth regulators did not cause any significant influence on test weight during both the years. The number of sprays had no significant effect on yield attributes of cumin during both the years. The increase in yield attributing characters due to application of plant growth regulators might be due to the stimulatory effect of growth regulators which induce large number of reproductive sinks leading to greater activity of carboxylating enzyme (ribose-1,5 -di phosphate carboxylase) thus resulting in higher photosynthetic rates with greater translocation and accumulation of metabolites in the sink. The favourable hormonal balance maintained at cellular level on NAA application might also have greater photosynthetic efficiency and enzymatic activity through the production of endogenous auxin. Such a mechanism may be operating in cumin also. Higher yield attributes as a result of application of plant growth regulators were also reported by Nehara *et al.* (2006) in fenugreek and Panda *et al*. (2007) in coriander.

Yield and economics

The yield of cumin increased significantly with the application of all growth regulator treatments over water spray (Table 2). Maximum seed yield was recorded during 2007-08 (503 kg ha^{-1}) and 2008-09 (551 kg ha^{-1}) with NAA @ 50 ppm closely followed by Triacontanol @ 1.0 ml L^{-1} during 2007-08 and Triacontanol @ 1.0 and 0.5 ml L^{-1} during 2008-09 but significantly superior to rest of the treatments. The application of Triacontanol @ 0.5 ml L^{-1} had also significant influence on seed yield over spray of water during both the years. The application of growth regulators did not affect straw and biological yields in 2007-08 but during 2008-09, the highest straw (1366 kg ha^{-1}) and biological yields (1910 kg ha^{-1}) was recorded with application of Triacontanol @ 1.0 ml L^{-1} which was comparable with application of NAA @ 50 ppm and Triacontanol @ 0.5 ml L^{-1}. The application of Triacontanol @ 0.5 ml L^{-1} had no significant influence on straw and biological yields over spray of water. These findings are in conformity with results obtained by Sarada *et al.* (2008) in coriander and Nehara *et al.* (2006) in fenugreek that reported higher vegetative growth and increased yield attributes resulting in maximum seed yield due to plant growth regulators application. The possible reason for increased yield was due to higher photosynthetic activity of treated plants as compared to control.

Table 2: Effect of bioregulators on yield, net returns and volatile oil content of cumin

Treatments	Seed yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Biological yield (kg ha^{-1})		Net returns (Rs ha^{-1})		Volatile oil content (%)	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
Bioregulators										
Triacontanol @ 0.5ml L^{-1}	440	528	799	1231	1239	1759	33830	44390	3.13	3.12
Triacontanol @ 1.0 ml L^{-1}	479	544	805	1366	1284	1910	38360	46160	3.22	3.20
NAA @ 50 ppm	503	551	783	1341	1286	1892	41364	47124	3.24	3.22
Water spray	399	405	834	1227	1233	1632	29050	29770	3.00	3.50
CD (P = 0.05)	39	60	NS	105	NS	193	3860	4076	NS	NS
Time of application										
One (40 DAS)	443	484	790	1252	1233	1736	34422	39342	3.15	3.13
Two (40 & 60 DAS)	456	521	809	1302	1265	1823	35743	43543	3.13	3.16
Three (40, 60 & 80 DAS)	467	516	816	1320	1283	1836	36825	42705	3.17	3.18
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	3546	NS	NS
Control vs. rest										
Control	401	389	835	1173	1236	1562	29620	28180	2.87	2.90
Rest	455	507	805	1291	1260	1798	35650	41890	3.15	3.14
CD (P= 0.05)	47	74	NS	117	NS	231	4632	4856	NS	NS

This may be due to greater accumulation of photosynthate in plant body owing to higher photosynthesis and better efficacy of sink, which would have enhanced the yields. The another possible reason may be explained in the light of the sole function of fertilized ovules or seeds in relation to growth of fruits is to synthesize one or more hormones, which initiate and maintain a metabolic gradient along which foods can be translocated from parts of plants towards the sink. Therefore, higher seed yield was obtained with foliar spray of NAA @ 50 ppm followed by Triacontanol. It is evident from the study that water spray and control registered significantly lower yields than growth regulator sprays which indirectly indicates that seed yield is the manipulation of morphological, physiological and growth parameters. Thus, the cumulative effect of yield attributes resulted in significant increase in seed yield. The improvement in vegetative growth led to increased straw and biological yields significantly. Higher yields as a result of application of growth regulators were also reported by Gour *et al.* (2012) in fenugreek. With regard to number of sprays, seed, straw and biological yields remained unaffected during both the years.

Maximum net returns were recorded during 2007-08 (Rs 41364 ha^{-1}) and 2008-09 (Rs 47124 ha^{-1}) with NAA @ 50 ppm closely followed by Triacontanol @ 1.0 ml L^{-1} during 2007-08 and Triacontanol @ 1.0 and 0.5 ml L^{-1} during 2008-09 but significantly superior to rest of the treatments (Table 2). During 2008-09, the net return significantly increased with two sprays (40 and 60 DAS) over single spray (40 DAS) and was comparable with three sprays (40, 60 and 80 DAS). The reason for higher net returns could be higher yield compared to cost involved in use of growth regulators as also reported by Sarada *et al.* (2008) and Singh *et al.* (2012) in coriander. Growth regulators did not cause significant influence on volatile oil content of seed during both the years.

The present study indicated that application of NAA @ 50 ppm / Triacontanol @ 1.0 ml L^{-1} twice at 40 and 60 days after sowing resulted in increased growth, yield and net monetary returns of cumin.

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