Optimization of hybrid corn seed production in pollination systems at various parent seed planting ratios

Supratman Sirih, Wenny Tilaar, Sisilia Wanget, Jantje Pongo, Steivie Karouw and Muhammad Azrai

Program Studi Magister Agronomi Pasca Sarjana Universitas Sam Ratulangi, Kampus Unsrat Manado 95115

Email: s2.agronomi@unsrat.ac.id

Abstract. The research was carried out on land belonging to the North Sulawesi Agricultural Technology Research Center located at the Agricultural Technology Research and Assessment Installation (IP2TP) Address Talawaan Bantik Village, Wori District, North Minahasa Regency in February 2021. This study aims to analyze the different effects of spray pollination treatment on the ratio female and male parents to increase hybrid corn seed production and to obtain the best pollination vs ratio between male and female parents in increasing hybrid seed productivity. This study uses a 2 x 4 Factorial Experimental Design where factor S consists of 2 levels and factor R consists of 4 levels in the RAK pattern, namely: Factor S = Pollination with 2 levels (S1 = Spray Pollination, S2 = Natural Pollination) and Factor R = Male to Female Planting Ratio (R1 = 4 female plants vs. 1 male plant, R2 = 5 female plants vs. 1 male plant, R3 = 6 female plants vs. 1 male plant, R4 = full female plants: solation of male plants) for each treatment repeated 3 times. Based on the analysis of interaction variance, spray pollination treatment at a planting ratio of 6 : 1 was able to increase the yield of hybrid corn seed production. The results of the 5% BNT further test showed the values obtained from observations of the number of rows filled with seeds, the number of seeds in a row, the weight of 10 cobs without husks and the weight of shelled 10 cobs in a row, namely, 12.1, 23.6, 1166.7, 867.3.

1. Introduction

Corn is a food crop commodity that still dominates among Indonesian farmers in general after rice. The tendency of farmers to choose hybrid corn cultivation is based on the results of the analysis of farming conducted by the farmers themselves. The average income/profit (net income) for one growing season is Rp. 5 million-7 million/ha (according to a corn farmer in Sidodadi Village, Sangkub District, and North Bolaang Mongondow Regency). In 2015, corn production was 19.61 million tons with a harvested area of 3.79 million ha and productivity of 5.18 tons/ha. In 2017, the target of corn planting area is 4.93 million ha, which is an increase of 1.14 million ha (30.08%) compared to 2015. In 2045 it is estimated that the demand for corn will reach 45.628 million tons. To meet this target, a corn planting area of 4.97 million ha is needed, which is an increase of 5.68 million ha (150%) compared to 2015. In 2045 Indonesia targets to be able to fill 25% of the ASEAN corn market share, so that the productivity target that must be achieved is at least 7.01 tons/ha with a production target of 63.16 million tons. From 2005 to 2015, the average corn harvested area increased by 0.49% each year, production increased by 5.02% and increased by 4.38% (Ministry of Agriculture, 2016).
Increasing corn production can be done through the application of technological innovations using quality hybrid seeds, balanced fertilizer application, HPT control, as well as good harvest and post-harvest handling. Hybrid varieties are superior varieties resulting from plant breeding which are proven to be able to produce 15% better than free pollinated varieties [1]. Among farmers, the use of hybrid seeds is very familiar. This is because in recent years the Government has provided hybrid seed assistance to farmer groups engaged in corn commodity. The result of the program is an increase in production. Thus, it can be said that the use of quality hybrid seeds can increase the productivity of maize commodities. According to [2] improving the quality of hybrid corn seeds is part of one of the strategies to increase national corn productivity. Corn production in Indonesia in 2013, 2014 and 2015 was 18.51 million tons, 19.01 million tons and 19.61 million tons with a productivity of 4.84 tons per hectare, 4.95 tons per hectare and 5.18 tons. Tons per hectare, and harvested area of 3.82 million ha, 3.84 million ha and 3.79 million ha (BPS, 2016). The data from the Central Statistics Agency shows that every year efforts are always carried out to increase production and productivity to achieve production targets in the following year. One of the efforts that can be done in increasing the productivity of corn is by using quality seeds. According to [3], efforts to improve seed quality make an important part in increasing the competitiveness of hybrid corn seed products.

