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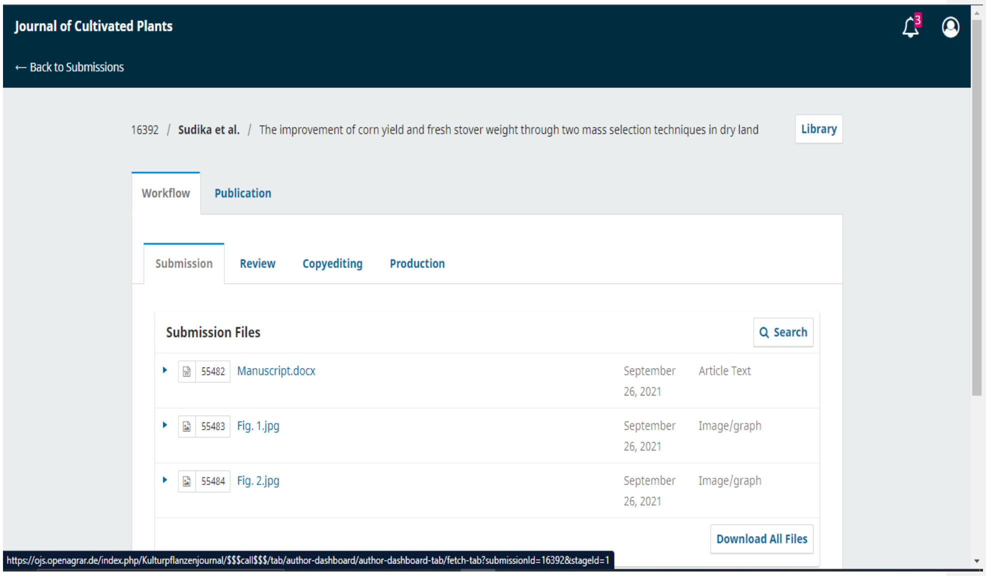

2. Artikel yang disubmission:

Draft Artikel Ilmiah

THE IMPROVEMENT OF YIELD AND CORN FRESH STOVER THROUGH TWO MASS SELESTION TECHNIQUES IN DRY LAND

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ABSTRACT

This study aims to determine the response of mass selection by controlling pollination and by selecting the basic index of yield and fresh stover weight in corn plants and to determine the magnitude of increase in yield and fresh stover results from the seven mass selection cycles. The method used to reduce environmental effects during selection is a subdevided block, which is a selection plot divided into small plots. Each plot contains 40 plants and the number of selected plants is 5 percent in each plot. A Randomized Completelly Block Design was used to test the results of the selection. The research data were analyzed by Analysis of Variance and differences between populations, tested with the Least Significant Differences at 5 percent significance level. The percentage increase in yield / fresh stover is obtained from the difference in the seventh cycle population of each technique reduced by the initial population divided by the initial population. The average selection response per cycle of each technique, obtained from the linear regression coefficient of polynomials between properties observed with the selection cycle. The results showed that the response of mass selection with pollination control was smaller compared to the selection of the basic index for yield and fresh stover weight and linear regression both were real. Increased yield and fresh stover of mass selection by pollination control is lower than the basic index technique after seven cycles. Increased yield by 43.46 percent and 59.81 percent fresh stover weight obtained after seven cycles of mass selection by pollination control; while the use of the base index causes an increase in yield of 79.21 percent and fresh stover of 103.47 percent compared to the initial population. Mass selection activities with the next two cycle techniques can still be continued so that there is a greater increase than the initial population for fresh yield and stover.

Keywords: Progress of selection, mass selection, selection by pollination control, index selection basic, fresh yield and stover.

INTRODUCTION

Mass selection is based on the selection of individual phenotypes of plants and seeds of selected plants dibulk to form the next cycle population. Mass selection will continue to be used even though this method is the oldest. The effectiveness of mass selection is very dependent on the properties selected, isolation, accuracy to reduce environmental effects and the number of selected plants. Mass selection will be effective for charcters with high heritability (Hallauer, A.R. *et al*., 2010). Jiban, *et al.* (2018) states that mass selection is effective to improve the agronomic characteristics of maize. This is evident from the five selection cycles it does lead to higher yields, reduced plant height, the location of the cob, the age of panicle exit and the age of outgoing cob hair compared to the initial population. Research conducted by Govind and Mani (2016). that there has been a significant progress in mass selection for the number of cobs per crop, diameter of cobs, number of rows per cob, weight of seeds per cob and yield. The highest expectation of genetic heritability and progress was obtained in seed weight per ear, followed by yield and number of ear per crop. An increase in yield of 23.2 percent was obtained by Wtanyoo, et al. (2019) after two simple iterative selection cycles.

Mass selection can be improved the selection progress if the selection is done before pollination and pollination among selected plants. Such selection is called mass selection by controlling pollination. Sutresna (2010), gained selection progress by controlling pollination on yield (weight of dried pipil seeds per plot) of 2.07 kg (44.04%) for three cycles; higher than without pollination control, which is 1.67 kg (33.99%). The average progress of selection with control is 14.04% and for selection without control is 11.33% per cycle.

Mass selection can be done to improve two or more characters simultaneously; one of them using the basic selection index. Kar and Warsi (2006). said that each environment has certain criteria to determine the index in an effort to improve the nature of young cobs. According to Smith, et al. (1981), the use of primary and base indices for the selection of single and combined charcters (yield, seed moisture content at harvest, the presence of roots and the presence of stems) is more efficient than the Smith-Hazel index. The use of a basic index can be done by compiling a selection index using economic weights, but it is rather difficult to assign economic weights to each trait (Ajala, 2010). According to Walsh (2010), that the value of heritability and genotypic correlation can be ignored in compiling a baseline index. The results of Asghar and Mehdi's (2010) research, that selection using the base index is more efficient for charcters related to quality and the combined nature of results and quality. Tardin et al. (2007), gained the Smith-Hazel index selection progress with full-sib selection of 4.68% for the dry weight of pipil seeds; while other properties are lower.

Mass selection with pollination control techniques and basic index techniques, has been carried out for seven cycles to improve yield and fresh stover. Pollination control techniques use plant height and number of leaves per plant as selected properties. The basic index is obtained from the economic value of two charcters, namely the weight of dried cobs harvested per plant and the weight of fresh stover. How big was the selection response and how much improvement both charcters have been assessed. Therefore, this study aimed to determine the response of mass selection by pollination control and with a basic index for yield and fresh stover after seven cycles and to determine the increase in both characteristics compared to the initial population.

MATERIAL AND METHOD

Mass selection with two techniques for seven cycles, carried out in dry land with pump wells. Subdevided blocks are used to reduce the influence of the environment on the selection plots for each cycle. The design used in testing the selection results is a complete randomized block design with 3 blocks.

The material used as the initial population (P0) for selection for seven cycles is the population produced by local cultivar assemblies (PHRKL). Materials used in the test are the initial population, the population selected for seven cycles with two techniques (14 types of population) and superior varieties of Gumarang.

The method used in research is an experimental method with all experiments carried out in dry land with pump wells. The selection method for improving the yield properties and fresh stover is mass selection. Two mass selection techniques are applied, namely by controlling pollination (DPP) and base index (IS). Both ways of mass selection are carried out for seven cycles in dry land. The characteristics of the land used, namely the texture of sandy granules. The method used to reduce the environmental effect in the selection plot is the subdivided block method by dividing the selection plot into 100 plots; each plot contains 40 plants. Selection is done in each plot with a percentage of selected plants as much as 5 percent. Mass selection by pollination control is done by selecting higher plants and more leaves before pollination and crossing between selected plants. The weight of each trait in the basic index technique is obtained from the ratio of gross income of each trait to the total gross income of the two charcters. The gross income of each trait is obtained by multiplying the average yield of 3 plots in the selection plot multiplied by the price that applies at the time of harvest. Randomized block design, used in testing the selection results with 3 blocks. Experiments carried out in dry land in the dry season. Irrigation is done once every 7 days from planting to the age of 70 days. Plant spacing used is 20 x 60 cm, one plant per hole. Each population in each block is planted by 2 rows; each row contains 25 plants.

Variables observed included plant height, number of leaves per plant, weight of dried cobs harvested per plant, cob length, ear diameter, number of fresh leaves per plant, weight of fresh stover per plant, yield capacity (dry weight of seeds per plot) and weight of 1,000 seed grain.

Observation data were analyzed by analysis of variance at 5% significance level. The population mean, was tested by the smallest significant difference test (LSD) at 5% significance level. The amount of increase in yield / fresh stover is obtained from the difference between the seventh cycle population and the initial population (P7DPP - P0 / P7IS - P0). The mass selection response per cycle of each technique, obtained from the linear regression coefficient between the observed properties and the selection cycle described from the linear equation (Little and Hills, 1972), is as follows:

$$\acute{Y}_L = \bar{Y} + (K_2P_1)\,X'$$

$$K_2P_1 = \{-7(Y_{0.}) -5(Y_{1.}) - 3\,(Y_{2.}) - 1(Y_{3.}) + 1(Y_{4.}) + 3(Y_{5.})+5(Y_{6.})+7(Y_{7.})\} / (168 \times r)$$

with K2P1 = linear polynomial regression coefficient = Selection response per cycle of each technique; r = number of blocks; Y0., Y1., Y2., Y3., Y4, Y5., Y6 and Y7. successively is the sum of all initial population blocks, cycle 1, cycle 2, cycle 3, cycle 4, cycle five, cycle six and population cycle 7. Testing the real / absence of the linear regression coefficient using the F0.05 test in the analysis of variance by breaking the source of population variance is linear and the remainder for each mode of selection. Heritability broad meaning (H2), obtained by the formula:

$$H^2 = (\sigma^2_g / \sigma^2_p) \times 100\ \%$$

Furthermore, the grouping of values according to the opinion of Stanfield (1991), which is 50-100, is high; 20 - <50; moderate and low if the value is <20.

Then the value grouping is done according to the opinion of Stansfield (1991), which is 50-100, high; 20 - <50; moderate and low if the value is <20.

RESULT AND DISCUSSION

Results

Mass selection with two techniques, aimed at improving yield and fresh stover. Selection causes changes in population averages and the difference is called selection response. The response responses for each trait for each technique are presented in Table 1.

Table 1. Average selection responses per cycle for selection with pollination control (DPP) and base index (IS) for seven cycles

Observed parameter	Average selection response per cyclus	
	DPP	IS
Lant height (cm)	1.67 *	1.17 *
Number of leaf (sheet)	0.06 *	0.08 *
Cob Harvest dry weight per plant (g)	2.42 *	2.86 *
Cob lenght (cm)	0.06 *	0.12 *
Cob Diameter (cm)	0.02 ns	0.02 ns
Grain Dry weight per plot (g)	47.88 *	72.80 *
Weight 1.000 seeds (g)	1.50 *	2.50 *
Number of fresh leaf at harvest (sheet)	0.12 *	0.12 *
Fresh stavor per plant (g)	7.82 *	11.50 *

Note: *) Significantly different at the 5 percent level and ns. not significantly different.

In Table 1 it can be seen that the yield (weight of dry piped seeds per plot) has a real linear selection response, which is 47.88 g / plot for mass selection with pollination control (DPP) and 72.80 g / plot for the base index (IS). Dry cob weights per plant have a real linear selection response for both mass selection techniques. The response of mass selection of fresh stover weight per plant is real linear for control selection, which is 7.82 g / tan and for index selection is 11.50 g / tan. Response to selection of plant height and number of leaves per plant as well as the number of fresh leaves per plant at harvest is also a real linear. The linear regression model for yield is presented in Figure 1 and Figure 2 presents the linear regression model for fresh stover weights.

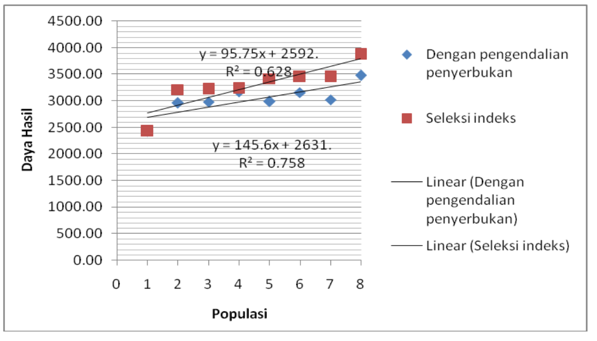

Figure 1. Linear graph of yield results with a selection cycle for two mass selection techniques

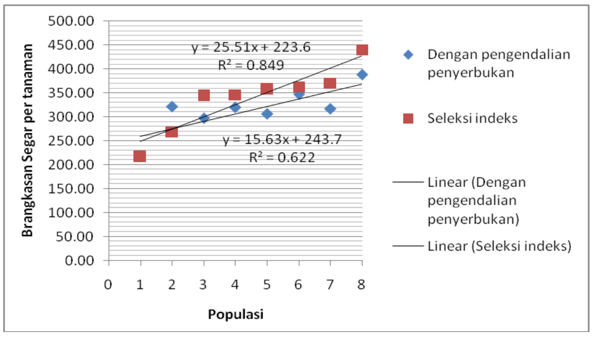

Figure 2. Linear graphs of fresh stover weights per plant with a selection cycle for two techniques mass selection.

The magnitude of the response response to the characteristics observed is also very dependent on genetic diversity and heritability. The magnitude of genetic diversity, diversity of phenotypes and heritability values of broad meaning (H2) are presented in Table 2.

Table 2. Variety of genotypes ($^{\delta}$2g). variety of phenotypes ($^{\delta}$2p) and broad sense heritability (H2) for each observed parameter

Observed characters	$^{\delta 2}_{g}$	$^{\delta 2}_{p}$	H^2(%)
Plant height	14.43	225.21	5.65
Number of leaf per plant	0.303	0.414	73.12

Dry cob weight per plant	115.32	288.19	40.02
Cob lenght (cm)	0.14	0.44	31.82
Cob Diameter (cm)	0.01	0.02	44.51
Yield potential (dry seed weight per plot)	76363.97	153496.75	49.75
Weight 1.000 seeds (g)	105.55	164.43	64.19
Number of fresh leaf at harvest per plant	0.28	0.54	51.85
Fresh stavor weight per plant	1592.04	4634.64	34.35

In Table 2 there is a high degree of heritability obtained in the number of leaves per plant, the weight of 1,000 seeds and the number of fresh leaves per plant. The characteristics of the weight of dried cobs harvested per plant, the length of the cobs, the diameter of the cobs, the yield capacity and the weight of fresh stover per plant were classified as medium and the plant height was classified as low.

Selection causes changes in population averages and the magnitude for each population according to the selection cycle, presented in Table 3.

