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RESEARCH ARTICLE

Effect of different plant growth regulators on growth, quality,yield and yield components in chrysanthemum (*Chrysanthemum coronarium* L.)

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SUMMARY

A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *Kharif 2008* to study the effect of different plant growth regulators on growth, seed yield and quality in annual chrysanthemum (*Chrysanthemum coronarium* L.). The experiment consisted of nine different plant growth regulators treatments combinations. It was laid-out in Randomized Block Design (RBD) having three replications. The results indicated significantly higher plant height (97.28cm /plant), number of branches (27.32),leaf area (4497.24cm^2/plant) and dry weight(0.747g/plant),number of seeds(265.33)/ flower and seed yield(500.00kg/ha) in GA3 @200ppm followed by all other treatments. The seed quality parameters like thousand seeds weight(2.14g /plant), germination percentage(67.67%), seedling length(10.60cm), vigour index (717) and dry weight (36.37mg) were also higher in treatment of GA3 @200 ppm .

Key Words **:** Growth regulators, Chrysanthemum, Germination per cent, Plant height, Seedling vigour index, Number of flower, Seed yield

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Chrysanthemum is a member of family Asteraceae. There are about 160 species of chrysanthemum among which the modern autumn flowering perennial (*Chrysanthemum morifolium*) is most common, usually propagated through suckers (mums) followed by annual chrysanthemums which are propagated through seeds. The crown daisy or Garland chrysanthemum (*C. coronarium*) is a native to Southern Europe, is a branching annual with finely cut foliage reaching a height up to a metre, size of flowers varies from 2.5 to 4 cm and colour is usually in shades of yellow and white with cream zone at the center (Swarup, 1967).

It is a fast growing winter blooming annual. In North India, it is one of the cheapest sources of floral material for worship and garland particularly in early summer months when flowers are inadequate in supply. Apart from this, it is used in potted plants, vases, and flower decoration, preparation of bouquets and as border in the garden. Its leaves are steamed or boiled and used as greens, especially in chinese cuisine, yellow and white chrysanthemum flowers are boiled to make a sweet drink in some parts of Asia known as 'chrysanthemum tea' has many medicinal uses, bioactive terpenes such as dihydro chrysanoride and cumambrin, contents of essential oil proven to have medicinal effect on cancer and blood pressure reduction. It is an economically important as a natural source of insecticide, the flowers are pulverized and an active component called pyrethrin is extracted and used in

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insecticidal preparation and it is a good companion plant, protecting neighbouring plants from caterpillars. In recent years, it has been introduced as a valuable source of feed for animals.

Chrysanthemum plants have also been shown to reduce indoor air pollution by the National Aeronautics and Space Administration (NASA) clean air study. The pre flowering application of growth regulators not only improve the quality and number of flowers produced but also increase the seed yield mainly by increasing the number of seeds in china aster (Doddagoudar, 2000). In the recent years the growth regulators play a major role in overcoming the factors limiting the yield and quality for obtaining maximum benefit from seed production. It is realized that the exogenous application of growth regulators stimulate flowering, pollination, fertilization and seed setting to yield better quality seeds (Sunitha, 2006). Yet, the information on the effect of growth regulators in realizing higher yield and quality in annual chrysanthemum is meagre.

MATERIALS AND METHODS

A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *Kharif* 2008 to study the effect of different plant growth regulators on growth, quality, yield and yield components in chrysanthemum (*Chrysanthemum coronarium* L.).

Treatment details		
G_0	-	Control (No spray)
G_1	-	Gibberellic acid (100 ppm)
G_2	-	Gibberellic acid (200 ppm)
G_3	-	Tricontanol (500 ppm)
G_4	-	Tricontanol (1000 ppm)
G_5	-	Cycocel (1000 ppm)
G_6	-	Cycocel (2000 ppm)
G_7	-	Mepiquat chloride (1000 ppm)
G_8	-	Mepiquat chloride (2000 ppm)

G = Sprays of plant growth regulators

Growth parameters :