The dependence on hybrid seeds at the farmer level is getting higher, the existence of hybrid seeds is becoming rare, even if they are very expensive. Farmers are currently complaining about the difficulty of obtaining hybrid seeds in the market amidst the increasing interest in growing hybrid corn. The provision of hybrid corn seeds produced by the nation's children is still limited to date, domestic corn seed resources and institutions are not yet capable and competitive agricultural producers (Baihaki, 2004). The productivity of hybrid corn seeds is currently around 1-2 tons/ha on average. The low production of hybrid corn seeds is one of the obstacles to meeting seed needs at the farmer level so that technological innovations are needed to increase production, including modification of the parent seed ratio, pollination and the application of technology components for hybrid corn production. The parent seed planting ratio is carried out as an effort to increase the population of female parent plants. The higher the ratio of female plants, the less population of male parent plants. This is of course a factor not optimal pollination. Pollination of the spray system is needed to anticipate the imperfect pollination of the natural system due to various unfavorable environmental factors. F1 hybrid seed production activities involve male parent plants as a source of pollen and female parent plants as seed producers. The technique commonly used is to plant rows of male plants between several rows of female plants. The population comparison value is commonly referred to as the row ratio. The application of the planting row ratio is adjusted to the character of the parent pair of hybrid varieties. [4] Stated that the ratio of female: male rows used depended on the ability of the male parent to produce pollen.

2. Material and Method

The research was carried out on land belonging to the North Sulawesi Agricultural Technology Study Center located at the Pandu Agricultural Technology Research and Assessment Installation (IP2TP) at Talawaan Bantik Village, Wori District, North Minahasa Regency in February 2021. Located at an altitude of ± 80 m above sea level, climate type C Oldeman and the state of the flat topography. One side of the garden boundary is the river, where the river is a potential water source with a length of about 3650 m, a width of about 8 m, a depth of 0.5 – 1 m. It is possible to carry out research because of the availability of water. Rainfall data in February 2021 is 217 mm, air temperature is 26.7 OC, humidity is 84%. The research scheme uses a 2 x 4 Factorial Experimental Design where factor A consists of 2 levels and factor B consists of 4 levels in the RAK pattern, namely: Factor A = Pollination with 2 levels (A1 = Spray Pollination, A2 = Natural Pollination) and Factor B = Male to Female Planting Ratio (B1 = 4 female plants vs. 1 male plant, B2 = 5 female plants vs. 1 male plant, B3 = 6 female plants vs. 1 male plant, B4 = full female plant: isolation of male plants) for each treatment repeated 3 times. The variables observed were data on production components including: length of the ear (cm), diameter of the ear (cm), number of rows filled with seeds (grains), number of
seeds in rows, weight of 1000 dry seeds harvested (g), moisture content (%) , the weight of 10 cobs (g) and the shelled weight of 10 cobs (g). Formation of planting plots from each treatment with a planting ratio of 5 m in length x width (following the 75 cm row spacing at the parent seed ratio). For a planting ratio of 4 vs 1, the plot area is 5 m long x 3 m wide, the cropping ratio is 5 vs 1, the plot is 5 m long x 375 cm wide, the plot is 6 vs 1 planting ratio, 5 m x 450 cm long. border width of each plot is 2 m. The spacing used is 75 cm x 20 cm. The main ingredients in this activity are corn seeds. Parent seed / male elder (CLYN) and female elder (MAL 03) description is attached (appendix 1). The seeds came from the Maros Cereals Research Institute, NPK fertilizer, urea fertilizer, pesticides, bamboo stakes, gembor, sprayer, planting tools, ropes, buckets, hoe, roll meter, ruler, Sigma, scales, crackle bags, sacks, etc. The application of spray pollination treatment was carried out in the morning at 9.00 WITA. Meanwhile, the pollen capture was carried out one hour earlier, at 8.00 WITA. Pollen catching was done by placing the male flowers from the male plant into a crackle bag and then shaking it carefully to prevent damage to the tassel and the male plant. As much as 1 tablespoon of pollen is dissolved in 5 liters of water and then stirred slowly and evenly until it looks cloudy. The pollen solution is then put into a trika sprayer container and sprayed on the female flower hair 3 times for each corncob.