Table 3. Average of all observed properties for each treatment during mass selection with pollination control and index indexes

Treatment	Average *)				
	1	2	3	4	5
Po	219.33	11.75 a	138.03 a	13.27 a	4.43 a
P1DPP	238.58	12.17 a	144.53 a	13.48 a	4.37 a
P2DPP	240.25	12.50 b	161.48 b	13.77 a	4.53 a
P3DPP	224.92	12.33 a	160.29 b	13.98 a	4.53 a
P4DPP	249.83	12.58 b	163.94 b	14.02 a	4.56 a
P5DPP	238.58	12.42 b	170.44 b	14.11 a	4.60 a
P6DPP	239.58	12.50 b	172.09 b	14.15 a	4.66 b
P7DPP	255.92	13.00 b	172.09 b	14.15 a	4.66 b
P1IS	231.67	11.92 a	161.33 b	14.05 a	4.54 a
P2IS	249.83	12.17 a	172.15 b	14.11 a	4.63 b
P3IS	247.75	12.42 b	172.35 b	14.15 a	4.63 b
P4IS	230.83	12.08 a	172.51 b	14.27 a	4.65 b
P5IS	239.58	12.58 b	179.67 b	14.49 b	4.67 b
P6IS	237.67	12.50 b	173.36 b	15.17 b	4.72 b
P7IS	249.83	13.17 b	194.93 b	15.15 b	4.72 b
Gumarang	240.75	14.25 b	165.10 b	14.23 a	4.40 a
$LSD_{0.05}$	-	0.58	21.92	1.18	0.17

Table 3. continued

Treatment	Average *)			
	6	7	8	9
Po	2426.67 a	178.33 a	6.25 a	216.50 a
P1DPP	2960.33 b	205.60 b	6.67 a	321.50 b
P2DPP	2982.50 b	206.03 b	6.42 a	297.13 a
P3DPP	3170.17 b	205.63 b	7.17 b	319.81 b
P4DPP	2986.33 b	205.60 b	7.00 a	306.50 a
P5DPP	3159.33 b	205.00 b	7.17 b	346.91 b
P6DPP	3023.17 b	208.10 b	7.75 b	316.93 b
P7DPP	3481.33 b (36.46 %)**)	213.07 b	8.17 b	387.99 b (59.81 %)**)

P1IS	3212.83 b	215.33 b	6.75 a	269.09 a
P2IS	3221.17 b	211.93 b	7.25 b	344.10 b
P3IS	3230.67 b	215.23 b	7.33 b	346.51 b
P4IS	3419.67 b	218.37 b	7.17 b	357.58 b
P5IS	3451.33 b	219.67 b	8.00 b	363.05 b
P6IS	3451.00 b	221.03 b	7.58 b	370.51 b
P7IS	3878.17 b (79.21 %)**	230.53 b	8.33 b	440.51 b (103.47 %)**)
Gumarang	3394.17 b	212.40 b	6.75 a	302.76 a
$LSD_{0.05}$	463.05	12.79	0.85	91.97

Note: *). The numbers followed by the same letter in the same column are not significantly different from the initial population with the BNT0.05 test. 1. Plant height (cm); 2. Number of leaves per plant (strands); 3. Weight of dried cobs harvested per plant (g); 4. The length of the cobs (cm); 5. Diameter of cob (cm); 6. Weight of dry pipil seeds per plot (g); 7. Weight of 1,000 seeds (g); 8. Number of fresh leaves per plant at harvest (strands); 9. Fresh stover weight per plant (g) and **) Percentage increase compared to the initial population (Po).

In Table 3 it can be seen that the average power yield of the seventh cycle DPP mass selection results is greater than the initial population. Likewise for the previous cycle population. Mass selection by index selection causes higher yield since the first cycle to the seventh cycle. The fresh stover weight of the seventh cycle population for mass selection with pollination control is higher than the initial population. Likewise for mass selection with a base index, the fresh stover weight of the initial population is smaller than the population of the second cycle to the seventh cycle. The initial population yield, the seventh cycle using the DPP technique and the seventh cycle with the basic index index technique were 2426.67 g / plot (5,056 t / ha), 3481.33 g / plot (7,253 t / ha) and 3878.17 g / plot (8,080 t / ha) /Ha).

Improvement of yield and fresh stover is done through the nature of plant height and number of leaves for mass selection by controlling pollination and through the weight of dried cobs harvested and fresh stover for base index. The magnitude of the change in the quality that is corrected depends on the closeness of the relationship with the selected trait. Correlation coefficient values between charcters with yield and fresh stover are presented in Table 4.

Table 4. Correlation coefficient values between the properties observed with yield and stover fresh

Observed Parameters	1	2 *)
Plant height	0.36*)	0.46 *)
Number of leaf per plant	0.40*)	0.32 *)
Dry Cob weight at harvest per plant	0.76*)	0.58*)
Cob lenght (cm)	0.59*)	0.50*)

Cob Diameter (cm)	0.57*)	0.43*)
Yield potential (dry seed weight per plot)	1.00	0.55*)
Weight of 1.000 seeds (g)	0.76*)	0.57*)
Number of fresh leaf at harvest per plant	0.50*)	0.55*)
Fresh stavor weight per plant	0.55*)	1.00

Note: *) The correlation coefficient is real at the 5 percent level; 1, yield and 2. weight fresh stover per plant.

In Table 4 it can be seen that all the observed charcters are significantly positively correlated with yield and fresh stover. The highest correlation coefficient value with yield obtained on the weight characteristics of dried cobs harvested per plant; while with fresh stover obtained four characteristics that have a coefficient higher than 0.50, namely the number of fresh leaves per plant, the weight of 1,000 seeds, yield, dry weight of harvested cobs per plant.

Discussions

The potential yield has a marked progress in linear selection up to the seventh cycle for both mass selection techniques. The average progress in the selection of fresh stover weight also experienced the same thing, which is real linear for both techniques. This means that the two mass selection techniques are still effective until the seventh cycle to increase yield and fresh stover. The same for yield was obtained by Baktash (2016), that the modification of mass selection was effective for yield yield and corn yield components. Regression between yields with a real linear selection cycle for five cycles of mass selection modification. Other studies that support this, namely Jiban, et al. (2018) states that mass selection is effective to improve the agronomic charcters of maize plants, namely to cause higher yields, reduced plant height, location of the cobs, age of panicle exit and age of exit of cob hair compared to the initial population after five cycles. Research conducted by Govind and Mani (2016). that there is a significant progress in mass selection for the number of cobs per plant, ear diameter, number of rows per ear, weight of seeds per ear and yields.

The difference in selection responses per cycle for yield results can also be seen from the linearity of the two selection techniques (Figure 1). The selection response for the base index is higher than the pollination control. Improved yield using both techniques, including indirect mass selection; the selection response is very dependent on the close relationship between the selected charcters and the corrected charcters. Mass selection by pollination control uses plant height and number of leaves as selected characteristics; whereas the dry weight of the harvested cobs is used for the properties selected through a basic index technique. A significant positive correlation coefficient is obtained between the weight of the dried cob harvest and the yield, which is 0.76. The same is true for the correlation between yields and dry cob weights harvested by Abdalla, et al. (2010), that a positive correlation between yield and the dry weight of harvested cobs. Subaedah, et al. (2016) added, that the longer the cob, aka the number of seeds more, resulting in an increase in yield. The correlation coefficient value is much higher than the plant height 0.36 and for the number of leaves 0.40 (Table 4). This is very possible, that the selection response uses a base index for higher yield compared to pollination control. The value of heritability also determines the magnitude of the selection response. The dry weight of the cob has a high heritability; while the plant height, heritability is low and the number of leaves is classified as high.

Linearity of the two techniques for fresh stover weight weights, as shown in Figure 2, indicates that index selection is higher since the third cycle compared to pollination control. The difference is even greater with more and more selection cycles. This can occur because fresh stover is selected directly by the basic index technique. Selection by pollination control to increase the weight of fresh stover using plant height and number of leaves as selected properties. High plants have low heritability; while the heritability of the number of leaves is classified as high, but both charcters have a correlation coefficient that is not too high (<0.50) so that the impact on selection progress is smaller than directly using index selection. This is in accordance with the opinion of Basuki (2005), that the size of the indirect response response depends greatly on the value of heritability and the closeness of the relationship between the two characters.

Selection causes an increase in gene frequency and genotype frequency for selected and improved charcters (Soemartono, et al., 1992). Both of these can be seen an increase in the population mean from the initial population to the seventh cycle. The increase in yield due to mass selection for seven cycles with pollination control and the base index was quite large respectively by 43.46 percent and 79.21 percent. This increase in yield is higher than that obtained by Sutresna (2010) of 44.04 percent for index selection. The weight of fresh stover per crop increased by 59.81 percent for selection with pollination control and 103.47 percent for index selection after seven cycles. This happens because the response of mass selection with a basic index for yield and fresh stover is higher than the mass selection by pollination control. The response of mass selection with a base index for fresh stover weight was 11.50 g / tan / cycle and with pollination control of 7.82 g / tan / cycle (Table 1). The difference in selection response was that big, causing an almost doubling increase

Conclusions and Sugestions

1 The response of mass selection with pollination control is smaller than the base index for yield and fresh stover weight and linear regression are both real.

2 Increased yield and fresh stover of mass selection with lower pollination control compared with the basic index technique after seven cycles. Increased yield vy 43.46 percent and 59.81 percent fresh stover weight obtained after seven cycles of mass selection by pollination control, while the use of base index causes an increase in yield of 79.21 percent and fresh stover of 103.47 percent compared to the initial population.

3 Mass selection activities with the next two cycles can still be continued so that there is a greater increase compared to the initial population for fresh yield and stover.

THANK YOU

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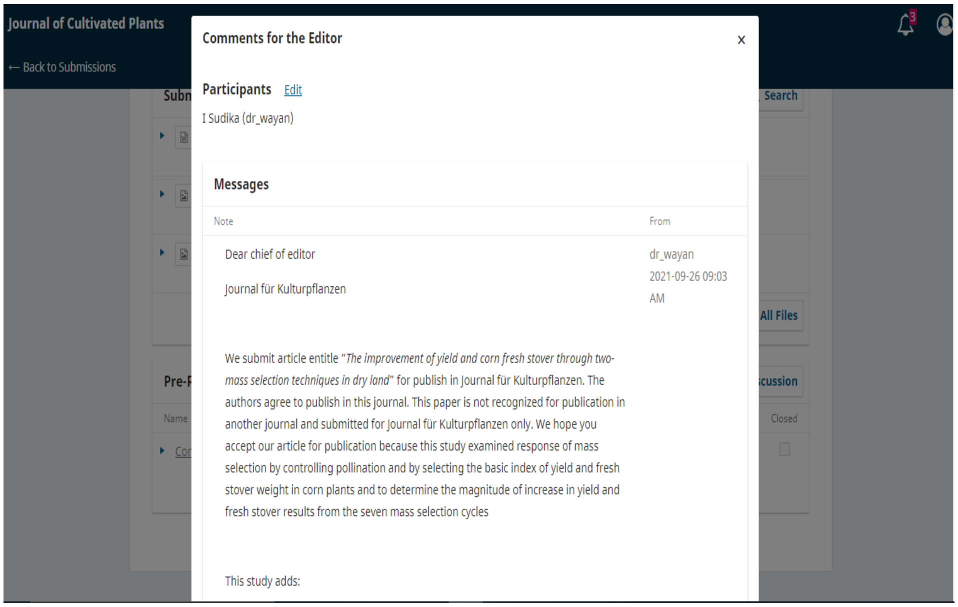
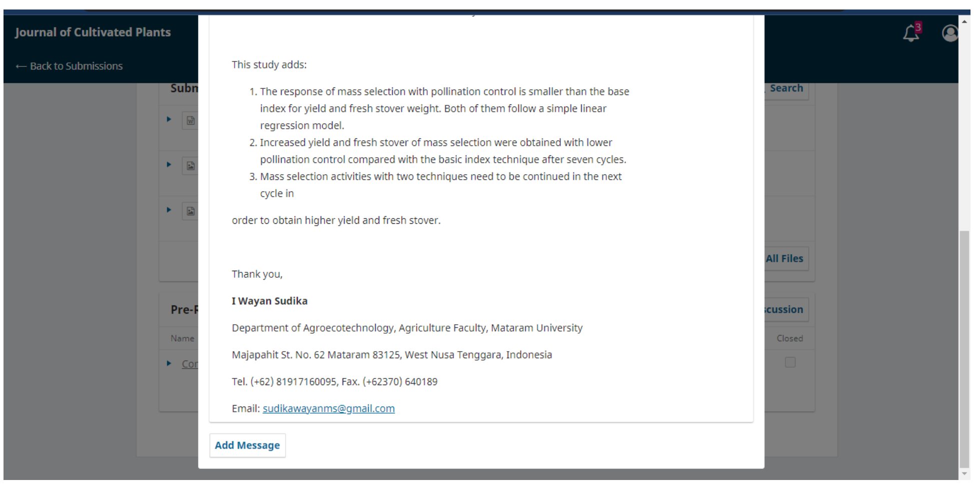
3. Komentar dari Editor tanggal 26 September 2021





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4. Point-point yang harus direvisi (3 November 2021)

Hans-Peter Kaul <hans-peter.kaul@boku.ac.at>3 November 2021 at 15:52To: I Sudika <wayan.sudika@klinikjurnal.com>, I Soemeinaboedhy <soemeinaboedhy@gmail.com>

Hallo I Sudika, I Soemeinaboedhy ,für Ihre Einreichung im Journal für Kulturpflanzen: "The Improvement of Yield and Corn Fresh Stover Through Two-Mass Selection Techniques in Dry Land" liegen uns nun die Gutachten vor (siehe unten).

Wir bitten Sie um Überarbeitung des Manuskriptes bis zum **xx.xx.20xx** unter Berücksichtigung der Kommentare undHinweise der Gutachter/innen. Die überarbeiteten Textstellen können Sie entweder farblich hervorheben oder mit der"Änderungen nachverfolgen"-Option in Word kennzeichnen. Bitte reichen Sie zusätzlich zum überarbeitetenManuskript auch eine Datei mit Antworten auf die Hinweise in den Gutachten ein. Das überarbeitete Manuskript wird in einer weiteren Begutachtungsrunde evaluiert.
Please think seriously about whether you feel able to dispel the criticism as raised by both reviewers and indicateyour reaction to each of their issues.Vielen Dank und beste Grüße

Gutachter/in A:
The manuscript "The Improvement of Yield and Corn Fresh Stover Through Two-Mass Selection Techniques in DryLand" by Sudika and Soemeinaboedhy describes the progress of selection for grain yield and fresh stover weight inmaize over seven selection cycles, using two mass selection techniques: pollination control and base index. Theauthors conclude that for both techniques substantial increases in yield and fresh stover can be obtained, following alinear trend. The results also indicate that base index leads to a larger response to selection compared to thepollination control. Based on these results, the authors plan to continue their mass selection activities for furthercycles to increase yield and fresh stover weight.

Major points:
I am not an English native speaker, but in my opinion the language should be improved. Sentences are sometimeshard to understand, which makes it hard to follow the storyline. Maybe a language editing service would be advisable.I just mention two examples in the "further points" section (lines 56-57 and lines 74-75) but language could beimproved at many more points in the text.
More details are needed in describing the underlying material of this study. The gains of selection that can beachieved depend very strongly on the initial population, in particular on its performance level (a comparably lowperforming population can be easier improved compared to an already high performing population) and its geneticdiversity (the prospects of improvement might be higher for a very diverse population compared to a population withrelatively small effective population size). Therefore more information about the source population would beappreciated. Due to this, I find it also very hard to make comparisons with other studies, as the achievable selectionresponse will always be depending on the source population. This should be taken into account when referring toresults of other studies.
More details describing the data analysis are needed. Lines 125-141 should be modified. Specify every singleparameter in each equation (YL, Y_bar, …). Describe exactly what data goes into the response vector "YL" (raw datawith three replicates?). Mention that the model is run for the two mass selection techniques separatelly. Explain whatis "168", "x" and "r". Edit the sentences in terms of language (especially lines 135-137). Describe how exactly youcalculated sigma_squared_g and sigma_squared_p.6/10/22, 4:09 PM Gmail - [JFK] Entscheidung der Redaktion https://mail.google.com/mail/u/0/?ik=2bb59ff57f&view=pt&search=all&permthid=thread-f%3A1715396571890940892&simpl=msg-f%3A17153965… 2/4

The percentages of increased yield and fresh stover from cycle 0 to cycle 7 for the two techniques are mixed up orwrong. Please describe exactly how this was calculated (it is not very clear from Lines 123-125). In my opinion, youshould calculate (value_cycle7-value_cycle0)/value_cycle0 to get the proportion of increase. If you do that accordingto the values given in Table 3, you obtain: for yield_DPP (3481.33-2426.67)/2426.67=43.46% instead of 36.46%, foryield_SI (3878.17-2426.67)/2426.67=59.81% instead of 79.21%, for fresh_stover_DPP (387.99-216.50)/216.50=79.21% instead of 59.81%, and for fresh_stover_SI (440.51-216.50)/216.50=103.47%. Update thevalues throughout the text (also in abstract). You refer to these percentages in many sentences in the manuscript, somake sure they are right.
I think you should make it clear from the beginning that the pollination control technique actually represents anindirect selection method, as you select on plant height and leaf number but not on yield and fresh stover. Thesuccess of indirect selection strongly depends on the genetic correlation between the selected trait and the targettrait. Therefore, a fair comparison of the two approaches "pollination control" and "base index" might be difficult. Yourefer to this point in a sentence in the discussion (lines 238-239) but maybe you could already emphasize this earlierin the manuscript.

