Effect of arresting the late formed umbels by growth regulators spray on seed yield and seed quality in onion cv. CO (On) 5 (Allium cepa L.)

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Abstract
The field experiment was carried out to study the effect of growth regulators spray on onion cv. CO (On) 5 seed production. The studies on the influence of foliar spray with growth regulators viz., benzylaminopurine at 60 and 90 ppm, mepiquat chloride at 500 and 750 ppm and brassinosteroid at 0.5 and 1 ppm spray were evaluated for restricting the late formed umbels. The growth regulators were sprayed at the time of flower stalk initiation (35 DAS) and 10 days after first spray. Among the growth regulators, brassinosteroid (1.0 ppm) was found to be effective in restricting the umbel orders at the optimum level of eight and reduced the duration for physiological maturity by 7 days when compared to control and enhanced the yield contributing characters viz., umbel diameter by 7.4%, number of capsules umbel\(^{-1}\) by 28.0%, number of filled capsules umbel\(^{-1}\) by 51.7%, seed set (%) by 11% and seed yield plant\(^{-1}\) by 4.7% over control and reduced the number of ill filled capsules umbel\(^{-1}\) by 7.2% and number of under sized seeds umbel\(^{-1}\) by 26.7% over control. It also improved the seed germination, drymatter production and vigour index by 3.4, 3.6 and 6.8% respectively over control. Hence, foliar spray with brassinosteroid at 1 ppm was found to be effective in restricting umbels orders and improving the seed yield and seed quality in onion.

Keywords: Onion, plant growth regulators, umbel orders, seed yield, seed quality

Introduction
Onion (Allium cepa L.) a member of Aliiaceae family, is the most important conventional vegetable crop; commercially grown in India. Onion is used in the preparation of salads, pickles, spices, condiments and all types of vegetarian and non-vegetarian dishes. Fresh as well as dehydrated onions are the good source of earning foreign exchange. It is believed to be originated from Central Asia. Onions have received considerable attention for their healthful, functional benefits. Phytochemicals in onions include the organosulfur compounds such as c apaenes and thiosulfinates (Dorsch and Wagner, 1991; Goldman et al., 1996) [6, 7].

India is the second largest producer of onion bulbs in the world. The major Onion producing states are Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Bihar, Rajasthan, Andhra Pradesh, Haryana, West Bengal, and Uttar Pradesh in the country. These States account for almost 90% of the total onion production of the country. The production of onion during the year 2017-18 is estimated to be 2.6% lower as compared to the previous year. However as compared to past 5 year’s average production, it is 10.8% higher (Onion monthly report, 2018) [17].

The area and production of onion in India is about 1.27 million hectares and 21.56 million tons of bulbs respectively, with an average productivity of 16.97 tons ha\(^{-1}\). In India, Maharashtra state has the prominent position in respect to onion production accounting 37.12 per cent of national production. Tamil Nadu ranks 8\(^{th}\) in cultivated area (0.34 lakhs hectares), 13\(^{th}\) in annual production (3.47 lakhs tons) and 23\(^{rd}\) in productivity (10.18 tones ha\(^{-1}\)) (Horticultural statistics at a glance, 2017) [10].

As the area under onion crop is increasing year after year due to its increasing demand, the demand for quality seed is also increasing fast. One of the major problems in onion production is lack of high quality seeds and improper agronomic practices used by farmers. Onion seed production might be increased by increasing the area with good variety and changing the existing management practices.

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The onion variety CO (On) 5 is a seed propagated variety of aggregatum type utilized in this study. The field experiment was carried out to study the effect of growth regulator spray on seed yield and seed quality in onion. The flower stalk emergence started at 35 days after bulb sowing. The individual plant produces 10 to 12 umbels plant\(^{-1}\). Seed harvested from this plant shows low seed quality because of long flowering period resulted in different stages of seed maturity in the umbel. The seeds collected from early formed umbels shows superior quantitative and qualitative characters than the later formed umbels. Hence restriction of late formed umbels to be determined for the quality seed production in onion cv. CO (On) 5. Generally the plant growth regulator promotes plant growth and improves the yield in crops at low concentration. It was hypothesized that the higher concentration of plant growth regulators may inhibit/reduce the vegetative growth and restricted the late formed umbels in onion. With this background, the present study was conducted to find out the effect of growth regulator spray on seed yield and quality in onion.