3. Result and Discussion

3.1 General condition

The research data collection of components of corn seed production was carried out after harvest. Harvesting is an important step to obtain quality seeds and must be done when the corn plant is really physiologically mature. Physiologically ripe condition when corn was harvested was 105 days old. The physiological ripening phase is marked by a black layer at the base of the corn kernels. Harvesting is carried out after the seeds on the cobs reach the harvest criteria with signs of blackish brown hair (silk) and has dried, yellow hulls, dry seeds and if pressed with a fingernail does not leave a mark. In this condition the water content based on measurements in the field is 28%. The results of observations on the variables of cob diameter, length of the cob, number of rows filled with seeds per cob, number of seeds per row, moisture content (%), weight of 1000 seeds (g), weight of 10 cobs without husks and weight of shelled 10 cobs (g), are presented. in Annexes 2a to 9a. The summary of the results of statistical analysis for the eight observations can be seen in Table 1.

| Source of variation   | Observation                          |
|-----------------------|-------------------------------------|
|                       | Cob diameter (cm)                   |
|                       | Cob length (cm)                     |
|                       | number of rows filled with seeds per cob |
|                       | number of seeds per row             |
|                       | Water content (%)                   |
|                       | Weight 1000 seeds (g)               |
|                       | The weight of 10 cobs without Kelobot (g) |
|                       | Peeled weight 10 cobs (g)           |
| Pollination system    | x) | tn) | xx) | xx) | tn) | tn) | xx) | xx) |
| Blocks in the         | tn) | tn) | xx) | xx) | tn) | tn) | xx) | tn) |
| pollination system    |                     |                     |                     |                     |                     |                     |                     |
| Ratio                 | tn) | tn) | xx) | xx) | tn) | xx) | xx) | xx) |
| System Interaction x  | tn) | tn) | xx) | xx) | tn) | xx) | xx) | xx) |

Note : tn ) = not real ; x) = real at 5% ; xx) = very real at 1%
From the table above (Table 1), it can be seen that the interaction of pollination vs. parent seed planting ratio on the observation of the number of rows of cobs, number of seeds per row, weight of 10 cobs and shelled weight of 10 cobs showed a very significant effect, which means that there was a different effect on each ear. Treatment combination. To find out which treatment combinations are different, see (Table 2).

**Table 2.** Summary of the results of the BNT 5% treatment combination in each observation variable

| Combination | Cob diameter (cm) | Cob length (cm) | number of rows filled with seeds per cob | number of seeds per row | Water content (%) | Weight 1000 seeds (g) | The weight of 10 cobs without Kelobot (g) | Peeled weight 10 cobs (g) |
|-------------|------------------|----------------|------------------------------------------|------------------------|-------------------|-----------------------|------------------------------------------|------------------------|
| S1 R1       | 3.52 a           | 12.8 a         | 11.4 bcd                                 | 18.1 bc                | 24.5 a            | 376.7 b               | 968.3 c                                 | 759.7 c                |
| S1 R2       | 3.60 a           | 13.2 a         | 11.7 cd                                  | 18.7 c                 | 24.3 a            | 386.7 b               | 1008.7 cd                               | 771.3 c                |
| S1 R3       | 3.60 a           | 13.6 a         | 12.1 d                                   | 23.6 d                 | 24.2 a            | 393.3 b               | 1166.7 d                               | 867.3 c                |
| S1 R4       | 3.64 a           | 13.3 a         | 10.0 b                                   | 19.2 c                 | 24.0 a            | 350.0 a               | 1000.0 d                               | 791.0 c                |
| S2 R1       | 3.44 a           | 14.1 a         | 10.2 b                                   | 15.9 bc                | 24.5 a            | 380.0 b               | 926.0 bc                               | 689.0 c                |
| S2 R2       | 3.30 a           | 13.6 a         | 11.1 bcd                                 | 15.1 b                 | 23.8 a            | 376.7 b               | 878.7 bc                               | 657.3 bc               |
| S2 R3       | 3.28 a           | 12.6 a         | 11.4 bcd                                 | 16.8 bc                | 24.0 a            | 353.3 a               | 713.3 b                                | 518.0 b                |
| S2 R4       | 3.23 a           | 13.4 a         | 2.0 a                                    | 1.0 a                  | 25.0 a            | 350.0 a               | 244.3 a                                | 7.1 a                  |
| BNT 5%      | 0.47             | 1.9            | 1.4                                      | 3.4                    | 1.4              | 21.3                   | 249.4                                   | 228.8                  |