The observations on growth parameters were recorded at three stages of plant growth *viz.,* 30, 60 days after transplanting and at harvest for recording various biometric observations, five plants at random from net plot area were selected and tagged in each plot. The observations were made on plant height, number of branches per plant, number of flowers per plant, flower diameter, dry weight of flower, and number of seeds per flower, test weight, seed yield per plant and per hectare

Seed quality parameters :

Germination percentage :

The seeds obtained from different treatments were tested for germination by adopting paper towel roll method kept at optimum conditions of temperature ($25^0C \pm 1^0C$) and relative humidity (95 ± 1% RH) in four replications of 100 seeds each (Anonymous, 1996). The number of normal seedlings was counted at the end of 21 days (final count) and the germination percentage was calculated.

Seedling length :

Ten normal seedlings from each of the replication from germination test were carefully removed on 21st day and used for measuring seedling length. The seedling length from tip of shoot to tip of root was measured in centimeter and the average length of the seedling was worked out and expressed in centimeters.

Seedling vigour index (SVI) :

Seedling vigour index was calculated by using the below mentioned formula as suggested by Abdul-Baki and Anderson (1973) and expressed in whole number :

Seedling vigour index = Germination (%) x

[Root length (cm) + shoot length (cm)]

Seedling dry weight :

The ten seedlings that were used for measuring seedling length were kept in butter paper packet and dried in hot air oven maintained at 70^0C for 48 hours. Then the seedlings were cooled in desiccators for one hour before recording the weight. The seedling dry weight was measured with the electronic balance and was expressed in milligrams.

Electrical conductivity of seed :

A sample of five gram of seeds from each of the four replications were washed in acetone for half a minute and later thoroughly washed in distilled water for five minutes. The seeds were soaked in 25 ml of distilled water and kept in an incubator maintained at $25^0C \pm 1^0C$ for 24 hours. The seed leachate was collected and volume was made up to 25 ml by adding distilled water. The electrical conductivity of seed leachate was measured by using the bridge (ELICO) with a cell constant 1.0 and the leachate values were expressed in desi Siemens per metre (dSm^{-1})

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

Growth parameter :

Plant height (cm) :

The data on plant height and number of branches at 30, 60 days after transplanting (DAT) and at harvest as influenced by different growth regulators are presented in Table 1. Initially

Table 1: Effect of growth regulators on plant height (cm) and number of branches at different growth stages of chrysanthemum

Treatments	Plant height (cm)			No. of branches/plant		
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest
G_0-Control	40.17	77.30	89.70	4.00	17.13	19.43
G_1-GA_3 @ 100ppm	40.50	82.77	94.00	4.33	24.33	26.20
G_2-GA_3 @ 200 ppm	40.00	84.93	97.28	4.00	25.80	27.32
G_3-Tricontanol@ 500 ppm	39.17	79.97	90.08	3.67	22.13	24.60
G_4-Tricontanol @ 1000 ppm	39.67	80.63	92.27	4.33	23.80	25.53
G_5-Cycocel @ 1000 ppm	40.83	73.01	85.01	4.67	20.00	22.27
G_6-Cycocel @ 2000 ppm	39.33	71.94	83.17	3.33	19.07	21.73
G_7-Mepiquat chloride @ 1000 ppm	39.67	75.91	87.87	4.33	21.00	23.47
G_8-Mepiquat chloride @ 2000 ppm	41.33	73.86	85.97	4.00	20.13	22.73
S.E.±	0.86	1.90	2.13	0.41	0.79	0.97
C.D. (P=0.05)	NS	5.69	6.37	NS	2.37	2.91