**Material and Methods**

A field experiment was conducted during rabi (2017) at Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore to study the effect of growth regulators spray on seed yield and seed quality in onion cv. CO (On) 5. The plants were sprayed with plant growth regulators of different concentrations as detailed below at 35 days after bulb sowing and 10 days after first spray.

**Treatments**

T\(_1\): Control (Unsprayed plot)
T\(_2\): Benzylaminopurine at 60 ppm
T\(_3\): Benzylaminopurine at 90 ppm
T\(_4\): Mepiquat chloride at 500 ppm
T\(_5\): Mepiquat chloride at 750 ppm
T\(_6\): Brassinosteroid at 0.5 ppm
T\(_7\): Brassinosteroid at 1.0 ppm

The trial was laid out in randomized block design with three replications. The plot size adopted was 2 x 1 m\(^2\). All the recommended packages of practices were adopted. The following observations were taken in first, second, third……n\(^{th}\) order umbels plant\(^{-1}\) from the randomly selected ten plants in each plot and mean values were calculated.

Number of days taken for flower stalk initiation, 50% flowering and days for physiological maturity may not be influenced significantly by different growth regulators spray. Brassinosteroid (1.0 ppm) reduced the duration for flower stalk initiation, 50 per cent flowering and days for physiological maturity by 2, 3 and 7 days respectively over control. Mepiquat chloride (750 ppm) increased the duration for flower stalk initiation, 50% flowering and days for physiological maturity by 8, 6 and 7 days respectively over control. Mepiquat chloride (750 ppm) increased the duration for flower stalk initiation, 50% flowering and days for physiological maturity by 8, 6 and 7 days respectively over control (Table 1). Spraying of brassinosteroid (1.0 ppm) reduced the vegetative growth and late formed umbels; therefore, it reduced the duration for crop growth. Application of BS accelerated the fruit ripening in tomato (Vidya vardhini and Rao, 2002)\(^{[28]}\) and accelerating the growth during first stages of vegetative bud development in Cactus pear (Cortes et al., 2003)\(^{[4]}\). However, days taken for 100% flowering did not influenced significantly by 28- homobrassinolide in mango (Ramani et al., 2016)\(^{[18]}\).

**Results and Discussion**

Flowering in onion was mainly induced by low temperature ranging from 4 to 15°C and higher temperature after floral initiation sometimes prevent normal development of flower stalks due to abortion of flower (Brewster, 1994)\(^{[3]}\). Flowering could be induced in onion through foliar spray with chemicals and growth regulators (Hakimi, 1987)\(^{[8]}\). The greater potentialities of growth regulators for maximizing the yield of vegetable crops had been reported by Mehrota et al. (1970)\(^{[14]}\), Srivastava and Adhikari (1972)\(^{[22]}\), Maurya and Lal (1987)\(^{[13]}\). Similarly, Nehra et al. (1992)\(^{[16]}\) stressed the use of ethrel, GA\(_3\) and boric acid for initiating early bulbs, bolting and seed set in onion. In the present study, the growth regulators viz. benzyl amino purine at 60 and 90 ppm, mepinquat chloride at 500 and 750 ppm, brassinosteroid at 0.5 and 1.0 ppm spray were evaluated for restricting the late formed umbels in aggregatum onion cv.CO (On) 5.

The result of the present experiment revealed that the number of days required for flower stalk initiation, 50 per cent flowering and days for physiological maturity varied significantly with different growth regulators spray. Brassinosteroid (1.0 ppm) reduced the duration for flower stalk initiation, 50 per cent flowering and days for physiological maturity by 8, 6 and 7 days respectively over control. Mepiquat chloride (750 ppm) increased the duration for flower stalk initiation, 50% flowering and days for physiological maturity by 2, 3 and 3 days respectively over control (Table 1). Spraying of brassinosteroid (1.0 ppm) reduced the vegetative growth and late formed umbels; therefore, it reduced the duration for crop growth. Application of BS accelerated the fruit ripening in tomato (Vidya vardhini and Rao, 2002)\(^{[28]}\) and accelerating the growth during first stages of vegetative bud development in Cactus pear (Cortes et al., 2003)\(^{[4]}\). However, days taken for 100% flowering did not influenced significantly by 28- homobrassinolide in mango (Ramani et al., 2016)\(^{[18]}\).