Note: Numbers followed by the same letter in the same column show no difference

Observing Table 2, it turns out that for spray pollination the observations of the diameter of the ear, length of the ear, weight of 1000 grains and moisture content showed no significant difference. While the observation of the number of rows per ear, the number of seeds per row, the weight of 10 ears and the weight of the shells of 10 ears showed a significant difference. The acquisition data is in (Table 3).

**Table 3.** Results of further test of BNT at 5% level for the treatment of pollination system

| Pollination system | Cob diameter (cm) | Cob length (cm) | number of rows filled with seeds per cob | number of seeds per row | Water content (%) | Weight 1000 seeds (g) | The weight of 10 cobs without Kelobot (g) | Peeled weight 10 cobs (g) |
|-------------------|------------------|----------------|------------------------------------------|------------------------|-------------------|-----------------------|------------------------------------------|------------------------|
| Spray             | 3.59 a           | 13.23 a        | 11.3 b                                   | 19.9 b                 | 24.3 a            | 368.3 a               | 1035.9 b                                | 797.3 b                |
| Natural           | 3.31 a           | 13.42 a        | 8.7 a                                    | 12.4 a                 | 24.3 a            | 365.0 a               | 469.8 a                                 | 469.8 a                |
| BNT 5%            | 0.23             | 0.94           | 0.7                                      | 1.7                    | 0.7               | 10.7                  | 114.4                                   | 114.4                  |

Note: Numbers followed by the same letter in the same column show no difference

Observing the number of rows per ear, the number of seeds per row, the weight of 10 ears and the weight of the shells of 10 ears showed that there was a difference in the data obtained due to the ratio of female: male (Table 4).
Table 4. The results of further tests on the effect of female vs male cropping ratio observation variables of the number of rows per ear, number of seeds per row, weight of 10 ears and weight of shelled 10 ears

| Ratio | Cob diameter (cm) | Cob length (cm) | number of rows filled with seeds per cob | number of seeds per row | Water content (%) | Weight 1000 seeds (g) | The weight of 10 cobs without Kelobot (g) | Peeled weight 10 cobs (g) |
|-------|-------------------|-----------------|-----------------------------------------|-------------------------|------------------|----------------------|------------------------------------------|--------------------------|
| 4:1   | 3.48 a            | 13.45 a         | 10.8 b                                  | 17.0 b                  | 24.5 a           | 378.3 a              | 947.2 b                                  | 724.3 b                  |
| 5:1   | 3.44 a            | 13.35 a         | 11.4 b                                  | 16.9 b                  | 24.1 a           | 381.7 b              | 943.7 b                                  | 714.3 b                  |
| 6:1   | 3.44 a            | 13.14 a         | 11.8 b                                  | 20.2 c                  | 24.1 a           | 357.7 a              | 940.0 b                                  | 692.7 b                  |
| 1:0   | 3.44 a            | 13.38 a         | 6.0 a                                   | 10.6 a                  | 24.5 a           | 350 a                | 622.2 a                                  | 399.0 a                  |
| BNT 5 % | 0.33             | 1.32            | 1.0                                     | 2.4                     | 1.0              | 15.1                 | 176.4                                    | 161.8                    |