Further points:

Line 19: "randomized completely block design" should be changed to "randomized complete block design". Languageexample, check for whole manuscript.
Line 61: It should be "was" instead of "is". Example for incorrect tense, check for whole manuscript.
Lines 28-41 (as well as lines 4-5): Translation from English to German could be improved. For example in Line 40"Massenauswahl" to "Massenselektion" and "Auswahlfortschritt" to "Selektionsfortschritt"
Lines 56-57: (Language) "Mass selection can lead to improved selection progress if the selection is done beforepollination and crossing among selected plants", this sentence is not clear and (as far as I understood) it should berephrased to e.g. "Selection progress of mass selection can be improved by conducting the selection beforepollination and crossing only selected plants"
Lines 74-75: (Language) "Tardin et al. (2007) gained the Smith–Hazel index selection progress with full-sib selectionof 4.68% for the dry weight of pipil seeds; while other properties are lower", this sentence is not correct, as youcannot "gain the Smith-Hazel index". It could be rephrased to "Tardin et al. (2007) used the Smith–Hazel index withfull-sib selection and obtained a selection progress of 4.68% for …". What exactly are "pipil seeds"? I looked in thepublication of Tardin et al. (2007) and there they refer to "grain weight" instead. And what do you mean with "whileother properties are lower"? Do you mean other traits showed lower responses to selection?
Use superscript where needed. For example in Line 159 "R2", the "2" should be written in superscript. Or for examplewhen you refer to variances like in Line 139, the "2" should be written in superscript and the "g" and "p" in subscript.
Table 1: explain what you mean with "significantly different". Describe the test that was performed. Do you meansignificantly different from 0? Or do you mean that the values are different between DPP and IS? But if so, how 0.12is different from 0.12 for number of fresh leaf at harvest.
Table 1: Do you have an explanation, why the number of leaves increases more for SI than for DPP? As this trait isdirectly selected in the DPP approach, I would have expected that it should increase more in DPP.
Line 154-155: It is not clear to me what "tan" means. Is it a unit of area? This appears more often in the manuscript.6/10/22, 4:09 PM Gmail - [JFK] Entscheidung der Redaktion
https://mail.google.com/mail/u/0/?ik=2bb59ff57f&view=pt&search=all&permthid=thread-f%3A1715396571890940892&simpl=msg-f%3A17153965… 3/4

Line 156 (Language): "… is also a real linear". This should be rephrased.
Fig1 and Fig2: Maybe you can use different styles or different colors for the two regression lines.
Table 3: For column 1 the letters of significance are missing.
Table 3: As already stated before, the percentages are mixed up or wrong.
Table 3: Make clear which pairwise comparisons were made when testing significance. I find it confusing, when forexample P7SI carries a "b" and also P7DPP carries a "b". Does that mean that these two values are not significantlydifferent from each other? If so, the statement that SI leads to higher yield compared to DPP would not be significant.
Table 4 as well as for the text in Lines 205-221: Specify how correlations were calculated. Was it done based on theraw data or based on adjusted means? Was it based on the whole set or calculated separately for the twoapproaches "DPP" and "SI"? If it was done for the whole set, I would be interested, if correlations change whencalculated per approach.
Empfehlung: Überarbeitung erforderlich---

Gutachter/in C:

The manuscript presents in detail the results of a breeder's routine selection work in a specific year (2018) and aspecific site in Indonesia.
The M&M section lacks some critical details. For instance, the plant material (what cultivars, population produced inwhat way, ...?) is described insufficiently; what's the meaning of PHRKL; what is meant by the 14 types of population;how was pollination control done, etc. To the reader it is hard to follow the arguments.
The data presented here is very specific to the germplasm used as well as to the evironment. I wonder, thus, howreaders could profit from this paper in some way. There are hardly any results presented which could be generalisedin order to apply them to other situations (plant materials, environments, …) or to generate a gain of knowledge. TheDiscussion does not discuss and interpret the results against the background of current knowledge. Rather, itcontinues the Results sections by adding further details of results.
To gain more general relevance to the readers of JfK, the manuscript should present a clear question (a gap ofknowledge) which remains to be answered (or filled, resp.) despite the previous studies cited by the authors. Theresults should be discussed, interpreted and, if possible, used to draw general conclusions in a way that readers(students, breeders or scientists) may benefit in some respect from reading the paper.
Empfehlung: Anderswo erneut einreichen---
Journal für Kulturpflanzen*Journal of Cultivated Plants*E-Mail: journal-kulturpflanzen@julius-kuehn.deWebsite: https://ojs.openagrar.de/

5. **Artikel yang telah direvisi. (Huruf merah adalah yang direvisi sesuai komentar reviewer)**

Original Article

The Improvement of Yield and Corn Fresh Stover Through Two-Mass Selection Techniques in Dry Land

Die Verbesserung von Ertrag und MaisfrischeinlagerungdurchZwei-Massen-Selektionsverfahren in trockenem Land

Abstract

This study aims to determine the response of mass selection by controlling pollination and by selecting the basic index of yield and fresh stover weight in corn plants and to determine the magnitude of increase in yield and fresh stover results from the seven mass selection cycles. The method used to reduce environmental effects during selection is a subdivided block. A randomized complete block design was used to test the results of the selection. The results showed that an increased yield of 43.46% and a fresh stover weight of 79.21% were obtained after seven cycles of mass selection by pollination control; while the use of the basic index causes an increase in yield of 59.81% and fresh stover of 103.47% compared to the initial population. Mass selection activities with two techniques need to be continued in the next cycle in order to obtain a higher yield and fresh stover.

Keywords:basic index selection,fresh stover, mass selection, progress of selection,selection by pollination control

Zusammenfassung

DieseStudiezieltdarauf ab, die Reaktion der Massenselektiondurch die Kontrolle der Bestäubung und durch die Auswahl des Basisindex des Ertrags und des FrischstrohgewichtsbeiMaispflanzenzubestimmen und das Ausmaß der Ertragssteigerung und der Ergebnisse von Frischstrohaus den siebenMassenselektionszyklenzubestimmen. Die MethodezurReduzierung von Umwelteinflüssenwährend der Auswahlisteinunterteilter Block. Ein randomisiertesBlockdesignwurdeverwendet, um die Ergebnisse der Selektionzutesten. Die Ergebnissezeigten, dassnachsiebenZyklenMassenselektiondurchBestäubungskontrolleeinerhöhterErtrag von 43,46 % und einFrischstrohgewicht von 59,81 % erhaltenwurden; während die Verwendung des BasisindexeineErtragssteigerung von 79,21 % und Frischstroh von 103,47 % imVergleichzurAusgangspopulationbewirkt. MassenselektionsaktivitätenmitzweiTechnikenmüssenimnächstenZyklusfortgesetztwerden, um einenhöherenErtrag und frischen Strauch zuerhalten.

Stichwörter: Grundindexauswahl, Frischstroh, Massenselektion, Selektionsfortschritt, AuswahldurchBestäubungskontrolle

Introduction

Mass selection is based on the selection of individual phenotypes of plants and seeds of selected plants debulked to form the next cycle population. Despite being known as the oldest method, the mass selection is still used continuously. The effectiveness of mass selection is very dependent on the properties selected, isolation, accuracy to reduce environmental effects, and the number of selected plants. Mass selection will be effective for characters with high heritability (Hallauer et al., 2010). Shresthaet al. (2018) state that mass selection is effective in improving the agronomic characteristics of maize. This is evident from the five selection cycles as it does lead to higher yields compared to the initial population. Research conducted by Govind and Mani (2016) states that there has been significant progress in mass selection for the number of cobs per crop, the diameter of cobs, number of rows per cob, weight of seeds per cob, and yield. The highest expectation of genetic heritability and progress was obtained in seed weight per ear, followed by yield and the number of ears per crop. An increase in yield of 23.2% was obtained by Khamkoh et al. (2019) after two simple iterative selection cycles.

Selection progress of mass selection can be improved by conducting the selection before pollination and crossing only selected plants. Such selection is called mass selection by controlling pollination. This technique is an indirect selection to improve yield and fresh stover. Sutresna (2010) gained selection progress by controlling pollination on yield (weight of dried Pipil seeds per plot) of 2.07 kg (44.04%) for three cycles, which is higher than without pollination control of 1.67 kg (33.99%). The average progress of selection with control was 14.04%, and the average progress of selection without control was11.33% per cycle.

Mass selection can be done to improve two or more characters simultaneously, one of them using the basic selection index. Kar and Warsi (2006) stated that each environment has certain criteria in determining the index in an effort to improve the nature of young cobs. According to Smith (1936), the use of the primary and base index for the selection of single and combined characters (yield, seed moisture content at harvest, the presence of roots, and the presence of stems) is more efficient than the Smith–Hazel index. The use of a base index can be done by compiling a selection index using economic weights, but it is rather difficult to assign economic weights to each trait (Ajala, 2010). According to Walsh (2010), the value of heritability and genotypic correlation can be ignored in compiling a baseline index. The results of Asghar and Mehdi (2010) revealed that selection using the base index is more efficient for characters related to quality and the combined nature of results and quality. Tardin et al. (2007) used the Smith–

Hazel index with full-sib selection and obtained a selection progress of 4.68% for the dry weight of pipil seeds;while other properties are lower. Mass selection with pollination control techniques and base index techniques has been carried out for seven cycles to improve the yield and fresh stover. Pollination control techniques use plant height and the number of leaves per plant as selected properties. The base index is obtained from the economic value of two characters, namely, the weight of dried cobs harvested per plant and the weight of fresh stover. How big was the selection response and how much was the improvement of both characters have been assessed? Therefore, this study aimed to determine the response of mass selection by pollination control and with a basic index for yield and fresh stover after seven cycles and to determine the increase in both characters compared to the initial population.

Materials and Methods

The method, time, and site location

The method used in research is an experimental method with all experiments carried out in dryland with pump wells. Testing the selection results is carried out from July to October 2018 Amor-Amor Village, North Lombok regency. The characteristics of the dry land include altitude of ± 60 m above sea level, air temperature of 20°C–37°C, and relative humidity during the test ranged from 63% to 100%. The texture of the soil is loam sand, soil pH is 6.2, C-organic is 1.22%, N-total is 0.27%, available-P is 83.63 ppm, and exchangeable K is 0.65 meq%.

Corn varieties

The material used as the initial population (P0) for selection for seven cycles is the population produced by local cultivar assemblies (PHRKL). Materials used in the test are the initial population, the population selected for seven cycles with two techniques (14 types of the population), and the superior varieties of Gumarang.

Experimental design and mass selection

The selection method for improving the yield properties and fresh stover is mass selection. Two mass selection techniques are applied, namely, by pollination control (DPP) and by base index (IS). Both techniques of mass selection are carried out for seven cycles in a dry land. The method used to reduce the environmental effect in the selection plot is the subdivided block method conducted by dividing the selection plot into 100 plots; each plot contains 40 plants. Selection is done in each plot with as much as 5% of the selected plants. Mass selection by pollination control is done by selecting higher plants and more leaves before pollination and crossing between selected plants. The weight of each trait in the base index technique is obtained from the ratio of the gross income of each trait to the total gross income of the two characters. The gross income of each trait is obtained by multiplying the average yield of three plots in the selection plot multiplied by the price that applies at the time of harvest. A randomized block design was used in testing the selection results with three blocks. Experiments were carried out in dry land in the dry season. Irrigation is done once every 7 days from planting to the age of 70 days. The plant spacing used is 20 cm × 60 cm, with one plant per hole. The population in each block is planted with 2 rows, where each row contains 25 plants (plot size is 1.2 m × 5 m).

Plant observation

Variables observed included plant height, the number of leaves per plant, the weight of dried cobs harvested per plant, cob length, ear diameter, the number of fresh leaves per plant, the weight of fresh stover per plant, yield (dry weight of seeds per plot), and the weight of 1,000 seed grains.

Data analysis

Observation data were analyzed using analysis of variance at a 5% significance level. The population means were tested by the smallest significant difference test (LSD) at a 5% significance level. The amount of increase in yield/fresh stover is obtained from the difference between the seventh cycle population and the initial population (P7DPP-P0/P7IS-P0). The mass selection response per cycle of each technique, obtained from the linear regression coefficient between the observed properties and the selection cycle described from the linear equation (Little and Hills, 1972), is as follows:

$$\acute{Y}L = \bar{Y} + (K2P1)\, X' \quad (1)$$

$$K2P1 = \{-7(Y0.) -5(Y1.) - 3\,(Y2.) - 1(Y3.) + 1(Y4.) + 3(Y5.)+5(Y6.) + 7(Y7.)\} / (168 \times r) \quad (2)$$

Where:

K2P1 is the linear polynomial regression coefficient, the selection response per cycle of each technique, r is the number of blocks, and Y0., Y1., Y2., Y3., Y4, Y5., Y6, and Y7. are the sum of all initial population blocks, cycle 1, cycle 2, cycle 3, cycle 4, cycle 5, cycle 6, and population cycle 7, respectively. Testing the real/absence of the linear regression coefficient using the F0.05 test in the analysis of variance by breaking the source of the population variance is linear and the remainder for each mode of selection. Broad sense heritability (H2) can be obtained through the following formula:

$$H2 = (\sigma 2g / \sigma 2p) \times 100\ \% \qquad (3)$$

Furthermore, the grouping of values according to the opinion of Stansfield (1991) is as follows: 50–100, high; 20–<50, moderate; and <20, low.

Results

Selection response per cycle for the two techniques of mass selection

Mass selection using the two techniques aimed at improving yield and fresh stover. The selection causes changes in population averages, and the difference is called selection response (Table 1).

Table 1. Average selection responses per cycle for mass selection with pollination control (DPP) and base index (IS) until seven cycles

Observed characters	Average selection response per cycles	
	DPP	IS
Plant height (cm)	1.67 *	1.17 *
Number of leaf (sheet)	0.06 *	0.08 *
Cob harvest dry weight per plant (g)	2.42 *	2.86 *
Cob length (cm)	0.06 *	0.12 *
Cob diameter (cm)	0.02 ns	0.02 ns
Dry weight of seeds per plot (g) (yield)	47.88 *	72.80 *
Weight of 1.000 seeds (g)	1.50 *	2.50 *
Number of fresh leaf at harvest (sheet)	0.12 *	0.12 *
Fresh stover per plant (g)	7.82 *	11.50 *

Note: * significantly different at the 5% level; ns,not significantly different

It can be seen (Table 1) that the yield (Grain dry weight per plot) has a real linear selection response, which is 47.88 g/plot for mass selection with pollination control (DPP) and 72.80 g/plot for the base index (IS). Dry cob weights per plant have a real linear selection response for both mass selection techniques. The response of mass selection of fresh stover weight per plant is real linear for control selection, which is 7.82 g/plant, and for index,the selection is 11.50 g/plant. Response to a selection of plant height and the number of leaves per plant as well as the number of fresh leaves per plant at harvest is also a real linear. The linear regression model for yield is presented in (Fig. 1) and the linear regression model for fresh stover weights is presented in (Fig. 2).