DAT-Days after transplanting NS-Non significant

there is no effect of plant growth regulators on plant height and number of branches because the any exogenously applied chemical not shown an effect immediately; it will take some time to inter in metabolic pathway. GA_3 and tricontanol significantly increased the plant height at 60 DAT and at harvest. Whereas CCC and mepiquat chloride significantly decreased the plant height at 60 DAT and at harvest compared to control (77.30 and 89.70 cm, respectively). Among the growth retardants, CCC at 2000 ppm recorded the minimum height at 60 DAT (71.94) and at harvest (83.17 cm). However, GA_3 200 ppm recorded maximum plant height at 60 DAT (84.93) and at harvest (97.28 cm) among the growth regulators. Increase in plant height with GA_3 and tricontanol may be attributed to increase in cell elongation in apical meristem leading to increased length of internodes. The increase in plant height due to GA_3 is in conformity with the reports of Syamal *et al.* (1990) in marigold and china aster, Das and Das (1992) in day lily, Shivaprasad Shetty (1995), Kumar *et al*. (2007), Pawar *et al.* (2008) in gaillardia and china aster; Shaikh *et al.* (2002) in onion and Dhall and Sanjeev (2004) in tomato with tricontanol spray. On the contrary the growth retardants are known to reduce auxin content in growing tissues by antagonizing them. Thus they exert an inhibitory effect by suppressing the cell elongation in the meristematic region of the growing point. The reduction in plant height is in agreement with the reports of Rajesh (1995) in calendula with mepiquat chloride spray; Pawar *et al*. (2007) in gaillardia and Khandelwal *et al*. (2003) in African marigold with cycocel spray.

Number of branches :

The number of branches per plant at 60 DAT and at harvest were significantly increased due to chemicals as compared to control (17.13 and 19.43, respectively) (Table 1). Among the growth regulators, GA_3 at 200 ppm recorded more number of branches per plant at 60 DAT and at harvest (25.80 and 27.32, respectively) followed by tricontanol. The increase in number of branches might be due to the promotion of horizontal growth (branching) apart from vertical growth. The increase in number of branches due to growth retardants (CCC and mepiquat chloride) might be due to antagonizing action of auxins responsible for the apical dominance and there by suppressed terminal bud growth, so the accumulated metabolites get translocated towards the auxillary buds and these in turn resulted in stimulation of laterals. Similar results were noticed by Sunita *et al.* (2007) in marigold, Syamal *et al*. (1990) in marigold and china aster with GA_3 spray; Shaikh *et al.* (2002) in onion and Dhall and Sanjeev (2004) in tomato with tricontanol spray; Rajesh (1995) in calendula with mepiquat chloride spray; Narayanagowda and Jayanthi (1991) and Khandelwal *et al*. (2003) in African marigold.

Number of leaves per plant :

The data on number of leaves per plant at 30, 60 DAT and at harvest as influenced by growth regulators are presented in Table 2. The number of leaves per plant differed significantly at 60 DAT and at harvest, while it was non significant at 30 DAT. The number of leaves per plant was significantly influenced by chemicals spray at 60 DAT and at harvest compared to control (365.00 and 620.33, respectively). Among the growth regulators, GA_3 at 200 ppm sprayed at 60 DAT and at harvest recorded the maximum number of leaves per plant (445.33 and 702.43, respectively) and minimum number in CCC 2000 ppm (376.97 and 639.33, respectively). The increase number of leaves in chemical spray might be due to increase in number of branches per plant. Such increase in number of leaves per plant due to growth regulators was

Table 2: Effect of growth regulators on number of leaves /plant and leaf area (cm^2) at different growth stages of chrysanthemum

Treatments	Number of leaves /plant			leaf area (cm^2)/plant		
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest
G_0-Control	73.00	365.00	620.33	375.33	2256.30	3123.77
G_1-GA_3 @ 100ppm	77.33	436.67	695.40	365.00	3599.74	4359.40
G_2-GA_3 @ 200 ppm	78.90	445.33	702.43	386.67	3742.67	4497.24
G_4-Tricontanol @ 500 ppm	76.60	416.33	666.33	377.83	3393.24	4161.63
G_3-Tricontanol@ 1000 ppm	78.33	425.33	676.40	391.67	3527.23	4286.43
G_5-Cycocel @ 1000 ppm	75.57	385.67	647.33	373.33	3097.20	4031.93
G_6-Cycocel @ 2000 ppm	74.67	376.97	639.33	394.50	2693.09	3562.09
G_7-Mepiquat chloride @ 1000 ppm	75.67	406.07	669.00	383.00	3309.57	4250.23
G_8-Mepiquat chloride @2000 ppm	75.07	396.33	654.67	378.33	3281.40	4190.63
S.E.±	2.54	9.16	10.83	12.71	45.32	54.33
C.D. (P=0.05)	NS	27.47	32.46	NS	135.88	162.88