Note: Numbers followed by the same letter in the same column show no difference

The interaction of pollination vs cropping ratio based on the results of statistical analysis (figure 2) showed a very significant effect on the observation variables of the number of rows filled with seeds per ear, the number of seeds in rows per ear, the weight of 10 ears without husks and the weight of shelled 10 ears. To parse the results of the analysis, it was continued with a further 5% BNT test on each treatment combination. It turned out that the results of further analysis showed that spray pollination was dominant compared to natural pollination (table 3). The results of the 5% BNT further test showed that the mean value of spray pollination treatment was higher on average (11.3) the number of rows filled with seeds per corncob compared to natural pollination, which was an average (8.7) rows filled with seeds per corncob. The results of the observation that the number of seeds in the corncob row when given spray pollination treatment was on average higher (19.9) grains than natural pollination of 12.4 grains. On the observation of the weight of 10 corn cobs without husks, spray pollination showed higher yields (1035.9) grams while natural pollination was lower (469.8) grams. The results of further test analysis on shelled weight of 10 corn cobs for spray pollination treatment obtained an average yield of 797.3 grams compared to natural pollination of 469.8 grams. The average results of the BNT follow-up test at 5% level of parent seed planting ratio treatment gave a different effect on the observation of the number of rows filled with seeds per ear, number of seeds in rows per ear, weight of 1000 grains, weight of 10 cobs without husks and weight of shelled 10 cobs (table 4, figure 4). The treatment of the 4:1, 5:1, 6:1 cropping pattern was different from the ratio of 1:0 while the planting ratio of 4:1, 5:1 and the ratio of 6:1 was not different from the observation of the number of rows filled with seeds per cob. The results of the further test analysis of 5% BNT observations of the number of seeds in the corncob row showed that there were differences in the yield of each planting ratio, namely the ratio of 6:1 was different from the ratio of 4:1, 5:1, and 1:0. Likewise, the ratio of 1:0 was different. With a ratio of 6:1, 5:1, 4:1. While the ratio of 4:1, 5:1 is no different. Further analysis of the 5% BNT test, observing the weight of 1000 grains, showed that there was a difference between the ratios of 4:1, 5:1, and ratios of 6:1, 1:0. Further analysis of BNT 5% observations on the weight of 10 cobs and shelled weight of 10 cobs showed that the ratio 1:0 was different from the ratio of 4:1, 5:1 and 6:1. While the ratio of 4:1, 5:1 and the ratio of 6:1 no difference (table 4, figure 4).

Discussion of the results of the observational data analysis focused on the results of the 5% BNT follow-up test which showed different effects due to pollination treatment or cropping ratio. The discussion includes: the number of rows filled with seeds per cob, the number of seeds in a row of cobs, the weight of 1000 grains, the weight of 10 cobs without husks and the weight of shelled 10 cobs.
1. Number of rows filled with seeds per cob

Based on the results of the 5% BNT further test, the observation of the number of rows filled with seeds per cob (table 3, figure 3) showed that there was a different effect of spray pollination and natural pollination. Spray pollination treatment obtained an average value of 11.3 rows filled with seeds per corncob, which was higher than the natural pollination average of 8.7 rows filled with seeds per corncob. This difference in results indicates that the pollination process that occurs by the presence of a spray system is more optimal than natural pollination. The formation of seeds in each row of corn cobs indicates the ongoing process of pollination and fertilization. The number of rows filled with seeds per corn cob in the spray pollination treatment was physiologically full and stable compared to natural pollination where rows of seeds were not completely filled. The stability of seed filling in the corncob row was due to the pollen received by female flower hairs through spray pollination which was viable pollen from the catch on male flowers of male plants that were anthesis.

**Figure 1.** Male flower anthesis

Anthesis is a condition in which male flowers are in bloom and contain viable juices. Pollen spraying was carried out when the female elders were 52 DAP. Physiologically, most of the female flowers had entered the anthesis period, marked by the appearance of uniform color and length of silk on female flowers. The visible silk color is a cream color with a silk length of 8-10 cm. According to the opinion expressed by [5] that the success of pollination is influenced by, among others, the level of pollen viability. Based on [6] that fertilization will run smoothly if the pollen and egg nucleus are healthy and fertile. Pollen must have a high growth rate while the stigma must be a good medium for germination and further pollen growth. The difference in the yield of the number of rows filled with seeds in the natural pollination treatment is due to the pollination that occurs depending on environmental factors such as wind, weather and insects. In the pollination process, the pollen received or captured by female flower hairs through natural pollination is less than optimal to pollinate and fertilize female plant flowers. This is because there is a mismatch between the anthesis of male and female flowers.