The greater R^2 value was obtained for mass selection using the base index selection technique compared to pollination control for yield (Fig. 1) and fresh stover weights per plant (Fig. 2). This shows that the prediction of yield and fresh stover weights per plant using a regression equation in the selection of the base index is more accurate than pollination control. With each addition of one mass selection cycle, the yield will increase by 145.6 g/plot for the base index technique, while up to 95.75 g/plot with pollination control (Fig. 1). Fresh stover weights per plant increased by 25.51 g with the base index technique and 15.63g with pollination control (Fig. 2).

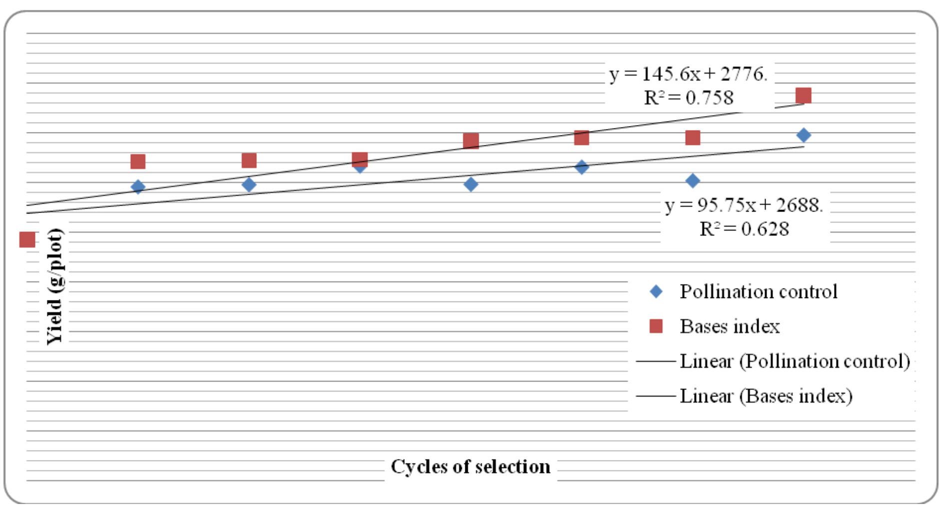

Fig. 1. Linear graph of yield results with a selection cycle for the two mass selection techniques.

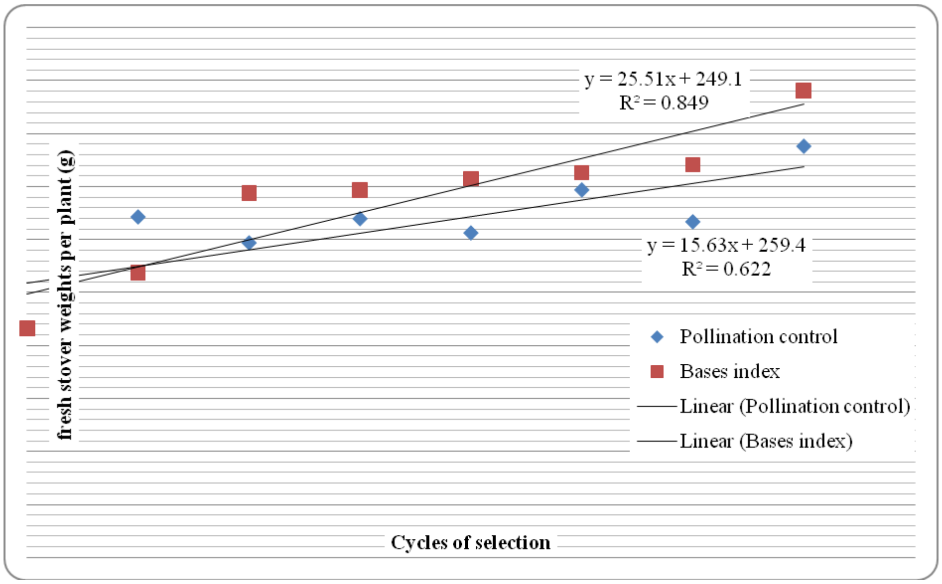

Fig. 2. Linear graphs of fresh stover weights per plant with a selection cycle for the two mass selection techniques.

The magnitude of response selection

The magnitude of the response to the observed characteristics is also very dependent on genetic variances and heritability. The magnitude of genetic variances, variance of phenotypes, and broad-sense heritability (H2) are presented in (Table 2).

Table 2. The variance of genotypes (σ^2_g), variance of phenotypes (σ^2_p), and broad-sense heritability (H2) for the observed characters

Observed characters	σ^2_g	σ^2_p	H^2(%)
Plant height	14.43	225.21	5.65
Number of leaf per plant	0.303	0.414	73.12
Dry cob weight per plant	115.32	288.19	40.02
Cob length (cm)	0.14	0.44	31.82

Cob diameter (cm)	0.01	0.02	44.51
Yield (dry weight of seeds per plot)	76363.97	153496.75	49.75
Weight of 1.000 seeds (g)	105.55	164.43	64.19
Number of the fresh leaf at harvest per plant	0.28	0.54	51.85
Fresh stover weight per plant	1592.04	4634.64	34.35

In Table 2, there is a high degree of heritability obtained in the number of leaves per plant, the weight of 1,000 seeds, and the number of fresh leaves per plant. The characteristics of the weight of dried cobs harvested per plant, the length of the cobs, the diameter of the cobs, the yield capacity, and the weight of fresh stover per plant were classified as moderate, and the plant height was classified as low. The grouping of values according to the opinion of Stansfield (1991) is as follows: 50–100, high; 20–<50, moderate; and <20, low.

The selection causes changes in population averages and the magnitude for each population according to the selection cycle, as presented in (Table 3). All selected populations (P1-P7) DPP and IS and Gumarang varieties were compared with the initial population (P0) for each observed trait.

Table 3. Average of all observed properties for each treatment during mass selection with pollination control and base index

Treatment	Average *)				
	1 **)	2	3	4	5
Po	219.33 a	11.75 a	138.03 a	13.27 a	4.43 a
P1DPP	238.58 a	12.17 a	144.53 a	13.48 a	4.37 a
P2DPP	240.25 a	12.50 b	161.48 b	13.77 a	4.53 a
P3DPP	224.92 a	12.33 a	160.29 b	13.98 a	4.53 a
P4DPP	249.83 a	12.58 b	163.94 b	14.02 a	4.56 a
P5DPP	238.58 a	12.42 b	170.44 b	14.11 a	4.60 a
P6DPP	239.58 a	12.50 b	172.09 b	14.15 a	4.66 b
P7DPP	255.92 a	13.00 b	172.09 b	14.15 a	4.66 b
P1IS	231.67 a	11.92 a	161.33 b	14.05 a	4.54 a
P2IS	249.83 a	12.17 a	172.15 b	14.11 a	4.63 b
P3IS	247.75 a	12.42 b	172.35 b	14.15 a	4.63 b
P4IS	230.83 a	12.08 a	172.51 b	14.27 a	4.65 b

P5IS	239.58 a	12.58 b	179.67 b	14.49 b	4.67 b
P6IS	237.67 a	12.50 b	173.36 b	15.17 b	4.72 b
P7IS	249.83 a	13.17 b	194.93 b	15.15 b	4.72 b
Gumarang	240.75 a	14.25 b	165.10 b	14.23 a	4.40 a
$LSD_{0.05}$	-	0.58	21.92	1.18	0.17

Treatment	Average *)			
	6	7	8	9
Po	2426.67 a	178.33 a	6.25 a	216.50 a
P1DPP	2960.33 b	205.60 b	6.67 a	321.50 b
P2DPP	2982.50 b	206.03 b	6.42 a	297.13 a
P3DPP	3170.17 b	205.63 b	7.17 b	319.81 b
P4DPP	2986.33 b	205.60 b	7.00 a	306.50 a
P5DPP	3159.33 b	205.00 b	7.17 b	346.91 b
P6DPP	3023.17 b	208.10 b	7.75 b	316.93 b
P7DPP	3481.33 b			387.99 b
		213.07 b	8.17 b	
	(43.46 %)***)			(79.21 %)***)
P1IS	3212.83 b	215.33 b	6.75 a	269.09 a
P2IS	3221.17 b	211.93 b	7.25 b	344.10 b
P3IS	3230.67 b	215.23 b	7.33 b	346.51 b
P4IS	3419.67 b	218.37 b	7.17 b	357.58 b
P5IS	3451.33 b	219.67 b	8.00 b	363.05 b
P6IS	3451.00 b	221.03 b	7.58 b	370.51 b
P7IS	3878.17 b			440.51 b
		230.53 b	8.33 b	(103.47
	(59.81 %)***			%)***)
Gumarang	3394.17 b	212.40 b	6.75 a	302.76 a

$LSD_{0.05}$	463.05	12.79	0.85	91.97

Note: *)The numbers followed by the same letter in the same column are not significantly different from the initial population with the $BNT_{0.05}$ test. **) There is no BNT value because the analysis of variance is not significantly different; 1, plant height (cm);2, number of leaves per plant (strands);3, weight of dried cobs harvested per plant (g);4, length of the cobs (cm);5, diameter of cob (cm);6, yield (dry weight of seeds per plot) (g);7, weight of 1,000 seeds (g);8, number of fresh leaves per plant at harvest (strands);9, fresh stover weight per plant (g) and ***) percentage increase compared to the initial population (Po).

It can be seen (Table 3) that the average yield of the seventh cycle DPP mass selection results is greater than the initial population, similar to the previous cycle population. Mass selection by base index selection causes a higher yield from the first cycle to the seventh cycle. The fresh stover weight of the seventh cycle population for mass selection with pollination control is higher than the initial population. Likewise, for mass selection with a base index, the fresh stover weight of the initial population is smaller than the population of the second cycle to the seventh cycle. The initial population yield, the seventh cycle using the DPP technique, and the seventh cycle with the base index technique were 2426.67 g/plot (5,056 t/ha), 3481.33 g/plot (7,253 t/ha), and 3878.17 g/plot (8,080 t/ ha), respectively.

Correlation between characters with yield and fresh stover

The improvement of yield and fresh stover is obtained through the nature of plant height and the number of leaves for mass selection by controlling pollination and through the weight of dried cobs harvested and fresh stover for base index. The magnitude of the change in the quality that is corrected depends on the closeness of the relationship with the selected trait. Correlation is calculated using the average data of each block. Each technique is separated, as shown in Table 4. The number of data correlated for each trait is 24 (treatment = 8 and block = 3).

Table 4. Correlation coefficient values between the properties observed with yield and fresh stover

Observed parameters	1	2 *)
Plant height	0.36*)	0.46 *)
Number of leaf per plant	0.40*)	0.32 *)
Dry cob weight at harvest per plant	0.76*)	0.58*)
Cob length (cm)	0.59*)	0.50*)

Cob diameter (cm)	0.57*)	0.43*)
Yield (dry weight of seeds per plot)	1.00	0.55*)
Weight of 1.000 seeds (g)	0.76*)	0.57*)
Number of fresh leaf at harvest per plant	0.50*)	0.55*)
Fresh stover weight per plant	0.55*)	1.00

Note: *) The correlation coefficient is real at the 5% level;1, yield; 2, weight offresh stover per plant.

It can be seen in (Table 4) that all the observed characters are significantly positively correlated with yield and fresh stover. The highest correlation coefficient value with yield was obtained on the weight characteristics of dried cobs harvested per plant, while with fresh stover obtained four characteristics that have a coefficient higher than 0.50, namely, the number of fresh leaves per plant, the weight of 1,000 seeds, yield, and the dry weight of harvested cobs per plant.

Revision of Table 4.

Tabel 4. Nilai koefisien korelasi antar sifat yang diamati dengan daya hasil dan dengan bobot brangkasan segar per tanaman (BBS) pada teknik dengan pengendalian penyerbukan (DPP) dan indeks dasar (IS)

No.	Observed parameters	Teknik DPP		Teknik Indeks dasar	
		Yield	weight offresh stover per plant.	Yield	weight offresh stover per plant.
1	Plant height	0.36 ns	0.25 ns	0.37 ns	0.28 ns
2	Number of leaf per plant	0.51 s	0.17 ns	0.23 ns	0.44 s
3	Dry cob weight at harvest per plant	0.65 s	0.54 s	0.87 s	0.61 s

4	Cob length (cm)	0.52 s	0.46 s	0.69 s	0.53 s
5	Cob diameter (cm)	0.58 s	0.59 s	0.60 s	0.32 ns
6	Yield (dry weight of seeds per plot)	1.00	0.53 s	1.00	0.56 s
7	Weight of 1.000 seeds (g)	0.75 s	0.65 s	0.78 s	0.47 s
8	Number of fresh leaf at harvest per plant	0.53 s	0.52 s	0.48 s	0.68 s
9	Fresh stover weight per plant	0.53 s	1.00	0.56 s	1.00

Note: s, the correlation coefficient is real at the 5% level and ns, not real different

In Table 4 it can be seen that there is a correlation between the observed traits and the yield of all traits, except plant height in the technique with pollination control; while in the basic index technique, only plant height and number of leaves per plant were not correlated. The weight of fresh heartwood per plant correlated with all traits, except plant height and number of leaves per plant in the pollination control technique and with plant height and ear diameter on the basic index technique.

Discussion

The potential yield has marked progress in linear selection up to the seventh cycle for both mass selection techniques. The average progress in the selection of fresh stover weight also experienced the same thing, which is real linear for both techniques. This means that the two mass selection techniques are still effective until the seventh cycle in increasing yield and fresh stover. The same for yield was obtained by Baktash (2016) who stated that the modification of mass selection was effective for yield and corn yield components. Other studies that support this, for example, Shresthaet al. (2018), state that mass selection is effective in improving the agronomic characters of maize plants, namely, to cause higher yields, reduced plant height compared to the initial population after five cycles. Research conducted by Govind and Mani

(2016) revealed that there is significant progress in mass selection for the number of cobs per plant, ear diameter, number of rows per ear, the weight of seeds per ear, and yields.

The difference in selection responses per cycle for yield results can also be seen from the linearity of the two selection techniques (Fig. 1). The selection response for the base index is higher than the pollination control. The improved yield was obtained using both techniques, including indirect mass selection; the selection response is very dependent on the close relationship between the selected and the corrected characters. Mass selection by pollination control uses plant height and the number of leaves as selected characteristics, whereas the dry weight of the harvested cobs is used for the properties selected through a base index technique. A significant positive correlation coefficient is obtained between the weight of the dried cob harvest and the yield, which is *0.65* for selection with pollination control and 0.87 for the base index.The same is true for the correlation between yields and dry cob weights harvested by Abdalla et al. (2010), who revealed a positive correlation between yield and the dry weight of harvested cobs. Subaedah et al. (2016) added that the longer the cob, or the more the number of seeds, results in an increase in yield. The correlation coefficient value is much higher than the plant height of 0.36 and for the number of leaves of 0.51 for techniques with pollination control and plant height and number of leaves were 0.37 and 0.23 respectively for the basic index technique (Table 4). It is very possible that the selection response uses a base index for higher yield compared to pollination control. The value of heritability also determines the magnitude of the selection response. The dry weight of the cob has a high heritability. On the other hand, the plant height has a low heritability, and the number of leaves is classified as high.

