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RESEARCH ARTICLE

ANALYZE THE SEED QUALITY OF *Capsicum annum (*Clv. GROSSUM) BY MAINTAINING AN OPTIMUM NUMBER OF FRUITS LOAD IN THE PLANT

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ABSTRACT

***Capsicum annum*, commonly known as bell pepper, belongs to the Solanaceae family, specifically the Grossum Group. Various cultivars of this plant yield fruits in diverse colors, such as red, yellow, orange, green, white, and purple. The quality of *Capsicum annum* seeds is closely tied to the quantity of fruits produced. It was observed that as the number of fruits per plant increases, the seed quality tends to decrease. The primary objective of this study was to examine the relationship between seed quality and the number of fruits per plant. Awareness of the optimal fruit yield achievable with high-quality seeds can reduce the cost associated with hybrid seed production. The study utilized fruit development in plants as the treatment, with fruit load categories ranging from 8–9 fruits/ plant to more than 18 fruits/plant. A completely randomized design with ten replicates was employed, and hand pollination of *Capsicum annum* exhibited a success rate of 75–80%. Various parameters, including the dry weight of seeds per pod, seed number per pod, seed volume, dry weight of 1000 seeds, seed germination, and viability percentage, were recorded. While the number of seeds per pod, seed germination, and viability percentage remained unaffected by the fruit load of plants, other selected parameters were influenced. The seed volume was recorded as the number of seeds per gram, with the lowest value considered the best. The treatment with 13–15 fruits/plant demonstrated the highest number of fruits and the best seed quality. Observations indicated the following values for this treatment: dry weight of seed per pod (0.533g), seed number per pod (86 seeds), seed volume (147 seeds), dry weight of 1000 seeds (7.45g), seed germination percentage (85%), and viability percentage (86.33%). For *Capsicum annum* (Cultivar: Grossum), it is recommended to maintain 13–15 fruits per plant in a greenhouse setting to ensure the production of high-quality seeds.**

Keywords: *Capsicum annum,* Fruit Load, Hand pollination, Quality, Seeds

INTRODUCTION

Bell peppers (*Capsicum annuum*) are warm-season crops grown in temperate climates, characterized by a glossy exterior that offers a variety of colors. Global production and consumption of bell peppers have steadily increased since 2000. Asia accounts for more than 70% of the world's bell pepper production, with China being the largest producer, followed by Mexico and Indonesia. Spain, Turkey, and the United States are also significant competitors in the bell pepper market (Biswas, Guan, and Wu, 2018). While bell peppers are self-pollinating plants, natural cross-pollination can lead to variations within species or cultivars (Haque *et al*. 2016). In some species, the pollen load is inversely correlated with fruit weight, size, and seed contents (Roldán Serrano and Guerra-Sanz, 2006).

To ensure each female plant produces the

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ideal quantity of cross-pollinated fruits, hand pollination should be performed on flowers that were emasculated the previous day. The number of seeds per fruit varies due to genetic and environmental factors, with a pollination success rate ranging from 60 to 80% (Berke and Berke, 2008). The flavor of bell peppers can be sweet, mild, or very tart, with a shiny appearance and green color in the pre-maturing stage that can turn red, golden, purple, orange, or brown when it ripens (Almadhoun, 2021).

Plant height, node number, and leaf size significantly increased in cultivation as light intensity was reduced. However, shade inhibited the development of lateral shoots below the first terminal flower on the plant's main stem, altering fruit set, fruit number per plant, fruit location, fruit development, and fruit production (Rylski and Spigelman, 1986). Numerous recent studies highlight the various health benefits of bell peppers, as they are a good source of dietary fiber and vitamin C. These nutrients are essential for collagen development, assisting skin regeneration, blood vessel creation, and the growth and repair of body tissue (Almadhoun, 2021). The aim of this study is to identify how the number of fruit settings in *C. annuum* affects seed quality. Additionally, the study addresses the correlation between the number of fruits per plant and seed quality. Various parameters and factors influencing the seed quality of *C. annuum* were also observed.

MATERIALS AND METHODS

The research was conducted in a greenhouse at Hayleys Quality Seeds Company (Pvt) Ltd., Boralanda, Badulla, Sri Lanka, from June 2022 to September 2022. The annual mean temperature and relative humidity in that area are 23.9°C and 85.71%, respectively.

The hybridization variety of *C. annum* (Clv. Grossum) was utilized for the experiment. Fifty (50) female plants and twenty (20) male plants were planted in plastic pots with a diameter of 19 cm and height of 15 cm, using a potting mixture of compost and coir dust. The pH and Electrical Conductivity (EC) of the media were monitored twice a month, maintaining the pH and EC within the range of 5.5–7.0 and 2.5–2.8 (dS/m), respectively. A completely randomized design with ten replicates was employed, focusing on the relationship between seed quality and fruit load. *C. annum* plants were transferred from the nursery upon completing the nursery stage. Female plants needed for the sample were transplanted in a separate section of the female parental line within the greenhouse, while plants required for pollen were transplanted in a distinct part of the male parental line.

Emasculation in the female parental line commenced a day after transplanting, continuing daily before flowering. Manual pollination occurred a day after emasculation, with pollen collected from the male parental line using a pollen brush and stored in a pollen cup. The success rate of hand pollination was 75-80%.

Daily irrigation and recommended agro-chemical applications were performed to control pests and diseases. Pods were harvested seventy days after pollination, and the harvested pods were taken to the seed processing unit for drying, separation, and cleaning procedures. The wet weight of the harvested pods was recorded separately. During the drying process, pods for each treatment were placed in separate bags and kept in dryers for three days. The dryer room maintained an air temperature ranging from 20°C to 28°C and a relative humidity ranging from 40% to 55%. Physical appearance

Table 1: Effect of numbers of fruit per plant to maintain high quality seeds of *Capsicum annum* Clv. Grossum.