The results of the BNT follow-up test of 5% observation of the number of rows filled with seeds showed that the planting ratio of 6 : 1 obtained the highest value of 11.8 the number of rows filled per ear but it was not significantly different from the planting ratio of 5 : 1 (11.4), the ratio of planting 4 : 4 : 1 (10.8) but significantly different with a ratio of 1 : 0 (6.0) in the number of rows filled with seeds per cob. There is a difference in yield at a planting ratio of 1 : 0 because the pollination process does not take place optimally, this is due to the unavailability of pollen-producing male plants to pollinate female flowers. Meanwhile, the three cropping ratios indicate that the availability of pollen...
is still sufficient for pollination. The cause of the value of the number of rows filled with seeds at a planting ratio of 6:1 was higher because the pollen distribution was evenly distributed by female flowers. It can be seen that the male population of pollen-producing plants at a ratio of 6:1 grew more than those of a planting ratio of 4:1, and 5:1. In addition, at a ratio of 6:1 the conditions between silk and shedding were more suitable. Based on [7] stated that the difference in flowering age between male and female parents affects seed yield. The population of male plants as pollen producers is still possible to pollinate the stigma, pollen viability and receptivity of female flowers and environmental conditions are important factors in the pollination process. Physiologically visible at the time of direct observation in the field of female plant stamens for a planting ratio of 6:1 showed uniformity of receptivity levels. Based on the morphological characteristics of these two types of parent seeds (attachment 1a description of the two parent seeds) it appears that the male parent (Mal 03) is shorter than the female parent of CLYN. Female plants rely on the effectiveness of pollination from male plants in addition to the number of populations affecting production yields [8]

2. Weight of 10 cobs
The results of the 5% BNT further test, the observation of the number of seeds in the cob row showed that there was a different effect due to the pollination treatment. Spray pollination treatment obtained a higher average value of 19.9 the number of seeds in a row per cob compared to natural pollination with an average of 12.4 the number of seeds in a row of cobs. This difference in results indicated that spray pollination had a different effect on seed filling in corn cob rows. The number of seeds formed in the spray pollination treatment is thought to be directly proportional to the number of hairs that receive pollen or are pollinated. At the time of spray pollination treatment, it was seen that physiologically the length of the female flower silk reached 10 cm with a shiny beige color like oily. Different things happened in natural pollination, it was seen that physiologically the silk condition was not uniform when the pollen dispersion process took place. Another thing is that when pollination occurs, environmental conditions are often erratic, the availability of viable pollen produced by male plants, and the time of agreement between pollen blooms and the receptivity of the stigma or hair of female flowers from female plants. It is suspected that the silk uniformity that appears is due to the vegetative conditions of the plants and the weather conditions in the field which are often erratic, sometimes rainfall occurs in the morning, sometimes in the afternoon or evening. When carrying out the detasseling activity (removal of male flowers on female plants) plants aged 46 DAP, the male flowers on the male plants have partially bloomed while the female flower hairs on the female plants are just starting to come out in length ranging from 1 - 2 cm, this indicates the unpreparedness of the fertilized stigma and pollen is wasted.

Figure 2. Female flowers
The research of [7] showed that the difference in flowering age between male and female parents affected the yield of corn seeds. From [8] reported that tassel anthesis in inbred strains occurred 2.7 - 4 days. Likewise, the condition of frequent and erratic rainfall is another barrier factor for natural pollination. According to [9], pollination in corn plants is completed within 24-42 hours, so that rain that falls within 42 hours after pollination has the potential to cause pollination failure. In addition, high RH (83-91%) during pollination causes pollen viability to decrease which according to Luna et al. (2001) the viability of corn pollen at RH >53% only lasted for 1-2 hours. Fresh pollen.