The linearity of the two techniques for fresh stover weight weights, as shown in (Fig. 2), indicates that the base index technique is higher in the third cycle compared to pollination control. The difference is even greater with more and more selection cycles. This can occur because fresh stover is selected directly by the base index technique. Selection by pollination control to increase the weight of fresh stover using plant height and number of leaves as selected traits, so the selection response depends on the close relationship between the two traits with fresh stover. High plants have low heritability; while the heritability of the number of leaves is classified as high. However, both characters have a correlation coefficient that is not too high (<0.50) and not significant in this technique (Table 4); so the impact on selection progress is smaller than directly using the base index technique. This is in accordance with the opinion of Basuki (2005) which states that the size of the indirect response greatly depends on the value of heritability and the closeness of the relationship between the two characters.

The selection causes an increase in gene frequency and genotype frequency for selected and improved characters (Soemartono et al., 1992). Increased frequency genes and frequency of genotypes can be seen by an increase in the average population selected from the initial population. The increase in yield due to mass selection for seven cycles with pollination control and the base index was quite large by 43.46% and 59.81%, respectively. This increase in yield is higher than that obtained by Sutresna (2010) of 44.04% for index selection. The weight of fresh stover per plant increased by 79.21% for selection with pollination control and 103.47% for the base index after seven cycles. This occurs because the response of mass selection with a base index for yield and fresh stover is higher than the mass selection by pollination control. The response of mass selection with a base index for fresh stover weight was 11.50 g/plant/cycle, and the response of mass selection with pollination control was 7.82 g/plant/cycle (Table 1). The difference in selection response was that big, causing an almost doubling increase.

The importance of research results:

The existence of a significant linear selection response for both mass selection techniques, indicates that both can be continued in the next cycle. Based on the magnitude of the selection response, the basic index technique is better used for increasing yield and fresh stover in dry land.

Conclusions

1. The response of mass selection with pollination control is smaller than the base index for yield and fresh stover weight. Both of them follow a simple linear regression model.
2. Increased yield and fresh stover of mass selection were obtained with lower pollination control compared with the basic index technique after seven cycles. Increased yield by 43.46% and 79.21% fresh stover weight were obtained after seven cycles of mass selection by pollination control, while the use of base index causes an increase in yield of 59.81% and fresh stover of 103.47% compared to the initial population.
3. Mass selection activities with base index technique need to be continued in the next cycle in order to obtain higher yield and fresh stover.

Conflict of Interest

The Authors state that there is no conflict of interest in this research.

Authors' Contributions

Sudika carried out the experiments and drafted the manuscript. Soemeinaboedhy conceived of the study and helped the draft manuscript. All authors read and approved the final manuscript.

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6. Point yang harus direvisi tahap kedua 7 Februari 2022

Hans-Peter Kaul <hans-peter.kaul@boku.ac.at>7 February 2022 at 20:53To: I Sudika <wayan.sudika@klinikjurnal.com>, I Soemeinaboedhy <soemeinaboedhy@gmail.com>

Hallo I Sudika, I Soemeinaboedhy ,für Ihre Einreichung im Journal für Kulturpflanzen: "The Improvement of Yield and Corn Fresh Stover Through Two-Mass Selection Techniques in Dry Land" liegen uns nun die Gutachten vor (siehe unten).

Wir bitten Sie um Überarbeitung des Manuskriptes bis zum **xx.xx.20xx** unter Berücksichtigung der Kommentare undHinweise der Gutachter/innen. Die überarbeiteten Textstellen können Sie entweder farblich hervorheben oder mit der"Änderungen nachverfolgen"-Option in Word kennzeichnen. Bitte reichen Sie zusätzlich zum überarbeitetenManuskript auch eine Datei mit Antworten auf die Hinweise in den Gutachten ein.
Overall, it seems to me as if you did not put too much effort in revising the manuscript. Often your revision seems tobe rather sloppy, as for example writing "completeblock" instead of "complete block", putting sub/superscripts orincluding a complete sentence in Indonesian language.
Vielen Dank und beste Grüße

Gutachter/in A:
The authors addressed some points from the previous review comments. However, there are still points forimprovement (see details below). The language still can be improved in many sections of the manuscript (see someexamples below, but applies to the whole text). Unclear or misleading sentences often cause confusion for the reader.The manuscript is rather descriptive and specific for the material used and the experiments conducted. Thus it is hardto draw general conclusions. However, it might serve as an example of mass selection in a maize population.
Lines 4-5: Check German translation again. There are spaces missing. “Zwei” should be written without capital letter.The hyphen after “Zwei-“ is not needed (also for the English title “…Two-Mass Selection…”, no hyphen). Not sure if“trockenem Land” is the best fitting translation for “Dry Land”.
Line 11: Again, space missing in “completeblock”.
Line 17: Again, space missing in “selection,fresh”. Many more examples throughout the text, which I will not mentionspecifically any more, but should be addressed.
Line 53: Parenthesis too much “(Sutresna…”.
You sometimes write “basic index” and sometimes “base index” and sometimes even “baseline index“. If you actuallyalways refer to the same thing, choose one expression and make it consistent throughout the manuscript. I think“base index” is the correct form.
Line 70: Again, space missing “dry seeds;while” and I would write comma instead of semicolon. And I find theexpression “dry weight of dry seeds” also a bit odd because “dry weight” already implies that seeds are dry. Maybeyou find an alternative solution (just “seeds”?). Also, instead of “the selection response of other properties is lower” Iwould write, “the selection response of other traits was lower”, which makes it more clear in my opinion.6/10/22, 4:10 PM Gmail - [JFK] Entscheidung der Redaktion
https://mail.google.com/mail/u/0/?ik=2bb59ff57f&view=pt&search=all&permthid=thread-f%3A1724112782576691242&simpl=msg-f%3A17241127… 2/4

Line 72: “have been carried out”
Lines 78-79: “How big was the selection response and how much was the improvement of both characters have beenassessed?” This sentence is grammatically wrong. Should be rephrased.
Line 83: what does “site location” mean? “site” and “location” are more or less synonyms of each other. Do you mean“trial location”? Or maybe you could just write “location”.
Line 85: “was carried out”
Line 93-94: What is “Po”? Do you mean “P0”? What means “superior Var.”? Do you mean “superior varieties”? Canyou give a reference or short explanation why/how these are superior? Are these 28 “cultivars” hybrids, breeding linesor landraces?
Line 106: “taller plants with more leaves”
Line 111: “randomized complete block design”?
Lines 118-119: Write “1000 kernel weight” instead of “weight of 1,000 seed grains”.
Line 123: “Least significant difference”. It’s called LSD, not SSD.
Lines 121-169: Is “K2P1” a common nomenclature in this context? For me, this variable name is still somehow odd.
Also, my previous comment has been completely ignored: “Use superscript where needed. For example in Line …“R2”, the “2” should be written in superscript. Or for example when you refer to variances like in Line …, the “2”should be written in superscript and the “g” and “p” in subscript.”. Even though you wrote as a response “Thank youfor your correction. We have revised it.”. Maybe that’s a formatting issue? But, putting subscripts and superscriptswhere they belong would make it much better readable in my opinion.
Also, again, language could be improved, as for example in this sentence “Testing the significant/not significant of thelinear regression coefficient using the F0.05 test in the analysis of variance by breaking the source of the populationvariance is linear and the remainder for each technique of selection. For example, we guess.”.
Why Coefficient of Genetic Diversity is abbreviated with “KKG”? Also, isn’t the more common name “coefficient ofgenetic variation”? Later at table 2, you name it “coefficient of genetic variances” (Lines 204-205). Only oneexpression should be used throughout the manuscript.
Line 164: Parenthesis missing.
Table 1: “Average selection response per cycle”
Table 1 and Figures 1 and 2: As far as I understand, the values given in Table 1 correspond to the K2P1 parameter ofthe linear regression, right? If so, why the values in the equations in Figures 1 and 2 differ from the values in Table 1? 6/10/22, 4:10 PM Gmail - [JFK] Entscheidung der Redaktion
https://mail.google.com/mail/u/0/?ik=2bb59ff57f&view=pt&search=all&permthid=thread-f%3A1724112782576691242&simpl=msg-f%3A17241127… 3/4

Line 202-203: Language.
Line 226-227: "**) There is no BNT value because the analysis of variance is not significantly different". I don'tunderstand this sentence, as there are letters in the column (just all of them are "a", ergo not significantly different).
In general a few more language examples: "Yield power" (Table 4)?, "fresh heartwood" (Line 256)?, "fresh stoverweight weights" (line 311)?, "High plants have low heritability" (line 317)? or very severely in lines 260-261 "padateknik indeks dasar dan bobot 1000 butir biji pada teknik dengan pengendalian penyerbukan"? Use English language!
Lines 325-326: "Increased frequency genes and frequency of genotypes…". Probably again a language issue, butthis doesn't make sense. Which genes? Which genotypes? You need to connect with the sentence before.
Table 4: Surprisingly Plant height and number of leaves per plant are not significantly correlated with the target traits(with one exception for DPP). Can this be an explanation for the inferior performance of the DPP technique?
Line 382: was this really a "Master Thesis"? Please revise all references again and edit if needed.
Empfehlung: Überarbeitung erforderlich--
Journal für Kulturpflanzen*Journal of Cultivated Plants*E-Mail: journal-kulturpflanzen@julius-kuehn.deWebsite: https://ojs.openagrar.de/index.php/Kulturpflanzenjournal

7. Artikel yang telah direvisi sesuai komentar tanggal 12 Februari 2022.

Original Article

The Improvement of Corn Yield and Fresh Stover Through Two Mass Selection Techniques in a Dry Land

Die Verbesserung von Ertrag und Mais Frisch einlagerung durch zwei Massen-Selektionsverfahren in Festland

Abstract

This study aims to determine the response of mass selection by pollination control and base index in the yield and fresh stover weight of corn and to determine the increase of yield and fresh stover after seven mass selection cycles. The method to reduce the environmental effects during the selections was a subdivided block. A randomized complete block design was used to test the selection results. The results showed a 43.46% increase in yield and a 79.21% increase in fresh stover weight after seven cycles of mass selection by pollination control; while the base index technique caused a 59.81% increase in yield and 103.47% increase in fresh stover weight compared to initial population. Mass selection activities with two techniques are needed to be continued in the next cycle to obtain a higher yield and fresh stover weight.

Keywords: base index selection, fresh stover, mass selection, selection progress, selection by pollination control

Zusammenfassung

Diese Studie zielt darauf ab, die Reaktion der Massenselektion durch die Kontrolle der Bestäubung und durch die Auswahl des Basisindex des Ertrags und des Frisch strohgewichts bei Maispflanzen zu bestimmen und das Ausmaß der Ertragssteigerung und der Ergebnisse von Frisch Stroh aus den Sieben Massenselektion Zyklen zu bestimmen. Die Methode zur Reduzierung von Umwelteinflüssen während der Auswahl ist ein unterteilter Block. Ein randomisiertes Blockdesign wurde verwendet, um die Ergebnisse der Selektion zu testen. Die Ergebnisse zeigten, dass nach Sieben Zyklen Massenselektion durch Bestäubungs kontrolle ein erhöhter Ertrag von 43,46 % und ein Frischstrohgewicht von 59,81 % erhalten wurden; während die Verwendung des Basisindex eine Ertragssteigerung von 79,21 % und Frischstroh von 103,47 % im Vergleich zur Ausgangspopulation bewirkt. Massenselektions Aktivitäten mit zwei Techniken müssen im nächsten Zyklus fortgesetzt werden, um einen höheren Ertrag und frischen Strauch zu erhalten.

Stichwörter: Grundindexauswahl, Frisch Stroh, Massenselektion, Selektionsfortschritt, Auswahl durch Bestäubungs kontrolle

Introduction

Mass selection is based on the selection of plant and seed individual phenotypes to form the population in the next cycle. Despite being known as the oldest method, it is still used continuously. The effectiveness of mass selection is dependent on the selected properties, isolation, accuracy in reducing environmental effects, and the number of selected plants. Mass selection will be effective if it is done on characters with high heritability (Hallauer et al., 2010). Shrestha et al. (2018) stated that mass selection is effective in improving the agronomic characteristics of maize. This is observed from the higher yield compared to the initial population after five selection cycles. A study conducted by Govind and Mani (2016) reported a significant increase in the number of cobs per crop, the cob diameter, number of rows per cob, seed weight per cob, and yield after mass selection. The highest expectation of genetic heritability and progress was obtained in seed weight per ear, followed by yield and the number of ears per crop. A 23.2% increase in yield was obtained by Khamkoh et al. (2019) after two simple iterative selection cycles.

The mass selection progress can be improved by conducting the selection before pollination and crossing the selected plants only. Such selection is called mass selection by controlling pollination and this indirect selection can be used to improve yield and fresh stover weight. The success of this technique is highly dependent on the relationship of the selected trait with the improved trait (Basuki, 2005). Sutresna (2010) gained a yield increase after controlling pollination in the weight of dry seeds per plot by 2.07 kg (44.04%) for three cycles, which is higher than without (1.67 kg or 33.99%). The average increase per cycle of selection with control was 14.04%, and 11.33% without control.

Mass selection can be done to improve two or more characters simultaneously, one of them using the base selection index. Kar and Warsi (2006) stated that each environment has a certain criterion in determining the index to improve the nature of young cobs. According to Smith (1936), the use of the primary and base index for the selection of single and combined characters (yield, seed moisture content at harvest, the presence of roots, and the presence of stems) is more efficient than the Smith–Hazel index. The use of a base index can be done by compiling a selection index by economic weights, but it is rather difficult to assign economic weights to each trait (Ajala, 2010). According to Walsh (2010), the value of heritability and genotypic correlation can be ignored in compiling a base index. The results of Asghar and Mehdi (2010) revealed that selection using the base index is more efficient for characters that are related to quality and the combined nature of results and quality. Tardin et al. (2007) used the Smith–Hazel index with full-sib selection and obtained a 4.68% increase in the seed's dry weight, while other traits' response was lower.

Mass selection with pollination control techniques and base index techniques have been carried out for seven cycles to improve the yield and fresh stover weight. The pollination control technique uses plant height and the number of leaves per plant as the selected properties. The base index is obtained from the economic value of two characters, namely the weight of dried cobs per plant and the weight of fresh stover. The selection has been carried out for seven cycles. However, the selection response per cycle of each technique was not known for its yield, fresh stover weight per plant, and other characteristics. How big was the selection response and how much was the improvement of the two assessed characters? Therefore, this study aimed to determine the response of mass selection by pollination control and base index in yield and fresh stover weight after seven cycles and to determine the increase of both characters compared to the initial population.

Materials and Methods

The method, time, and location

This study used an experimental method with all experiments carried out in dryland with pump wells. The study was carried out from July to October 2018 or in the dry season in Amor-Amor Gumantar village, North Lombok district. The characteristics of the dry land were ± 60 m above sea level, 20 °C – 37 °C of air temperature, and 63% to 100% relative humidity during the test. The soil texture was loam sand, with soil pH of 6.2, 1.22% C-organic, 0.27% N-total, 83.63 ppm available-P, and 0.65 meq% of exchangeable K.

Corn varieties

The material used as the initial population (P_0) for seven cycles selection was produced by local cultivar assemblies (PHRKL). P_0 is the result of the hybridization of 28 local cultivars of West Nusa Tenggara with the superior varieties of Gumarang, Lamuru, and Sukmaraga. The superiority of the 28 local cultivars was due to the higher root weight and yield compared to other tested cultivars, while also they can be harvested early. They belong to landraces. Then, the population was selected for seven cycles with two techniques (14 types of the population) i.e.: P_1DPP, P_2DPP, P_3DPP, P_4DPP, P_5DPP, P_6DPP, P_7DPP, P_1IS, P_2IS, P_3IS, P_4IS, P_5IS, P_6IS, P_7IS, and the Gumarang superior variety. DPP stands for pollination control and IS stands for the selection index.