Among the foliar sprays given for arresting the late formed umbels, the brassinosteroid (1.0 ppm) spray restricted umbel number up to a minimum of 8.0 and benzylaminopurine (90 ppm) reduced umbel order to a minimum of 10.6 umbels plant\(^{-1}\). It was maximum in mepiquat chloride at 750 ppm (13.5) spray compared to control (12.0) (Table 1). However, homo-brassinolide spray increased the number of tillers m\(^{-2}\) in rice (Dey et al., 2014)\(^{[5]}\). In the present study, the onion plant sprayed with brassinosteroid (1.0 ppm) inhibits the late formed umbels, which helps the early formed umbels to utilize the source effectively resulting in production of more number of filled capsules and lesser number of ill filled capsules and undersized seeds by improving the source-sink relationship in onion. However, the different growth regulators spray had significant influence on umbel diameter, total number of

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capsules umbel\(^{-1}\) and seed set (%). It was recorded maximum (5.8 cm, 119.2 and 71\%) with brassinosteroid at 1.0 ppm followed by benzylaminopurine at 90 ppm (5.6 cm, 110.2 and 67 per cent) compared to control (5.4 cm, 93.1 and 60%) (Table 1) (Fig. 1). It might be due to higher leaf area index (LAI) and dry matter accumulation per unit area (Sairam, 1994 and Sengupta et al., 2011)\(^{[21, 23]}\) increasing the umbel diameter, total number of capsules umbel\(^{-1}\) and seed set (%). Brassinolide spray at new leaf initiation stage increased the flowering and fruit set in mango cv. Kesar (Ramani et al., 2016)\(^{[18]}\). The number of pods per unit area was recorded 3.4 per cent and 2.2 per cent due to brassinosteroid at 1.0 ppm respectively over control (Table 1 and 2). Hence, the brassinosteroid (1.0 ppm) reduced the number of ill filled capsules and number of undersized seeds umbel\(^{-1}\) and number of undersized seeds per umbel by 7.2% and 26.7% respectively over control. The mepiquat chloride (750 ppm) increased the number of ill filled capsule and number of drymatter production also recorded the same trend as that of germination and vigour (Table 2). This may be due to increase of food reserves in seeds by effective utilization of photo assimilates. Brassinosteroid spray increased the RNA and DNA content, polymerase activity, protein synthesis (Bajguz and Hayat, 2009)\(^{[20]}\) carbohydrate fraction, reducing sugars, non- reducing sugars and starch (Vidy a Vardhini and Rao, 2002)\(^{[28]}\).

Thus the study highlighted that foliar spray with brassinosteroid at 1.0 ppm twice at first flower stalk emergence (35 DAS) and at 10 days after first spray (45 DAS) improved the seed yield (556.5 kg ha\(^{-1}\)) and resultant seed quality characteristics.

### Table 1: Effect of growth regulators spray on crop growth and yield contributing characters in onion cv. CO (On) 5

| Treatment | Days for flower stalk initiation (DAS) | Days for 50 per cent flowering (DAS) | Days for physiological maturity (DAS) | Number of umbels plant\(^{-1}\) | Number of capsules umbel\(^{-1}\) | Number of filled capsules umbel\(^{-1}\) | Number of ill filled capsules umbel\(^{-1}\) | Seed set (%) |
|-----------|--------------------------------------|-------------------------------------|-------------------------------------|---------------------|------------------------|------------------------|------------------------|--------------|
| T\(_1\)   | 53.5                                 | 79.9                                | 124.8                               | 12.0                | 93.1                   | 55.7                    | 37.4                    | 60 (50.77)   |
| T\(_2\)   | 53.4                                 | 80.6                                | 125.5                               | 12.2                | 98.8                   | 63.2                    | 35.6                    | 64 (53.13)   |
| T\(_3\)   | 49.7                                 | 76.5                                | 125.2                               | 10.6                | 110.2                  | 74.3                    | 35.9                    | 67 (54.33)   |
| T\(_4\)   | 54.9                                 | 81.2                                | 130.6                               | 13.0                | 93.7                   | 54.1                    | 39.6                    | 58 (49.60)   |
| T\(_5\)   | 56.4                                 | 82.7                                | 127.9                               | 13.5                | 90.5                   | 50.1                    | 40.4                    | 55 (47.87)   |
| T\(_6\)   | 52.6                                 | 79.4                                | 124.4                               | 11.3                | 106.4                  | 68.4                    | 38.0                    | 64 (53.13)   |
| T\(_7\)   | 46.3                                 | 73.8                                | 117.8                               | 8.0                 | 119.2                  | 84.5                    | 34.7                    | 71 (54.94)   |
| Mean      | 52.4                                 | 79.2                                | 125.2                               | 11.5                | 101.7                  | 64.3                    | 37.4                    | 63 (52.54)   |
| S,Ed      | 0.8477                               | 1.7578                              | 2.8629                              | 0.2481              | 2.4539                 | 1.4659                  | 0.6462                  | 0.6643       |
| CD (P=0.05)| 1.8469                               | 3.8300                              | 6.2377                              | 0.5405              | 5.3467                 | 3.1939                  | 1.4079                  | 1.4473       |