DAT-Days after transplanting NS-Non significant

reported by Ravidas *et al.* (1992) and Umrao *et al.* (2007) in gladiolus, Dhaduk *et al.* (2007) in anthurium, Sujatha *et al.* (2002) in gerbera and Singh and Bijimol (2001) in tuberose due to GA_3 spray; Shaikh *et al.* (2002) in onion with tricontanol spray; Doddagoudar *et al.* (2002) in china aster with mepiquat chloride spray; Khandelwal *et al.* (2003) in African marigold and Shreedhar (1993) in gaillardia with cycocel spray.

Leaf area (cm^2/plant) :

The data on leaf area per plant at 30, 60 DAT and at harvest as influenced by growth regulators are presented in Table 2. At 30 DAT the leaf area per plant did not differ significantly, while significant at 60 DAT and at harvest.The leaf area per plant differed significantly due to growth regulator spray at 60 DAT and at harvest. Among the chemicals GA_3 at 200 ppm recorded more leaf area (3742.67 and 4497.24 cm^2, respectively) compared to all other chemicals and control and less with CCC 2000 ppm (2693.09 and 3562.09 cm^2, respectively). The increase in leaf area due to growth regulators can be attributed to more number of leaves per plant (Kumar *et al*., 2003) in china aster with GA_3 spray; Karuppaiah *et al.* (2007) in radish due to tricontanol spray; Samruban and Karuppaih (2007) due to cycocel spray.

Days to 50 per cent flowering :

The data on days to 50 perc ent flowering as influenced by growth regulators are presented in Table 3. GA_3 at 200 ppm spray recorded significantly less number of days (54.00) to 50 per cent flowering while growth retardants took more number of days among chemicals cycocel at 2000 ppm (59.67) recorded maximum days to 50 per cent flowering followed by control (60.33). Early flowering with GA_3 spray may be due to increase in the endogenous gibberellins levels in the plant, as gibberellins are well known for inducing early flowering in several crop plants. The delayed flowering in the plants sprayed with growth retardants spray may be due to reduced availability and synthesis of endogenous gibberellins. As the growth retardants effectively reduce the availability of endogenous gibberellins by blocking

Table 3 : Effect of growth regulators on days to 50 per cent flowering, number of flower/plant, diameter of flower (cm) and number of seeds/flower in chrysanthemum

Treatments	Days to 50% flowering	Number of flower/plant	Diameter of flower (cm)	Number of seeds/flower
G_0-Control	60.33	70.81	5.27	236.00
G_1-GA_3 @ 100ppm	54.67	88.76	5.80	261.67
G_2-GA_3 @ 200 ppm	54.00	91.60	6.15	265.33
G_3-Tricontanol@ 500 ppm	57.00	83.86	5.69	258.13
G_4-Tricontanol @ 1000 ppm	56.67	86.07	5.72	259.80
G_5-Cycocel @ 1000 ppm	59.33	76.37	5.36	247.67
G_6-Cycocel @ 2000 ppm	59.67	74.80	5.32	242.33
G_7-Mepiquat chloride @ 1000 ppm	58.00	80.73	5.55	254.73
G_8-Mepiquat chloride @2000 ppm	58.33	77.73	5.40	251.67
S.E.±	0.74	1.52	0.11	3.11
C.D. (P=0.05)	2.23	4.55	0.32	9.33

their synthesis (Dicks, 1976). Early flowering was reported by Sunita *et al.* (2007), Singh *et al.* (1991) in African marigold with GA_3 spray; the delay in flowering due to mepiquat chloride and CCC compared to control which may be due to suppression of vegetative growth with subsequent increase in number of flower bearing branches which perhaps need more days for development and initiation of flowering. Similar results were noticed by Doddagoudar *et al.* (2004) in china aster due to mepiquat chloride spray; Kumar *et al.* (2004) in china aster due to cycocel spray.

