Optimum Time of Pollination and Number of Fruit Pickings and Its Effect on Seed Yield in CGMS Based Chilli (*Capsicum annuum* L.) Hybrid

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Authors’ contributions

This work was carried out in collaboration among all authors. Authors SNV and BVT designed the study. Author NT performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NT and SRD, SNV managed the analyses of the study. Authors NT, SRD, SIM and MGP managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study proposed standardization of best time of pollination and stage of picking fruits in newly released chilli CGMS hybrid. As optimum pollination time can result in better fruit set and thus produce seeds with superior yield. Another purpose of conducting the experiment was selection of a fruit picking stage that positively influence the seed yield parameters as under matured or over matured fruits often cause losses. In present investigation during *kharif* season of 2016 and 2017 stigma of A line (male sterile line) was pollinated at six different times with pollens from R line (male fertile/restorer line) starting from 9 am to 5 pm. Fruits labeled with different coloured threads were harvested 60 days after pollination in three different pickings. Pollination time 10 to 11 am yielded hybrid with higher fruit set (40 %), dry fruit weight (1.50g), seed weight per fruit (0.451 g), number of seeds per fruit (76) and test weight (6.26 g) as compared to late afternoon timings. Also second picking fruits were better in these seed yield parameters when compared to early and late pickings. The interaction effect was also significant for these two objectives.
Keywords: CGMS; pollination time; fruit picking; seed yield; test weight.

1. INTRODUCTION

Chilli (Capsicum annuum L.) termed as Kapsimo, Mensinkaayi, Mirch, etc in many vernacular languages is a member of the nightshade family called Solanaceae. Originated in the new world tropics and subtropics with evidences found in Peru, this spice and vegetable crop is cultivated commercially across the world. In view of its introduction to India from Brazil by Portuguese towards the end of fifteenth century, India has become the secondary centre of diversity for chilli. It holds a high economic value as India is the world leader in chilli production followed by China, Mexico, Turkey, Indonesia, Spain and United States [1]. This spice-cum-vegetable has gained popularity due to its nutritional as well medicinal value. It is a rich source of calcium, magnesium, Vit C, A B6 and Iron. Capsaicin is a bioactive compound found in chilli that has antibacterial and anti-inflammatory properties. Moreover chilli is also contemplated as an immunity booster [2].

The five main species of chilli viz., C frutescens L., C. chinense Jacquin, C. pendulum Willdenow, C. pubescens Ruiz & Pavon and C. annuum are cultivated throughout the world. Among the breeding method evolved in development of C. annuum hybrids, pollination and use of Cytoplasmic Genetic Male Sterility (CGMS) is the most acknowledge. Adopting it as technique of hybrid seed production in chilli may reduce the cost of hybrid seed production by 50 % by reducing labour requirement for emasculation [3]. Chilli is an often cross pollinated crop with natural crossing ranging from 7.6 to 36.8 per cent out crossing. Hybrid chilli crop contribute for high vigour, uniformity, disease resistance, stress tolerance and good horticultural traits including earliness and long shelf-life with consistent stable high yield. Albeit crossing can be done at any moment during day hours but the best time of pollinating is during morning and late afternoon when flowers have attained the balloon or mature bud stage. Further to reap seeds with exceptional seed quality standards and genetic purity it is always essential to pollinate maximum flowers at the best time. Pollinating tomato crop at 11 am resulted in highest 100 seed weight, seed yield per berry, number of seed as well as germination percentage [4]. Seeds of fruits harvested at highest physiological maturity contribute to better germination because of higher seed qualitative and quantitative levels [5] as compared to over or under matured fruits. Therefore standardizing the best time of pollination and right stage of fruit maturity and its effect on the CGMS based chilli hybrid seed yield was the aim of present investigation.

2. MATERIALS AND METHODS

The best quality seeds of A line and R line were procured from the plant breeder to produce seeds of CGMS based chilli hybrid UARChH42 (JCH42). After nursery, seedlings were transplanted onto the main field of Seed Science and Technology, University of Agricultural Sciences, Raichur, Karnataka (India) during kharif 2016 and 2017. Female and male plants were planted separately in ratio of 75:25 respectively. At initiation of flowering which was 50 days after transplanting the stigma of A line (male sterile line) was pollinated by pollens of flowers collected on the spot from R line (male fertile line) at six different times of the day starting from 9 am to 5 pm with different coloured threads. It was continued till the end of crossing period. Physiologically matured red dried chilli fruits developed 60 days after pollination were harvested in three pickings. Fruits developed from crossing female flower in mid-September to mid-October were harvested in month of November as first picking. Fruits developed from crossing female flower in mid-October to mid-November, were harvested in month of December as second picking. Fruits developed from crossing female flower in mid-November to mid-December were harvested in the month of January as third picking. The experimental was laid out in Factorial Randomized Complete Block Design.