(Figures in parenthesis indicate arc sine values)

T\(_1\) - Control (Unsprayed plot); T\(_2\) - Benzyl amino purine @ 60 ppm; T\(_3\) - Benzyl amino purine @ 90 ppm; T\(_4\) - Mepiquat chloride @ 500 ppm; T\(_5\) - Mepiquat chloride @ 750 ppm; T\(_6\) - Brassinosteroid @ 0.5 ppm; T\(_7\) - Brassinosteroid @ 1.0 ppm

### Table 2: Effect of growth regulators spray on seed yield and seed quality parameters in onion cv. CO (On) 5

| Treatment | Number of seeds umbel\(^{-1}\) | Number of undersized seeds umbel\(^{-1}\) | Seed yield umbel\(^{-1}\) (g) | Seed yield ha\(^{-1}\) (kg) | Germination (%) | Root length (cm) | Shoot length (cm) | Dry matter production (mg seedlings\(^{-1}\)) | Vignour index |
|-----------|-------------------------------|-------------------------------------------|----------------------------|-----------------------------|-----------------|-----------------|-----------------|-----------------------------------------------|--------------|
| T\(_1\)   | 163.8                         | 27.7                                      | 0.526                       | 521.1                       | 88 (69.73)      | 6.0             | 9.1             | 16.6                            | 1329         |
| T\(_2\)   | 168.3                         | 27.2                                      | 0.529                       | 532.2                       | 89 (70.63)      | 6.0             | 9.2             | 16.6                            | 1353         |
| T\(_3\)   | 229.4                         | 22.8                                      | 0.619                       | 542.1                       | 90 (71.57)      | 6.1             | 9.4             | 16.9                            | 1395         |
| T\(_4\)   | 162.5                         | 32.5                                      | 0.471                       | 505.5                       | 88 (69.73)      | 5.1             | 9.0             | 16.3                            | 1241         |
| T\(_5\)   | 145.6                         | 37.4                                      | 0.446                       | 496.9                       | 85 (67.22)      | 5.1             | 8.9             | 16.1                            | 1190         |
| T\(_6\)   | 175.6                         | 24.0                                      | 0.574                       | 534.1                       | 88 (69.73)      | 6.1             | 9.3             | 16.5                            | 1355         |
| T\(_7\)   | 246.5                         | 20.3                                      | 0.828                       | 556.5                       | 91 (72.54)      | 6.1             | 9.5             | 17.2                            | 1420         |
| Mean      | 184.5                         | 27.4                                      | 0.570                       | 526.9                       | 88 (66.42)      | 5.8             | 9.2             | 16.6                            | 1326         |

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References

T1 - Control (Unsprayed plot); T2 - Benzyl amino purine @ 60 ppm; T3 - Benzyl amino purine @ 90 ppm; T4 - Mepiquat chloride @ 500 ppm; T5 - Mepiquat chloride @ 750 ppm; T6 - Brassinosteroid @ 0.5 ppm; T7 - Brassinosteroid @ 1.0 ppm

Fig 1: Effect of growth regulators spray on umbel diameter and seed yield/plant in onion cv. CO (On) 5

Conclusion

Arresting of late formed umbels by spraying brassinosteroid at 1.0 ppm at the time of flower stalk initiation and 10 days after first spray found to record highest values for seed set (71%), number of seeds umbel1 (246.5), seed yield umbel1 (0.828 g), seed yield plant1 (6.62 g), germination (91%), seedling length (15.6 cm), dry matter production (17.2 mg seedlings10) and vigour index (1420).

Figures in parenthesis indicate arsine values

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