Experimental design and mass selection

Two mass selection techniques were applied, pollination control (DPP) and base index (IS). Both mass selection techniques were carried out for seven cycles in a dry land. The method used to reduce the environmental effect in the selection plot is the subdivided block method, conducted by dividing the selection plot into 100 plots with 40 plants in each plot. The selection was done in each plot with as much as 5% of the selected plants. Mass selection by pollination control was done by selecting the taller plants with more abundant leaves as much as 5% before pollination and crossing between the selected plants. The weight of each trait in the base index technique was obtained from the ratio of the gross income of each trait to the total gross income of the two characters. The gross income of each trait was obtained by multiplying the average yield of three plots in the selection plot multiplied by the market price at the time of harvest. A randomized complete block design was used in testing the selection results with three blocks. The irrigation was done once every 7 days from planting to 70 days after planting. The plant spacing was 20 cm x 60 cm, with one plant per hole. The plants were planted in 2 rows, where each row contained 25 plants in a plot size of 1.2 m x 5 m.

Plant observation

The observed variables in this study were plant height, the number of leaves per plant, dried cobs weight per plant, cob length, cob diameter, the number of fresh leaves per plant at harvest, the weight of fresh stover per plant, yield based on the dry weight of seeds per plot, and 1,000 kernel weight.

Data analysis

The observation data were analyzed using analysis of variance (ANOVA) at a 5% significance level with the least significant difference test (LSD) at a 5% significance level for the post-hoc test. The increase in yield or fresh stover weight was calculated from the difference between the seventh cycle population and the initial population (P7DPP-P0/P7IS-P0). The mass selection response per cycle of each technique was obtained from the linear regression coefficient between the observed properties and the selection cycle described in the following linear equation (Little and Hills, 1972):

$$\acute{Y}L = \bar{Y} + (K_2P_1)\, X' \quad (1)$$

description:

ÝL: Linear estimator value for a certain cycle population of each technique

$\bar{Y}$: General average value of a trait

K_2P_1 = Linear regression coefficient, which is the average selection progress per cycle

X' = number of selection cycles

$$K_2P_1 = \{-7(Y_0.) -5(Y_1.) - 3 (Y_2.) - 1(Y_3.) + 1(Y_4.) + 3(Y_5.) + 5(Y_6.) + 7(Y_7.)\} / (168 \times r) \quad (2)$$

Where:

K_2P_1 is the linear polynomial regression coefficient, the selection response per cycle of each technique. r is the number of blocks. Y_0., Y_1., Y_2., Y_3., Y_4, Y_5., Y_6, and Y_7. are the sum of all initial population blocks in cycle 1, cycle 2, cycle 3, cycle 4, cycle 5, cycle 6, and population cycle 7, respectively.

To test whether the regression coefficient is linear or not, the source of treatment variance (population) on the ANOVA is divided into two, namely linear and residual. This is done for each selection technique. For example, we guess the 7th cycle yield ($\acute{Y}_L$), then $\bar{Y}$ is the average yield of three blocks of the entire population (from P_0 to 7th cycle). X' will be 7 for the multiplier of K_2P_1. After obtaining K_2P_1, the equation can be made by replacing it with the average and K_2P_1 from the calculation results. The model was applied to each technique.

Broad sense heritability (H^2) was obtained through the following formula (Ujianto et al., 2020):

$$H^2 = (\sigma^2_g / \sigma^2_p) \times 100 \% \quad (3)$$

Description:

σ^2_g: the center square of treatment on avova – center square of the error

σ^2_p: σ^2_g + center square of the error

Furthermore, the grouping of values was based on the opinion of Stansfield (1991), which was 50–100 for high, 20–<50 for moderate, and <20 for low.

Furthermore, the calculation of the coefficient of genetic variation (CGV) was carried out with the following formula:

CGV (%) = (σ_g/μ) * 100 % (4)

Descriptions:

CGV = coefficient of genetic variation

σ_g = standard deviation of genetic variation

μ = general mean of a trait.

The software used in this analysis was Minitab version 18 (Minitab LLC, USA).

Results

Selection response per cycle for both mass selection techniques

The selection caused changes in population averages and the difference was called selection response (Table 1).

Table 1. The average selection response per cycle for DPP and IS techniques after seven cycles

Observed characters	Average selection response per cycle	
	DPP	IS
Plant height (cm)	1.67 *	1.17 *
Number of leaf (sheet) per plant	0.06 *	0.08 *
Cob dry weight per plant (g)	2.42 *	2.86 *
Cob length (cm)	0.06 *	0.12 *
Cob diameter (cm)	0.02 ns	0.02 ns
Seeds dry weight per plot (g) (yield)	47.88 *	72.80 *
Weight of 1.000 seeds (g)	1.50 *	2.50 *
Number of fresh leaves at harvest (sheet)	0.12 *	0.12 *
Fresh stover per plant (g)	7.82 *	11.50 *

Note: * Linear significantly different at the 5% level; ns, not significant linear.

It can be seen in Table 1 that the yield (grain dry weight per plot) had a significant linear selection response, which was 47.88 g/plot for DPP and 72.80 g/plot for IS. Dry cob weights per plant have a significantly linear selection response for both techniques. The fresh stover weight per plant was significant linear for control selection, which was 7.82 g/plant for DPP and 11.50 g/plant for index. The response to a selection of plant height and the number of leaves per plant, as well as the number of fresh leaves per plant at harvest, was also a significant linear.

The linear regression model for yield is presented in Figure 1 and the linear regression model for fresh stover weights is presented in Figure 2. The greater R^2 value was obtained in IS compared to DPP for both yield (Fig. 1) and fresh stover weights per plant (Fig. 2). This showed that the prediction of yield and fresh stover weights per plant using a regression equation in the IS is more accurate than DPP. With each addition of one mass selection cycle, the yield will increase by 145.6 g per plot for IS, while only 95.75 g per plot increase in DPP (Fig. 1). Meanwhile, the fresh stover weights per plant were observed to be increased by 25.51 g in IS and 15.63g in DPP (Fig. 2).

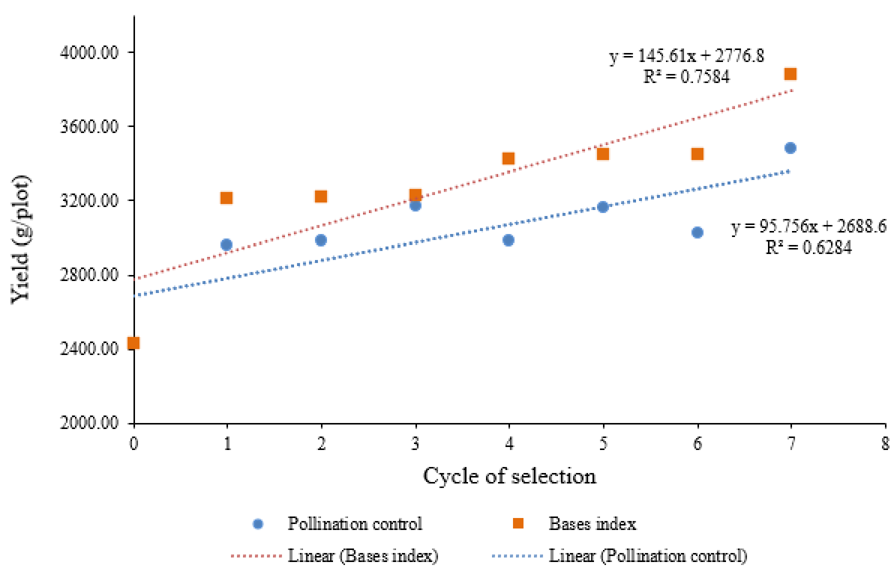

Fig. 1. The linear graph of yield results for both mass selection techniques.

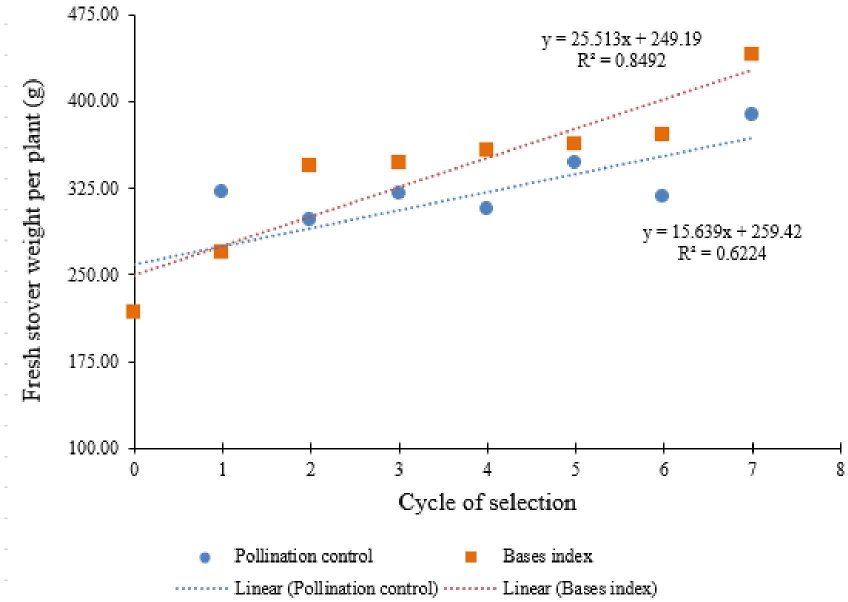

Fig. 2. The linear graphs of fresh stover weights per plant for both mass selection techniques.

The magnitude of response

The magnitude of response in the observed characteristics is highly dependent on heritability and genetic variance. General variances are expressed in the CGV. The magnitude of broad-sense heritability (H^2) and the CGV are presented in table 2.

Table 2. Heritability value (H^2) and the coefficient of genetic variation (CGV) for each trait in DPP and IS.

No.	Observed parameters	DPP Technique			Base Index Technique		
		H^2 (%)	Classification	CGV (%)	H^2 (%)	Classification	CGV (%)
1	Plant height	35.79	Moderate	2.54	10.46	Low	3.59
2	Number of leaves per plant	44.94	Moderate	2.43	57.56	High	3.59
3	Cob dry weight at	38.24	Moderate	7.18	59.47	High	7.66

	harvest per plant						
4	Cob length (cm)	1.86	Low	0.63	13.07	Low	2.41
5	Cob diameter (cm)	49.39	Moderate	1.96	29.13	Moderate	1.54
6	Yield (dry weight of seeds per plot)	51.95	High	8.56	60.32	High	11.29
7	Weight of 1,000 seeds (g)	70.19	High	4.82	67.13	High	6.66
8	Number of fresh leaves per plant at harvest	55.76	High	8.16	57.71	High	8.08
9	Fresh stover weight per plant	40.08	Moderate	14.24	65.61	High	14.50

Based on Table 2, the weight of 1,000 seeds and the number of fresh leaves at harvest had a high heritability in DPP. Meanwhile, the plant height, number of leaves per plant, dry weight of harvested cob per plant, the diameter of cob, and the weight of fresh stover per plant were classified as medium. Low heritability was obtained at the length of the cob. In the IS, the heritability was high in the number of leaves per plant, weight of dry ear harvested per plant, yield, the weight of 1,000 seeds, number of fresh leaves at harvest, and the weight of fresh stover.

The selection causes changes in the population averages and the magnitude for each population according to the selection cycle (Table 3). All selected populations (P_1-P_7) DPP, IS and Gumarang varieties were compared with the initial population (P_0) for each observed trait.

Table 3. The average of all observed properties for each treatment during mass selection.

Treatment	Average *)				
	1 **)	2	3	4	5

P_0	219.33	11.75 a	138.03 a	13.27 a	4.43 a
P_1DPP	238.58	12.17 a	144.53 a	13.48 a	4.37 a
P_2DPP	240.25	12.50 b	161.48 b	13.77 a	4.53 a
P_3DPP	224.92	12.33 a	160.29 b	13.98 a	4.53 a
P_4DPP	249.83	12.58 b	163.94 b	14.02 a	4.56 a
P_5DPP	238.58	12.42 b	170.44 b	14.11 a	4.60 a
P_6DPP	239.58	12.50 b	172.09 b	14.15 a	4.66 b
P_7DPP	255.92	13.00 b	172.09 b	14.15 a	4.66 b
P_1IS	231.67	11.92 a	161.33 b	14.05 a	4.54 a
P_2IS	249.83	12.17 a	172.15 b	14.11 a	4.63 b
P_3IS	247.75	12.42 b	172.35 b	14.15 a	4.63 b
P_4IS	230.83	12.08 a	172.51 b	14.27 a	4.65 b
P_5IS	239.58	12.58 b	179.67 b	14.49 b	4.67 b
P_6IS	237.67	12.50 b	173.36 b	15.17 b	4.72 b
P_7IS	249.83	13.17 b	194.93 b	15.15 b	4.72 b
Gumarang	240.75	14.25 b	165.10 b	14.23 a	4.40 a
$LSD_{0.05}$	-	0.58	21.92	1.18	0.17

Treatment	Average *)			
	6	7	8	9
P_0	2426.67 a	178.33 a	6.25 a	216.50 a
P_1DPP	2960.33 b	205.60 b	6.67 a	321.50 b
P_2DPP	2982.50 b	206.03 b	6.42 a	297.13 a
P_3DPP	3170.17 b	205.63 b	7.17 b	319.81 b
P_4DPP	2986.33 b	205.60 b	7.00 a	306.50 a
P_5DPP	3159.33 b	205.00 b	7.17 b	346.91 b
P_6DPP	3023.17 b	208.10 b	7.75 b	316.93 b
P_7DPP	3481.33 b	213.07 b	8.17 b	387.99 b

	(43.46 %) ***)			(79.21 %) ***)
P_1IS	3212.83 b	215.33 b	6.75 a	269.09 a
P_2IS	3221.17 b	211.93 b	7.25 b	344.10 b
P_3IS	3230.67 b	215.23 b	7.33 b	346.51 b
P_4IS	3419.67 b	218.37 b	7.17 b	357.58 b
P_5IS	3451.33 b	219.67 b	8.00 b	363.05 b
P_6IS	3451.00 b	221.03 b	7.58 b	370.51 b
P_7IS	3878.17 b	230.53 b	8.33 b	440.51 b
	(59.81 %) ***			(103.47 %)***)
Gumarang	3394.17 b	212.40 b	6.75 a	302.76 a
LSD$_{0.05}$	463.05	12.79	0.85	91.97

Note: *) The numbers followed by the same letter in the same column are not significantly different from the initial population with the BNT$_{0.05}$ test. **) There is no BNT value because the ANOVA showed insignificant difference; 1: plant height (cm); 2: number of leaves per plant (strands); 3: weight of dried cobs harvested per plant (g); 4: length of the cobs (cm); 5: diameter of cob (cm); 6: yield (dry weight of seeds per plot) (g); 7: weight of 1,000 seeds (g); 8: number of fresh leaves per plant at harvest (strands); 9: fresh stover weight per plant (g). ***) percentage increase compared to the initial population (Po).

It can be seen from Table 3 that the average yield of the seventh cycle was greater than the initial population in DPP, similar to the previous cycle population. IS mass selection caused a higher yield from the first cycle to the seventh cycle. The fresh stover weight of the seventh cycle population for DPP was higher than the initial population and a similar result was observed for IS. The initial population yield, the seventh cycle using the DPP technique, and the seventh cycle with the IS technique were 2426.67 g/plot (5,056 t/ha), 3481.33 g/plot (7,253 t/ha), and 3878.17 g/plot (8,080 t/ ha), respectively.