For each treatment yield parameters were recorded viz., fruit set (%), dry fruit weight (g), seed weight per fruit (g), number of seeds per fruit, and test weight (g). The per cent fruit set was calculated as per below mentioned formula.

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\text{Fruit set } \% = \frac{\text{Number of fruits harvested}}{\text{Total number of buds pollinated}} \times 100
\]

3. RESULTS AND DISCUSSION

Pollinating chilli flowers at 10-11 am recorded higher fruit set (38.06 and 40.36), fruit weight (1.49 and 1.50), seed weight per fruit (0.449 and 0.452), number of seeds per fruit (76.53 and 76.81), test weight (6.21 and 6.26) in 2-16 and 2-
17 respectively (Table 1). This increase in seed quantitative characters might be due to higher anther dehiscence and availability of pollen due to optimum weather in morning

Table 1. Effect of time of pollination and number of fruit pickings on seed yield in chilli hybrid UARChH42 (JCH42)

| Treatments | Fruits set (%) | Dry fruit weight (g) | Seed weight per fruit (g) | No. of seeds per fruit | Test weight (g) |
|------------|----------------|----------------------|--------------------------|------------------------|----------------|
|            | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| Main effect (Pollination time- T) |
| $T_1$       | 34.42 | 34.93 | 1.34 | 1.31 | 0.370 | 0.383 | 63.47 | 64.54 | 5.22 | 5.30 |
| $T_2$       | 38.06 | 40.36 | 1.49 | 1.50 | 0.449 | 0.452 | 76.53 | 76.81 | 6.21 | 6.26 |
| $T_3$       | 31.64 | 33.40 | 1.28 | 1.32 | 0.339 | 0.343 | 63.32 | 64.96 | 5.34 | 5.33 |
| $T_4$       | 32.23 | 31.56 | 1.43 | 1.45 | 0.402 | 0.423 | 72.80 | 74.61 | 5.67 | 5.92 |
| $T_5$       | 29.87 | 30.72 | 1.32 | 1.32 | 0.351 | 0.357 | 59.42 | 60.84 | 5.18 | 5.23 |
| $T_6$       | 26.89 | 28.46 | 1.26 | 1.22 | 0.340 | 0.339 | 54.81 | 56.43 | 5.00 | 5.28 |
| S. Em±      | 0.77  | 1.02  | 0.011 | 0.015 | 0.009 | 0.007 | 0.91  | 0.82  | 0.071 | 0.051 |
| CD @ 5 %    | 2.21  | 2.94  | 0.031 | 0.043 | 0.025 | 0.020 | 2.62  | 2.36  | 0.203 | 0.147 |
| Main effect (Fruit picking- P) |
| $P_1$       | 32.32 | 32.56 | 1.36 | 1.36 | 0.375 | 0.382 | 64.91 | 66.99 | 5.37 | 5.51 |
| $P_2$       | 34.08 | 35.38 | 1.40 | 1.39 | 0.394 | 0.398 | 69.06 | 68.91 | 5.70 | 5.79 |
| $P_3$       | 30.16 | 31.76 | 1.30 | 1.32 | 0.357 | 0.369 | 61.21 | 63.19 | 5.24 | 5.36 |
| S. Em±      | 0.54  | 0.72  | 0.008 | 0.011 | 0.006 | 0.005 | 0.65  | 0.58  | 0.050 | 0.036 |
| CD @ 5 %    | 1.57  | 2.08  | 0.022 | 0.030 | 0.018 | 0.014 | 1.86  | 1.67  | 0.144 | 0.104 |
| Interaction effect (T×P) |
| $T_1P_1$    | 34.92 | 34.29 | 1.36 | 1.32 | 0.393 | 0.401 | 67.31 | 69.29 | 5.15 | 5.31 |
| $T_1P_2$    | 35.31 | 36.82 | 1.37 | 1.36 | 0.372 | 0.398 | 67.63 | 67.79 | 5.29 | 5.35 |
| $T_1P_3$    | 33.03 | 33.67 | 1.31 | 1.25 | 0.345 | 0.351 | 55.48 | 56.54 | 5.23 | 5.25 |
| $T_2P_1$    | 36.39 | 38.18 | 1.47 | 1.48 | 0.429 | 0.437 | 74.77 | 74.28 | 6.17 | 6.38 |
| $T_2P_2$    | 42.03 | 44.92 | 1.56 | 1.58 | 0.475 | 0.476 | 82.34 | 84.45 | 6.78 | 6.69 |
| $T_2P_3$    | 35.77 | 37.97 | 1.43 | 1.45 | 0.445 | 0.445 | 72.47 | 71.71 | 5.68 | 5.70 |
| $T_3P_1$    | 31.17 | 33.57 | 1.29 | 1.32 | 0.310 | 0.311 | 64.05 | 66.26 | 5.32 | 5.28 |
| $T_3P_2$    | 32.80 | 34.34 | 1.31 | 1.34 | 0.377 | 0.379 | 66.45 | 65.33 | 5.51 | 5.50 |
| $T_3P_3$    | 30.97 | 32.30 | 1.23 | 1.31 | 0.330 | 0.338 | 59.47 | 63.29 | 5.21 | 5.19 |
| $T_4P_1$    | 32.80 | 31.09 | 1.44 | 1.45 | 0.402 | 0.418 | 71.75 | 74.84 | 5.49 | 5.54 |
| $T_4P_2$    | 34.36 | 36.40 | 1.47 | 1.49 | 0.414 | 0.428 | 77.69 | 75.36 | 6.18 | 6.64 |
| $T_4P_3$    | 29.53 | 28.98 | 1.38 | 1.41 | 0.390 | 0.424 | 68.96 | 73.64 | 5.34 | 5.57 |
| $T_5P_1$    | 31.79 | 30.40 | 1.34 | 1.35 | 0.372 | 0.376 | 56.25 | 59.63 | 5.22 | 5.22 |
| $T_5P_2$    | 31.33 | 32.91 | 1.39 | 1.35 | 0.382 | 0.369 | 64.41 | 64.02 | 5.24 | 5.25 |
| $T_5P_3$    | 26.49 | 28.84 | 1.23 | 1.26 | 0.298 | 0.326 | 57.59 | 58.86 | 5.09 | 5.22 |
| $T_6P_1$    | 26.82 | 27.86 | 1.24 | 1.23 | 0.342 | 0.346 | 55.32 | 57.66 | 4.89 | 5.33 |
| $T_6P_2$    | 28.67 | 28.69 | 1.33 | 1.21 | 0.344 | 0.340 | 55.84 | 56.50 | 5.24 | 5.31 |
| $T_6P_3$    | 25.19 | 28.83 | 1.22 | 1.21 | 0.334 | 0.330 | 53.28 | 55.12 | 4.87 | 5.21 |
| Mean        | 32.19 | 33.24 | 1.35 | 1.35 | 0.375 | 0.383 | 65.06 | 66.36 | 5.44 | 5.55 |
| S. Em±      | 1.33  | 1.77  | 0.018 | 0.026 | 0.015 | 0.012 | 1.58  | 1.42  | 0.122 | 0.088 |
| CD @ 5 %    | NS    | NS    | NS    | NS    | 0.043 | 0.035 | 4.55  | 4.09  | 0.352 | 0.254 |