Yield and yield parameters :

Number of flowers per plant :

The data on number of flowers per plant as influenced by growth regulators are presented in Table 3 . Number of capitula per plant were significantly increased by growth regulators as compared to control (70.81). Among the growth regulators, maximum number of capitula per plant were recorded with GA_3 at 200 ppm (91.60) and minimum with CCC at 2000 ppm (74.80). This increase in number of capitula per plant could be attributed to the increase in the number of branches per plant. The above results are in conformity with the findings of Sunita *et al.* (2007) in marigold, Lal and Mishra (1986) in marigold, Singh and Bijimol (2001) in tuberose, Sujatha *et al.,* 2002 in gerbera with GA_3 spray; Miniraj and Sanmugavelu (1997) in chilli due to tricontanol spray; Rajesh (1995) in calendula by mepiquat spray; Pawar *et al.* (2007) in gaillardia due to cycocel spray.

Flower diameter (cm) :

The data on flower diameter as influenced by growth regulators are presented in Table 3. The flower diameter differed significantly due to growth regulators spray. However, GA_3 at 200 ppm recorded maximum diameter (6.15 cm). Increase in flower diameter might be due to active cell elongation in the flower which increased the flower diameter. GA_3 is also known to increase strength of the actively growing parts. The findings are in line with those of Kumar *et al.* (2003) in china aster, Samruban and Karuppaiah *et al.* (2007) in French marigold and Sujatha *et al.* (2002) in gerbera.

Number of seeds per flower :

The data on number of seeds per flower as influenced by growth regulators are presented in Table 3. All treatments differed significantly over control. GA_3 at 200 ppm recorded significantly more number of seeds per flower (265.33) which was at par with GA_3 at 100 ppm, tricontanol at 1000 and 500 ppm which recorded 261.67, 259.80 and 258.13, respectively. The later three treatments, GA_3 at 100 ppm, tricontanol at 100 and 500 ppm were at par with each other followed by mepiquat chloride at 1000, 2000 ppm and CCC 1000 ppm which recorded 254.73, 251.67 and 247.67, respectively. CCC 2000 ppm recorded less number of seeds (242.33) among chemical and least with control (236.00).

Flower dry weight (g) :

The data on flower dry weight as influenced by growth regulators are presented in Table 4.The flower dry weight differed significantly due to growth regulator spray. However, GA_3 at 200 ppm recorded maximum flower dry weight (0.747 g). Improvement in flower dry weight as a result of GA_3 spray might be due to better overall plant growth which resulted in net increase in photosynthates. This finding is in line with those of Kumar *et al.* (2003) in china aster, Nagarjuna *et al.* (1988) in chrysanthemum and Swaroop *et al.* (2007) in African marigold.

Seed yield per plant (g)

The data on seed yield per plant as influenced by growth regulators are presented in Table 4. The seed yield per plant was significantly higher by spraying of GA_3 at 200 ppm (6.75 g) followed by GA_3 at 100 ppm (6.55 g). Increase in seed yield per plant can be attributed to increase in number of branches per plant, number of capitulum per plant and thousand seed

Table 4 : Effect of growth regulators on flower dry weight (g), seed yield (g/plant) and seed yield (kg/ha) in chrysanthemum

Treatments	Flower dry weight (g)	Seed yield (g/plant)	seed yield (kg/ha)
G_0-Control	0.527	4.35	322.47
G_1-GA_3 @ 100ppm	0.717	6.55	485.19
G_2-GA_3 @ 200 ppm	0.747	6.75	500.00
G_3-Tricontanol@ 500 ppm	0.642	6.17	457.28
G_4-Tricontanol @ 1000 ppm	0.678	6.42	475.56
G_5-Cycocel @ 1000 ppm	0.592	5.67	420.00
G_6-Cycocel @ 2000 ppm	0.559	5.42	401.73
G_7-Mepiquat chloride @ 1000 ppm	0.625	6.04	447.16
G_8-Mepiquat chloride @2000 ppm	0.597	5.84	432.35
S.E.±	0.03	0.19	14.33
C.D. (P=0.05)	0.09	0.58	42.96

weight. The results are in conformity with the reports of Shivaprasad shetty *(1995)* in china aster, Shivakumar (2000) in marigold by GA_3 spray; Doddagoudar *et al*. (2004) in china aster due to GA_3 and mepiquat chloride spray, Kareekatti (1996) in safflower due to mepiquat chloride spray and Hugar (1997) in gaillardia with cycocel spray.