The correlation between characters with yield and fresh stover

The yield and fresh stover improvement were obtained through the plant height and the number of leaves for DPP and through the weight of dried cobs harvested and fresh stover for IS. The magnitude of the change in the quality was corrected per the closeness of the relationship with the selected trait. The correlation was calculated using the average data of each block. Each technique was separated, as shown in Table 4, with the number of correlated data for each trait being 24 (treatment = 8 and block = 3).

Table 4. The correlation of coefficient values between observed traits with yield and fresh stover weight per plant (BBS) in both techniques

No.	Observed parameters	DPP Technique		IS Technique	
		Yield	BBS	Yield	BBS
1	Plant height	0.36 ns	0.25 ns	0.37 ns	0.28 ns
2	Number of leaves per plant	0.51 s	0.17 ns	0.23 ns	0.44 s
3	Dry cob weight at harvest per plant	0.65 s	0.54 s	0.87 s	0.61 s
4	Cob length (cm)	0.52 s	0.46 s	0.69 s	0.53 s
5	Cob diameter (cm)	0.58 s	0.59 s	0.60 s	0.32 ns
6	Yield (dry weight of seeds per plot)	1.00	0.53 s	1.00	0.56 s
7	Weight of 1,000 seeds (g)	0.75 s	0.65 s	0.78 s	0.47 s
8	Number of fresh leaves per plant at harvest	0.53 s	0.52 s	0.48 s	0.68 s
9	Fresh stover weight per plant	0.53 s	1.00	0.56 s	1.00

Note: s = significantly different at 5% significance level. ns = not significantly different.

There was a correlation between the observed parameters and the yield of all traits, except plant height in DPP. Meanwhile, plant height and the number of leaves per plant were not correlated in IS. The weight of fresh stover per plant was correlated with all traits, except plant height and the number of leaves per plant in DPP and with plant height and cob diameter in IS. The highest correlation coefficient value to yield was obtained in the weight of dried cobs harvested per plant of IS and the weight of 1,000 seeds of DPP. For fresh stover, there were five characteristics with a coefficient value higher than 0.50 in DPP, namely the number of fresh leaves per plant, the weight of 1,000 seeds, yield, cob diameter, and the dry weight of harvested cobs per plant. On the other hand, there were four characteristics in IS with higher than 0.50 in coefficient value: dry weight of harvested cobs per plant, cob length, yield, and the number of fresh leaves per plant.

Discussion

The potential yield has marked progress in linear selection up to the seventh cycle for both mass selection techniques. The average progress in the fresh stover weight selection also experienced the same thing, which was significantly linear for both techniques. This means that the two mass selection techniques are effective until the seventh cycle in increasing the yield and fresh stover weight. The same for yield was obtained by Baktash (2016), who stated that the modification of mass selection was effective for yield and corn yield components. Other studies also supported the findings. Shrestha et al. (2018) stated that mass selection is effective in improving the agronomic characters of maize plants by causing higher yields and reducing the plant height compared to the initial population after five cycles. A study conducted by Govind and Mani (2016) revealed that there is significant progress in mass selection for the number of cobs per plant, cob diameter, number of rows per cob, the weight of seeds per cob, and yields. The difference in the selection responses per cycle for yield can also be seen from the linearity of the two selection techniques (Fig. 1).

The success of the indirect selection is highly dependent on the level of genetic correlation between the selected trait and the improved trait (Soemartono, et al., 1992; Basuki, 2005). The improved yield obtained using both techniques also includes the indirect mass selection; the selection response is very dependent on the close relationship between the selected and the corrected characters. Mass selection by pollination control used plant height and the number of leaves as the selected characteristics, while the dry weight of the harvested cobs was used in the base index technique. A significant positive correlation coefficient is obtained between the weight of the dried cob and the yield (0.65 for DPP and 0.87 for IS). This may cause the base index selection response to be greater than the pollination control. The same is true for the correlation between the yields and dry cob weights harvested by Abdalla et al. (2010), who revealed a positive correlation between them. Subaedah et al. (2016) added that the longer the cob, or the higher number of the seeds, will increase the yield. The correlation coefficient value is higher than the plant height (0.36) and the number of leaves (0.51) for DPP and 0.37 and 0.23 respectively for IS (Table 4). It is possible that the selection response with the base index has a higher yield compared to pollination control.

The heritability value of the selected characters also determines the magnitude of the selection response. The cob dry weight has a high heritability in the base index technique. On the other hand, the plant height, and the number of leaves were classified as moderate. This can also be seen in the number of leaves selection responses; the base index technique for selection response per cycle is greater than the pollination control technique, whereas the number of leaves per plant is a selection criterion in pollination control techniques. This happened because the number of leaves per plant in the base index selection had a higher heritability than the number of leaves in the selection controlled by pollination (Table 2). The heritability value of the number of leaves per plant in the pollination control technique was 44.94 % (moderate), while the base index technique was 57.56% (high). The coefficient of genetic variation also influences the selection response. The number of leaves per plant has a coefficient of genetic variation of 3.59% and 2.54% in pollination control techniques. This difference in value can also affect the size of the selection response per cycle.

The linearity of the two techniques for fresh stover weight indicates that the base index technique is higher in the third cycle compared to the pollination control (Fig. 2). The difference is even greater with the higher number of selections cycles. This can occur because fresh stover weight is selected directly by the base index technique. The pollination control uses plant height and number of leaves as selected traits to increase the weight of fresh stover, so the selection response depends on the close relationship between the two traits with fresh stover weight. Higher plants had low heritability, while the heritability of the leaf number was classified as high. However, both characters had a not too high (<0.50) correlation coefficient and were not significant in this technique (Table 4). So, the impact on selection progress is smaller than the base index technique. This is per the opinion of Basuki (2005), who stated that the size of the indirect response greatly depends on the value of heritability and the closeness of the relationship between the two characters.

The increased yield and fresh stover weight can occur due to an increase in gene frequency and genotype frequency. It is supported by Soemartono *et al.* (1992) that selection causes an increase in the gene and genotype frequency for the selected and improved characters. Increased genes and genotypes frequency can be seen from the increase in the average selected population from the initial population. The increase in yield due to mass selection for seven cycles with pollination control and the base index was quite large, accounting for 43.46% and 59.81%, respectively. This increase in yield is higher than that obtained by Sutresna (2010), who observed a 44.04% increase after index selection. The weight of fresh stover per plant was increased by 79.21% for selection with pollination control and 103.47% for the base index after seven cycles. This occurs because the response of base index for yield and fresh stover weight is higher than by pollination control. The response of base index for fresh stover weight was 11.50 g/plant/cycle and the response of mass selection with pollination control was 7.82 g/plant/cycle (Table 1). Shrestha et al. (2018) said that the significant increase in grain yield of the selected population may be attributed to improvement in other physiological and yield-related traits. Furthermore, the existence of a significant linear selection response for both mass selection techniques indicates that both can be continued in the next cycle. Based on the magnitude of the selection response, the base index technique is better to increase the yield and fresh stover of corn in a dry land.

Conclusions

1. The response of mass selection with pollination control was smaller than the base index for yield and fresh stover weight. Both of them followed a simple linear regression model.
2. The increase in yield and fresh stover weight were lower in pollination control compared to the base index technique after seven cycles. The yield increase by 43.46% and 79.21% in fresh stover weight were obtained after seven cycles of pollination control, while the base index technique caused an increase of yield by 59.81% and 103.47% in fresh stover weight compared to the initial population.
3. Mass selection activities with the base index technique need to be continued in the next cycle to obtain a higher yield and fresh stover.

Conflict of Interest

The authors state that there is no conflict of interest in this study.

Authors' Contributions

Sudika carried out the experiments and drafted the manuscript. Soemeinaboedhy conceived the study and helped in manuscript drafting. All authors read and approved the final manuscript.

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8. Komentar dari reviewer: setelah artikel diperbaiki;

Point-to-point responses

Reviewer 1

No	Issues	Responses
1	The authors addressed some points from the	Thank you for your time in reviewing and responding this

	previous review comments. However, there are still points for improvement (see details below). The language still can be improved in many sections of the manuscript (see some examples below, but applies to the whole text). Unclear or misleading sentences often cause confusion for the reader. The manuscript is rather descriptive and specific for the material used and the experiments conducted. Thus it is hard to draw general conclusions. However, it might serve as an example of mass selection in a maize population.	manuscript. We have proofread this manuscript as well as revised the unclear and misleading sentences. I agree with you that the materials used and the experiments were really specific, that is to dry land. This was done because the ultimate goal is to form superior varieties of corn for dry land. The mass selection technique with the basic index using the weight of harvested dry cobs and fresh stover as the selected trait is something that has been tried on corn plants. Likewise, pollination control techniques use plant height and number of leaves as selected traits.
2	Lines 4-5: Check German translation again. There are spaces missing. “Zwei” should be written without capital letter. The hyphen after “Zwei-“ is not needed (also for the English title “…Two-Mass Selection…”, no hyphen). Not sure if “trockenem Land” is the best fitting translation for “Dry Land”.	Thank you for your correction. We have revised and changed the trockenem Land in to Frestland which may be the best fitting translation for dry land.
3	Line 11: Again, space missing in “completeblock”.	Thank you for your correction. We have revised.
4	Line 17: Again, space missing in “selection,fresh”. Many more examples throughout the text, which I will not mention specifically any more, but should be addressed.	Thank you for your correction. We have revised.
5	Line 53: Parenthesis too much “(Sutresna…”.	Thank you for your correction. We have revised.
6	You sometimes write “basic index” and sometimes “base index” and sometimes even “baseline index“. If you actually always refer to the same thing, choose one expression and make it consistent throughout the manuscript. I think “base index” is the correct	Thank you for your correction. We have revised.

	form.	
7	Line 70: Again, space missing "dry seeds;while" and I would write comma instead of semicolon. And I find the expression "dry weight of dry seeds" also a bit odd because "dry weight" already implies that seeds are dry. Maybe you find an alternative solution (just "seeds"?). Also, instead of "the selection response of other properties is lower" I would write, "the selection response of other traits was lower", which makes it more clear in my opinion.	Thank you for your correction. We have revised.
8	Line 72: "have been carried out"	Thank you for your correction. We have revised.
9	Lines 78-79: "How big was the selection response and how much was the improvement of both characters have been assessed?" This sentence is grammatically wrong. Should be rephrased.	Thank you for your correction. We have revised.
10	Line 83: what does "site location" mean? "site" and "location" are more or less synonyms of each other. Do you mean "trial location"? Or maybe you could just write "location".	Thank you for your correction. We have revised.
11	Line 85: "was carried out"	Thank you for your correction. We have revised.
12	Line 93-94: What is "Po"? Do you mean "P0"? What means "superior Var."? Do you mean "superior varieties"? Can you give a reference or short explanation why/how these are superior? Are these 28 "cultivars" hybrids, breeding lines or landraces?	Thank you for your correction and responses. Initially, exploration was carried out in the NTB area which is classified as dry land and obtained 280 local cultivars. All local cultivars were evaluated on dry land, then 28 local cultivars were determined with dry root weight, higher yield and super early age (≤80 days). So the superiority of the 28 local cultivars was due to the higher root weight and yield compared to other cultivars tested and the super early harvest age. These 28 cultivars include landraces. We have revised at page 3 line 93-96.

13	Line 106: "taller plants with more leaves"	Thank you for your correction. We have revised.
14	Line 111: "randomized complete block design"?	Thank you for your correction. We have revised.
15	Lines 118-119: Write "1000 kernel weight" instead of "weight of 1,000 seed grains".	Thank you for your correction. We have revised.
16	Line 123: "Least significant difference". It's called LSD, not SSD.	Thank you for your correction. We have revised.
17	Lines 121-169: Is "K2P1" a common nomenclature in this context? For me, this variable name is still somehow odd. Also, my previous comment has been completely ignored: "Use superscript where needed. For example in Line … "R2", the "2" should be written in superscript. Or for example when you refer to variances like in Line …, the "2" should be written in superscript and the "g" and "p" in subscript.". Even though you wrote as a response "Thank you for your correction. We have revised it.". Maybe that's a formatting issue? But, putting subscripts and superscripts where they belong would make it much better readable in my opinion.	Thank you for your responses. K2P1 should be written as K_2P_1. It is a symbol used in polynomial linear regression equations. The equations using superscript and subscript have been fixed in the manuscript
18	Also, again, language could be improved, as for example in this sentence "Testing the significant/not significant of the linear regression coefficient using the F0.05 test in the analysis of variance by breaking the source of the population variance is linear and the remainder for each technique of selection. For example, we guess.".	Thank you for your response. We have rewritten the sentence at page 5 line 147-150. We hope the revised sentence is clearer.
19	Why Coefficient of Genetic Diversity is abbreviated with "KKG"? Also, isn't the more common name "coefficient of genetic variation"? Later at table 2, you name it "coefficient of genetic variances" (Lines 204-205). Only one expression should be used throughout the manuscript.	Thank you for your suggestion. We have revised it into coefficient of genetic variation (CGV).

20	Line 164: Parenthesis missing.	Thank you for your correction. We have revised.
21	Table 1: “Average selection response per cycle”	Thank you for your correction. We have revised.
22	Table 1 and Figures 1 and 2: As far as I understand, the values given in Table 1 correspond to the K2P1 parameter of the linear regression, right? If so, why the values in the equations in Figures 1 and 2 differ from the values in Table 1?	Thank you for your question. In Figure 1 and 2, the equations are made on the basis of the regression analysis' result, while K_2P_1 uses polynomial linear equation. To calculate the selection response, the coefficients according to formula (2) are used. This causes the difference in value between equation on the graph and the table (selection response).
23	Line 202-203: Language.	Thank you for your correction. We have revised.
24	Line 226-227: “**) There is no BNT value because the analysis of variance is not significantly different”. I don’t understand this sentence, as there are letters in the column (just all of them are “a”, ergo not significantly different).	Thank you for the response. We decided to remove the letter "a" after the numbers because the sources of variance for the populations on the ANOVA are not significantly different.
25	In general a few more language examples: “Yield power” (Table 4)?, “fresh heartwood” (Line 256)?, “fresh stover weight weights” (line 311)?, “High plants have low heritability” (line 317)? or very severely in lines 260-261 “pada teknik indeks dasar dan bobot 1000 butir biji pada teknik dengan pengendalian penyerbukan”? Use English language!	Thank you for your correction. We have revised those words into “Yield” (Table 4), “fresh stover” (line 257), “fresh stover weight” (line 312), “The higher plants have low heritability” (Line 318) and translated the Indonesian sentence into English at line 261.
26	Lines 325-326: “Increased frequency genes and frequency of genotypes…”. Probably again a language issue, but this doesn’t make sense. Which genes? Which genotypes? You need to connect with the sentence before.	Thank you. Gene and genotype refer to the yield and fresh stover weight. We have written additional information regarding this at page 15 line 325.
27	Table 4: Surprisingly Plant height and number of leaves per plant are not significantly correlated with the target traits (with one exception for DPP). Can	Thank you for your suggestion. I agree with you that this could be the reason for the lower selection response for yield and fresh stover weight on selection by the DPP

	this be an explanation for the inferior performance of the DPP technique?	technique. This is due to plant height and number of leaves as traits selected for yield improvement and fresh stover.
28	Line 382: was this really a “Master Thesis”? Please revise all references again and edit if needed.	Thank you for your correction. We have revised.