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hours and more stigma receptivity which yielded heavy fruits with more number of heavier and bolder seeds contributing higher seed weight [6], [7]. Whereas lowest values of these parameters were recorded in T_6 (4 to 5 pm) which could be due to low availability of pollen as well as lesser stigma receptivity in the evening time which produced seeds [8], [9]. Also P_2 (2nd picking) of fruits recorded highest fruit set (34.08 and 35.38), dry fruit weight (1.40 and 1.39), fruit weight (1.49 and 1.50), seed weight per fruit (0.449 and 0.452), number of seeds per fruit (76.53 and 76.81), and test weight (6.21 and 6.26) (Table 1). Further the interaction due to time of pollination (10-11 am) and fruit pickings (2nd picking) was also found to be significant for various seed yield parameters. This might be because fruits were completely developed and physiologically matured which favoured maximum accumulation of food reserves, amino acids, phosphorous active substances, dry matter, sugar and other water soluble protein [10], [11]. Whereas lowest seed yield parameters were recorded in P_3 (3rd picking) which may be due to loss in seed weight resulting from more dead or immature seeds. This could be attributed due to non-availability of sufficient nutrients in the seeds as the complete utilization of applied fertilizers as well as plant nutrients by the earlier set fruits.

The interaction showed significant effect on some of the yield parameters among the treatments. Maximum seed weight per fruit (0.475 g in 2016, 0.476 g in 2017), number of seeds per fruit (82.34 in 2016, 84.45 in 2017) and test weight (6.78 in 2016, 6.69 g in 2017) was observed in T_2P_2 (10 to 11 am + 2nd picking). It might be due to the interaction of the optimum pollination time and best climate for fruit development which gave more yield.

4. CONCLUSION

From present experiment it can be concluded that 10 to 11 am pollination time is best for crossing female line as it resulted in better seed set of chilli hybrid UARChH42 (JCH42). Also fruits harvested in second picking can yield maximum seed yield parameters.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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