Seed yield (kg/ha) :

The data on seed yield per hectare as influenced by growth regulators is presented in Table 4. In the present study, significantly higher seed yield per ha (500 kg) was recorded in GA_3 at 200 ppm as compared to control (322.47 kg). This increase in seed yield per ha could be attributed to increase in yield attributes such as seed yield per plant, number of capitulum, thousand seed weight and increase in growth parameters like number of branches per plant. The above results are in conformity with the findings of Sunita *et al.* (2007) in marigold, Swaroop *et al.* (2007) in African marigold with GA_3 spray; Doddagoudar *et al*. (2004) in china aster due to GA_3 and mepiquat chloride spray; Hugar (1997) in gaillardia with CCC spray.

Seed quality parameters :

1000 seed weight (g) :

The data on test weight (1000 seed weight) as influenced by growth regulators are presented in Table 5. Thousand seed weight was significantly increased by all growth regulators compared to control (1.90 g). The maximum thousand seed weight was recorded with GA_3 at 200 ppm (2.11 g) and minimum in CCC at 2000 ppm (1.97 g). Increase in thousand seed weight might be due to increase in individual seed weight. Similar findings on increase in thousand seed weight due to chemicals spray were reported by Sunita *et al.* (2007) in marigold with GA_3, Doddagoudar *et al*. (2004) in china aster due to GA_3 spray and mepiquat chloride spray and Hugar (1997) in gaillardia with cycocel spray.

Germination (%)

The data on germination percentage influenced by growth regulators are presented in Table 5. The growth regulators significantly increased the germination percentage as compared to control (62.33 %). The maximum germination was recorded with GA_3 at 200 ppm (67.67 %) and minimum with CCC 2000 ppm (64.00 %). Increase in germination percentage with GA_3 spray may be due to increased 1000 seed weight, which might have supplied adequate food reserves to resume embryo macromolecules to be utilized in growth promoting processes. Such increase in germination percentage due to growth regulators spray are reported by Doddagoudar *et al*. (2004) in china aster, Shivaprasad Shetty (1995) in china aster and *Sunita et al.* (2007) in marigold.

Seedling length (cm) :

The data on seedling length influenced by growth regulators are presented in Table 5. Seedling length was significantly influenced by all the growth regulators compared to control (9.67 cm). The maximum seedling vigour index was recorded with GA_3 at 200 ppm (10.60 cm) and minimum with CCC at 2000 ppm (9.67 cm). The results are in conformation with Doddagoudar *et al*. (2004) in china aster, Shivaprasad Shetty (1995) in china aster and Sunita *et al.* (2007) in marigold.

Seedling dry weight (mg) :

The data on seedling dry weight as influenced by growth regulators are presented in Table 6. All the treatments differed significantly over control. However, Seedling dry weight was significantly influenced by all the chemicals compared to control. The maximum seedling dry weight recorded with GA_3 200 ppm (36.67 mg) due to chemicals and minimum with CCC 2000 ppm (32.00 mg). The increase in seedling dry weight

Table 5: Effect of growth regulators on 1000 seed weight (g), germination (%) and seedling length (cm) in chrysanthemum