Treatment	Number of fruits
T1	Maintain 8-9 fruits per plants
T2	Maintain 10-12 fruits per plants
T3	Maintain 13-15 fruits per plants
T4	Maintain 16-18 fruits per plants
T5	Maintain >18 fruits per plants

parameters such as fruit shape, color, and size were observed visually. The dry weight of seeds per pod, seed number per pod, dry weight of 1000 seeds, seed volume, seed germination, viability percentage, and number of seeds per gram were recorded as yield parameters.

Statistical analysis of all parameters was performed using SPSS Inc. (2011). IBM SPSS Software for Windows, Version 20.0 and mean comparisons were conducted using the Least Significant Difference (LSD) test.

Figure 1: Emasculation

Figure 2: Pollen collection

Figure 3: Pollination

RESULTS AND DISCUSSION

The study unveiled that, under greenhouse conditions, *C. annum* seed quality is intricately linked to the number of fruits per plant. Fruits per plant, fruit size, fruit form, and fruit color constituted the primary criteria employed in the study. Plants bearing eight or nine fruits exhibited significantly larger fruit size compared to all other treatments (10–12 fruits/plant, 13–15 fruits/plant, 16–18 fruits/plant, and more than 18 fruits/plant). The main reason for this difference lies in the competition for plant nutrients and available space as fruit production increases. Similar findings were reported by Xu *et al*., 2007, attributing lower total fruit yield in sweet pepper to low nutrient element concentration. No significant differences were observed in fruit color or shape among all treatments, including 8–9 fruits/plant, 10–12 fruits/plant, 13–15 fruits/plant, 16–18 fruits/plant, and more than 18 fruits/plant.

Seed Quality Parameters

Dry weight of 1000 seeds (DW1000), number of seeds per pod (SN), seed volume (SV), germination percentage (GR), and viability percentage (GP) are pivotal measures in evaluating seed quality. The average values of dry weight of seeds per pod (DW), dry weight of 1000 seeds (DW1000), and seed volume (SV) were considered as parameters for seed quality assessment (Table 2). Plants containing eight to nine fruits exhibited the maximum dry weight of seeds per pod (0.667 g) and significantly higher average 1000 seeds weight (7.65 g), whereas plants with more than eighteen fruits had the lowest DW (0.463 g) and DW1000 (7.00 g).

Seed Volume (SV) was considered for selection based on the seed quality of *C. annuum* (Table 2). According to data analysis, the number of seeds per gram (g) was used as the seed volume. Consequently, the highest seed volume (154 seeds) was recorded in plants with more than 18 fruits, while plants with 8–9 and 10–12 fruits/plant had the lowest (141 seeds). Seeds number per pod (SN), germination percentage, and viability percentage parameters did not show

Table 2: Effects of treatments on yield characters of *C. annuum*

Treatment	DW	SN	DW1000	SV	GP	VP
T1	0.667^{a}	94^{a}	7.65^{a}	141^{bcd}	84.6^{a}	86^{a}
T2	0.631^{a}	95^{a}	7.45^{ac}	141^{bcd}	85.3^{a}	85.33^{a}
T3	0.533^{ac}	86^{a}	7.45^{ad}	147^{ad}	85.3^{a}	86.33^{a}
T4	0.586^{ab}	82^{a}	7.05^{bcd}	150^{ac}	83.3^{a}	84.33^{a}
T5	0.463^{bc}	83^{a}	7^{bcd}	154^{a}	83.6^{a}	82.33^{a}

Note: Means denoted by different letters indicate significant differences between treatments ($p<.0.05$) DW- Dry weight of seeds per pod (g), SN-Seed number per pod, DW1000- Dry weight of 1000 seeds (g), SV-Seed Volume (g), GP-Germination parentage (%), VP-viability percentage (%)

significant differences among plants with 8–9 fruits/plant, 10–12 fruits/plant, 13–15 fruits/ plant, 16–18 fruits/plant, and more than 18 fruits/plant (Table 2). The significantly highest seed number (95 seeds) was recorded in plants containing 10–12 fruits, and the lowest seed number (82 seeds) was recorded in plants with 16–18 fruits.

Fertilization and seed setting are significantly influenced by nighttime temperatures. If the temperature drops below 15°C at night, sweet peppers may have fewer seeds. Rylski *et al*., 1986, observed that low nighttime temperatures limit fertilization and encourage parthenocarpic fruit set in capsicum.

No significant fluctuations were observed in seed germination percentage (GP) (Table 2). Plants with 10–12 fruits and those with 13–15 fruits exhibited the highest seed germination rate (85.3%), while plants with 16–18 fruits and more than 18 fruits had the lowest germination percentage (83.3%). Fruit ripeness, indicated by a change in color from green to red or yellow, is crucial for maximizing germination rates. Berke *et al*., 2008, reported a potential drop in germination rates if fruits are left on the plants for an extended period in sweet pepper. Plants with 10–12 fruits showed the highest viability percentage (86.3%), while those with more than 18 fruits exhibited the lowest (82.3%).

CONCLUSION

In greenhouse conditions, plants bearing 13–15 fruits demonstrated the highest fruit number and seed quality. It was observed that, when selecting plants with optimal seed quality, the critical factors were identified in relation to the weight of 1000 seeds and seed volume. In conclusion, 13–15 fruit-bearing plants were chosen based on the aforementioned criteria.

AUTHOR CONTRIBUTION

NA, ASB and Up designed and supervised the study, WMDD perform the experiments, analyzed the data, and wrote the manuscript. All authors discussed the results and commented on manuscript.

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