Based on the results of further analysis of 5% BNT, observations on the number of seeds in the cob row showed that the highest value was obtained from a planting ratio of 6:1 (20.2), while the lowest was at a ratio of 1:0 (10.6), a planting ratio of 5:1 gets the value (16.9), the cropping ratio is 4:1 (17.0). The results of the analysis showed that the ratio of 5:1 and 4:1 there was no difference. The difference is seen in a ratio of 1:0 and a ratio of 6:1. The difference is due to the ratio of 1:0 there is no male plant as a pollen producer so that the pollination process does not occur. While at a ratio of 6:1, the filling of seeds was more stable and evenly filled the rows of seeds on the corncobs. Physiologically, from the observation, it can be seen that corn kernels at a ratio of 6:1 are smaller and flatter than seeds at other ratios. According to [10], the difference in the number of rows of seeds per cob and the number of seeds per row affects the size of the seeds produced. The pollination process occurs when pollen is released from the anther which lasts 3 - 6 days, depending on the variety, temperature and humidity. Cob hair remains receptive in 3 - 8 days. Pollen is still alive within 4-16 hours after being released. Pollination is complete in 24-36 hours and seeds begin to form after 10-15 days. After pollination, cob hair color turns brown and then dries.

3. Peeled weight 10 cobs
The result of further analysis of 5% BNT in table 3 shows that spray pollination resulted in the highest value of 1035.9 g compared to natural pollination of 469.8 g. This difference indicates that spray pollination has a significantly different effect on the process of pollination, fertilization and seed formation. From the results of spray pollination treatment, it was seen that physiologically on the cob filling the seeds more evenly filled the rows of corn cobs. The success of seed filling indicates that the pollen received by the stigma is viable pollen so that under receptive pistil conditions it can be fertilized and form seeds. The hairs begin to appear on the cob stalks and the cob closes to full growth, all hairs will continue to elongate until they are fertilized. The next stage of cob, cob and cob is complete and starch begins to accumulate into the endosperm (filling the seed). Seed production of a plant is strongly influenced by external factors, namely the process of photosynthesis, where the photosynthesis process is strongly influenced by light. If a little light is received, it will result in a decrease in the rate of photosynthesis so that crop yields decrease. [11] Suggested that the delay in plant hair removal reduces seed weight by slowing down the seed filling process.
Based on the results of further analysis of 5% BNT in the cropping ratio shown in Table 4, there are differences in results where the ratio of 4:1, 5:1, 6:1 is different from the ratio of 1:0. While the three ratios are not different in the observation of the weight of 10 cobs and a shell weight of 10 cobs. The existence of this difference is because at a ratio of 1:0 there is no perfect pollination process due to a planting ratio of 1:0 there is no male plant. According to [12], in the ratio of plants with a smaller distance between rows of male plants, the process of pollination or pollen falling onto female hairs is more appropriate, because in the process of pollinating corn plants the factor that plays a role is wind.

4. Peeled weight of 10 cobs
Based on the results of the 5% BNT further test, the highest shell weight of 10 cobs was 797.3 g from the spray pollination treatment while for natural pollination the results were 469.8 g. This difference indicates that the weight level of the spray pollination treatment is higher than that of natural pollination. This can be seen from the filling of seeds in each row of corn cobs which shows that the transfer of pollen to the stigma corresponds to each other.

The results of further analysis of 5% BNT in the cropping ratio shown in Table 4, there are differences in results where the ratio of 4:1, 5:1, 6:1 is different from the ratio of 1:0. While the three ratios are not different in the observation of the weight of 10 cobs and shell weight 10 cobs. The existence of this difference is because at a ratio of 1:0 there is no perfect pollination process due to a planting ratio of 1:0 there is no male plant. According to [12], in the ratio of plants with a smaller distance between rows of male plants, the process of pollination or pollen falling onto female hairs is more appropriate, because in the process of pollinating corn plants the factor that plays a role is wind.
4. Conclusion
Results based on statistical analysis, it can be said that spray pollination treatment at a planting ratio of 6:1 was able to increase the yield of corn seed production. Spray pollination interaction with a ratio of 6 vs 1 is the treatment model that produces the best yield component. The results of the 5% BNT follow-up test analysis showed that the mean obtained from observations of the number of rows filled with seeds, the number of seeds in rows, the weight of 10 ears and the weight of shells of 10 ears, were 12.1, 23.6, 1166.7, respectively. 867, 3.

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