Treatments	1000 seed weight (g)	Germination (%)	Seedling length (cm)
G_0- Control	1.90	62.33 (52.12)*	9.67
G_1- GA_3 @ 100ppm	2.11	66.33 (54.51)	10.45
G_2- GA_3 @ 200 ppm	2.14	67.67 (55.33)	10.60
G_3-Tricontanol@ 500 ppm	2.04	65.33 (53.91)	10.18
G_4-Tricontanol @ 1000 ppm	2.08	66.00 (54.31)	10.26
G_5-Cycocel @ 1000 ppm	1.99	64.33 (53.31)	9.69
G_6-Cycocel @ 2000 ppm	1.97	64.00 (53.11)	9.67
G_7-Mepiquat chloride @ 1000 ppm	2.03	65.00 (53.71)	9.80
G_8-Mepiquat chloride @2000 ppm	2.00	64.67 (53.51)	10.17
S.E.±	0.03	0.42	0.07
C.D. (P=0.05)	0.10	1.26	0.22

Note : Figures in parenthesis are arcsine transformed values

Table 6 : Effect of growth regulators on seedling dry weight (mg), seedling vigour index, and electrical conductivity of seed leachate (dSm^{-1}) in chrysanthemum

Treatments	Seedling dry weight (mg)	Seedling vigour index	Electrical conductivity of seed leachate (dSm^{-1})
G_0- Control	31.00	602	0.849
G_1- GA_3 @ 100 ppm	35.34	699	0.695
G_2- GA_3 @ 200 ppm	36.67	717	0.662
G_3-Tricontanol@ 500 ppm	34.33	656	0.700
G_4-Tricontanol @ 1000 ppm	35.33	664	0.667
G_5-Cycocel @ 1000 ppm	33.00	636	0.782
G_6-Cycocel @ 2000 ppm	32.00	626	0.797
G_7-Mepiquat chloride @ 1000 ppm	34.00	654	0.729
G_8-Mepiquat chloride @2000 ppm	33.34	638	0.744
S.E.±	0.52	7.51	0.03
C.D. (P=0.05)	1.55	22.52	0.08

might be due to higher seedling length. The results are in line with the findings of Doddagoudar *et al*. (2004) in china aster and Sunita *et al.* (2007) in marigold.

Vigour index

The data on vigour index as influenced by growth regulators are presented in Table 6. Seedling vigour index was significantly influenced by all the growth regulators compared to control (602). The maximum SVI was recorded with GA_3 200 ppm (717) due to chemicals and minimum with CCC 2000 ppm (626). Increase in SVI due to growth regulators is in agreement with the results of Shivaprasad Shetty (1995) and Doddagoudar *et al*. (2004) in china aster and Sunita *et al.* (2007) in marigold

Electrical conductivity (dSm^{-1}) :

The data on electrical conductivity of seed leachate as influenced by growth regulators are presented in Table 6. Electrical conductivity of seed leachate differed significantly by all the growth regulators compared to control. The minimum EC was recorded with GA_3 at 200 ppm (0.662 dSm^{-1}) treatment and maximum in CCC at 2000 ppm (0.797 dSm^{-1}) and control (0.849 dSm^{-1}), respectively. The results are in line with the findings of Shivaprasad Shetty (1995) and Doddagoudar *et al*. (2004) in china aster.

Conclusion :

Spraying of GA_3 at 200 ppm significantly increased plant height,number of branches, induced early 50 per cent flowering, number of capitulum per plant, capitulum diameter, number of seed per capitulum, dry weight of capitulum, 1000 seed weight and seed yield (per plant and per ha) , followed by GA_3 at 100 ppm and tricontanol at 1000 and 500 ppm spray. On the contrary growth retardants mepiquat chloride at 1000 and 2000 ppm and cycocel at 1000 and 2000 ppm decreased above all the mention plant growth parameters, respectively. The seed quality parameters such as germination percentage, seedling length and vigour index and seedling dry weight were higher with lower electrical conductivity was recorded with GA_3 at 200 ppm followed by GA_3 at 100 ppm and tricontanol at 1000 ppm and 500 ppm. Among the growth retardants, mepiquat chloride at 1000 ppm recorded significantly more germination percentage, seedling length and vigour index and seedling dry weight with lower electrical conductivity followed by mepiquat chloride at 2000 ppm, cycocel at 1000 and 2000 ppm.

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