9. Artikel yang dilakukan *Proofreading*

Original Article

The improvement of corn yield and fresh stover weight through two mass selection techniques in dry land

Verbesserung des Maisertrags und des Frischstrohgewichts durch zwei Massenselektionstechniken in Trockengebieten

Abstract

This study aims to determine the response of the yield and fresh stover weight of corn under mass selection by pollination control and base index techniques and to determine the increase in yield and fresh stover after seven mass selection cycles. Subdivided blocks were used to reduce the environmental effects during the selection cycles. A randomized complete block design was used to test the selection results. Compared to the initial population, the results showed a 43.46% increase in yield and a 79.21% increase in fresh stover weight after seven cycles of mass selection by pollination control, while the base index technique produced a 59.81% increase in yield and a 103.47% increase in fresh stover weight. Mass selection using the two techniques needs to be continued in future cycles to obtain a higher yield and fresh stover weight.

Keywords: base index selection, fresh stover, mass selection, selection progress, selection by pollination control

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Zusammnefassung

In dieser Studie wurde untersucht, welchen Einfluss die Massenselektion durch Bestäubungssteuerung und Basisindextechniken auf den Ertrag und das Frischstrohgewicht von Mais haben und wie hoch der Anstieg des Ertrags und des Frischstrohgewichts nach sieben Massenselektionszyklen ist. Es wurden unterteilte Blöcke verwendet, um die Umwelteinflüsse während der Selektionszyklen zu reduzieren. Zur Prüfung der Selektionsergebnisse wurde ein randomisierter vollständiger Blockaufbau verwendet. Verglichen mit der Ausgangspopulation zeigten die Ergebnisse nach sieben Zyklen der Massenselektion durch Bestäubungskontrolle eine 43,46%ige Steigerung des Ertrags und eine 79,21%ige Steigerung des Frischstrohgewichts, während die Basisindextechnik eine 59,81%ige Steigerung des Ertrags und eine 103,47%ige Steigerung des Frischstrohgewichts ergab. Die Massenselektion unter Verwendung beider Techniken muss in künftigen Zyklen fortgesetzt werden, um einen höheren Ertrag und ein höheres Frischstrohgewicht zu erzielen.

Keywords: Basisindex-Selektion, Frischstroh, Massenselektion, Selektionsfortschritt, Selektion durch Bestäubungskontrolle

Introduction

Mass selection is based on the selection of phenotypes exhibited by individual plants and seeds that form a population in the next cycle. Despite being known as the oldest method, it is still used continuously. The effectiveness of mass selection is dependent on the selected properties, isolation, accuracy in reducing environmental effects, and the number of selected plants. Mass selection will be effective if it is performed on characters with high heritability (Hallauer et al., 2010). Shrestha et al. (2018) stated that mass selection is effective in improving the agronomic characteristics of maize, such as the increased yield of a population after five selection cycles. A study conducted by Govind and Mani (2016) reported a significant increase in the number of cobs per crop, cob diameter, number of rows per cob, seed weight per cob, and yield after mass selection. The highest expectation of genetic heritability and progress was obtained for seed weight per ear, followed by yield and the number of ears per crop. A 23.2% increase in yield was obtained by Khamkoh et al. (2019) after two simple iterative selection cycles.

The mass selection progress can be improved by conducting selection before pollination and by crossing only the selected plants. Such selection is called mass selection by pollination control, and this indirect selection can be used to improve yield and fresh stover weight. The success of this technique is highly dependent on the relationship between the selected trait and the improved trait (Basuki, 2005). Under pollination control, Sutresna (2010) showed an increase in yield, measured as the weight of dry seeds per plot, of 2.07 kg (44.04%) for three cycles, which was higher than the increase without pollination control (1.67 kg or 33.99%). The average increase per selection cycle was 14.04% under pollination control and 11.33% without such control.

Mass selection can be performed to improve two or more characters simultaneously if the base selection index is also used. Kar and Warsi (2006) stated that each environment has a certain factors that affect the index used to improve the characters of young cobs. According to Smith (1936), the use of the primary and base index for the selection of single and combined characters (yield, seed moisture content at harvest, the presence of roots, and the presence of stems) is more efficient than the Smith–Hazel index. A base index can be used by compiling a selection index based on economic weights, but it is rather difficult to assign economic weights to each trait (Ajala, 2010). According to Walsh (2010), the heritability and genotypic correlation values can be ignored in compiling a base index. The results of Asghar and Mehdi (2010) revealed that selection using the base index was more efficient for characters that are related to quality and their interactions. Tardin et al. (2007) used the Smith–Hazel index with full-sib selection and obtained a 4.68% increase in seed dry weight, while the response of other traits was lower.

Previously, mass selection with pollination control and base index techniques was carried out for seven cycles to improve the yield and fresh stover weight of maize. The pollination control technique used plant height and the number of leaves per plant as the selected properties. The base index was obtained from the economic value of two characters, namely, the weight of dried cobs per plant and the weight of fresh stover. The selection process was carried out for seven cycles. However, the selection response per cycle under each technique was not known for yield, fresh stover weight per plant, and other characters. How large was the selection response, and how much did the two assessed characters improve? This study aimed to determine the response of yield and fresh stover weight after seven cycles of mass selection by pollination control and base index techniques and to determine the increase in both characters compared to the initial population.

Materials and Methods

The method, time, and location

All experiments were carried out in dry land with pump wells. The study was carried out from July to October 2018 or in the dry season in Amor-Amor Gumantar village, North Lombok district. The dry land was ± 60 m above sea level, with 20 °C – 37 °C air temperature and 63% to 100% relative humidity during the experiments. The soil texture was loam sand, with a soil pH of 6.2, 1.22% C-organic, 0.27% N-total, 83.63 ppm available P, and 0.65 meq% exchangeable K.

Corn varieties

The material used as the initial population (P_0) that underwent seven cycles of selection was produced by local cultivar assemblies (PHRKL). P_0 is the result of the hybridization of 28 local cultivars of West Nusa Tenggara with the superior varieties Gumarang, Lamuru, and Sukmaraga. The superiority of the 28 local cultivars (landraces) was due to their higher root weight and yield compared to other tested cultivars and their ability to be harvested early. The P_0 population was selected for seven cycles with two techniques (14 resulting populations), i.e., P_1DPP, P_2DPP, P_3DPP, P_4DPP, P_5DPP, P_6DPP, P_7DPP, P_1IS, P_2IS, P_3IS, P_4IS, P_5IS, P_6IS, P_7IS, and were compared to the superior variety Gumarang. DPP represents the pollination control technique, and IS represents the selection (base) index technique.

Experimental design and mass selection

Two mass selection techniques were applied: pollination control (DPP) and base index (IS). Both mass selection techniques were carried out for seven cycles in dry land. The subdivided block method used to reduce the environmental effect in the selection plot and was conducted by dividing the selection plot into 100 subplots with 40 plants in each subplot. A selection pressure of 5% was performed in each plot. Mass selection by pollination control was performed by selecting taller plants with more abundant leaves before pollination and crossing these selected plants. The weight of each trait in the base index technique was obtained from the ratio of the gross income for each trait to the total gross income for the two characters. The gross income for each trait was obtained by multiplying the average yield of three subplots in the selection plot by the market price at the time of harvest. A randomized complete block design was used to test the

Comment [Ed6]: Please ensure that the intended meaning has been maintained in this edit.

Comment [DAS7R6]: Thank you. We approve it selection results with three blocks. Irrigation was performed once every 7 days from planting to 70 days after planting. The plant spacing was 20 cm x 60 cm, with one plant per hole. The plants were planted in 2 rows, where each row contained 25 plants in a plot size of 1.2 m x 5 m.

Plant observations

The observed variables in this study were plant height, the number of leaves per plant, dried cob weight per plant, cob length, cob diameter, the number of fresh leaves per plant at harvest, the weight of fresh stover per plant, yield based on the dry weight of seeds per plot, and 1,000 kernel weight.

Data analysis

The observation data were analyzed using analysis of variance (ANOVA) at a 5% significance level with the least significant difference test (LSD) at a 5% significance level for the post hoc test. The increase in yield or fresh stover weight was calculated from the difference between the population at the seventh cycle and the initial population (P7DPP-P0/P7IS-P0). The mass selection response per cycle of each technique was obtained from the linear regression coefficient between the observed properties and the selection cycle described in the following linear equation (Little and Hills, 1972):

$$\acute{Y}L = \bar{Y} + (K_2P_1)\,X' \quad (1)$$

where

$\acute{Y}L$: linear estimator value for a population at a certain cycle of each technique

$\bar{Y}$: general average value of a trait

K_2P_1 = linear regression coefficient, which is the average selection progress per cycle

X' = number of selection cycles

$$K_2P_1 = \{-7(Y_0.) - 5(Y_1.) - 3(Y_2.) - 1(Y_3.) + 1(Y_4.) + 3(Y_5.) + 5(Y_6.) + 7(Y_7.)\}/(168 \times r) \quad (2)$$

where

K_2P_1 is the linear polynomial regression coefficient, or the selection response per cycle of each technique. r is the number of blocks. Y_0., Y_1., Y_2., Y_3., Y_4, Y_5., Y_6, and Y_7. are the sums of all initial population blocks in cycles 1, 2, 3, 4, 5, 6, and 7, respectively.

To test whether the regression coefficient is linear or not, the source of treatment variance (population) based on the ANOVA is divided into two values, namely, linear and residual. This is done for each selection technique. For example, we estimate the 7th cycle yield ($\acute{Y}_L$); then, $\bar{Y}$ is the average yield of three blocks from the entire population (from P_0 to the 7th cycle). X' will be 7 for the multiplier of K_2P_1. After obtaining K_2P_1, the equation can be simplified by replacing this value with the average from the calculation results. The model was applied to each technique.

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Broad sense heritability (H^2) was obtained through the following formula (Ujianto et al., 2020):

$$H^2 = (\sigma^2_g/\sigma^2_p) \text{ x } 100\% \quad (3)$$

where

σ^2_g: the centrality squared value of each treatment based on ANOVA – the centrality squared value of the error

σ^2_p: σ^2_g + the centrality squared value of the error

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Furthermore, the grouping of the values was based on Stansfield (1991), where 50–100 represented high, 20–<50 moderate, and <20 low.

The calculation of the coefficient of genetic variation (CGV) was carried out with the following formula:

$$CGV (\%) = (\sigma_g/\mu) * 100\% \quad (4)$$

where

CGV = coefficient of genetic variation

σ_g = standard deviation of genetic variation

μ = general mean of a trait.

The software used in this analysis was Minitab version 18 (Minitab LLC, USA).

Results

Selection response per cycle for both mass selection techniques

The selection techniques caused changes in the population averages, and the difference was called the selection response (Table 1).

Table 1. The average selection response per cycle for the DPP and IS techniques after seven cycles

Observed characters	Average selection response per cycle	
	DPP	IS
Plant height (cm)	1.67 *	1.17 *
Number of leaves (sheet) per plant	0.06 *	0.08 *
Cob dry weight per plant (g)	2.42 *	2.86 *
Cob length (cm)	0.06 *	0.12 *
Cob diameter (cm)	0.02 ns	0.02 ns
Seed dry weight per plot (g) (yield)	47.88 *	72.80 *
Weight of 1,000 seeds (g)	1.50 *	2.50 *
Number of fresh leaves at harvest (sheet)	0.12 *	0.12 *
Fresh stover per plant (g)	7.82 *	11.50 *

Note: * Significantly different at the 5% level; ns, not significant.

Table 1 shows that the yield (grain dry weight per plot) had a significant linear selection response, which was 47.88 g/plot for DPP and 72.80 g/plot for IS. Dry cob weight per plant had a significant linear selection response under both techniques. The fresh stover weight per plant had a significant linear relationship under mass selection, with values of 7.82 g/plant for DPP and 11.50 g/plant for IS. The response to selection of plant height and the number of leaves per plant, as well as the number of fresh leaves per plant at harvest, was also significant and linear.

The linear regression model for yield is presented in Figure 1, and the linear regression model for fresh stover weight is presented in Figure 2. A greater R^2 value was obtained in IS than in DPP for both yield (Fig. 1) and fresh stover weight per plant (Fig. 2). This result showed that the prediction of yield and fresh stover weight per plant using a regression equation under IS was more accurate than that under DPP. With each addition of one mass selection cycle, the yield increased by 145.6 g per plot for IS, while it increased by only 95.75 g per plot for DPP (Fig. 1). Moreover, the fresh stover weight per plant increased by 25.51 g in IS and 15.63 g in DPP (Fig. 2).

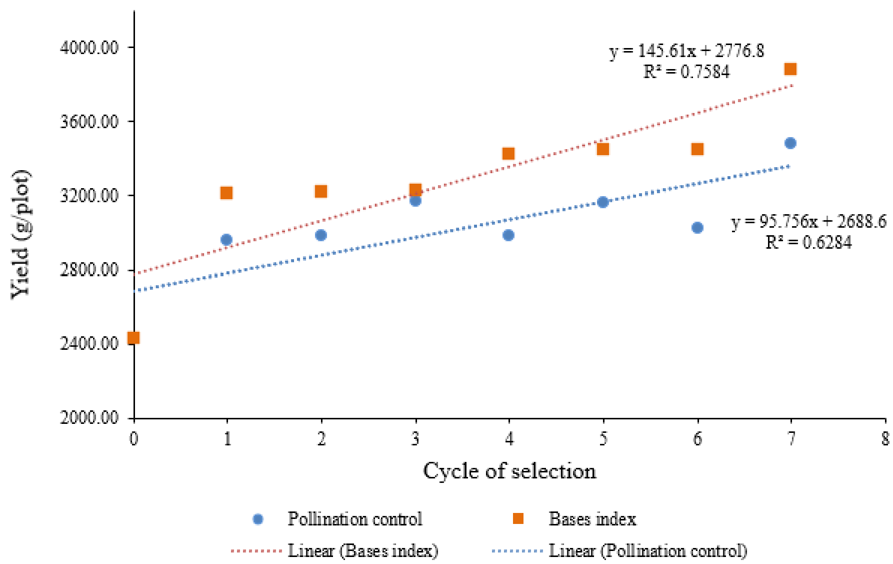

Fig. 1. Linear graph of yield results for both mass selection techniques.

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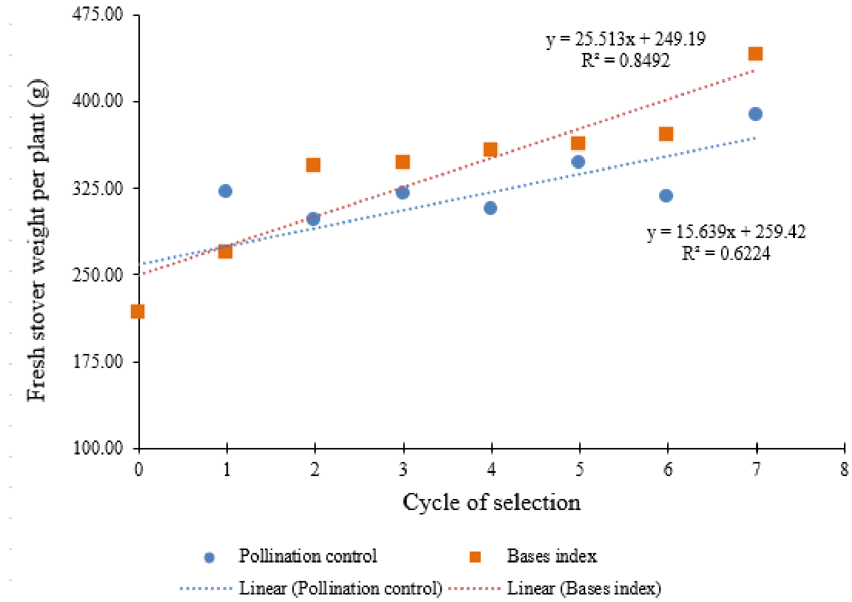

Fig. 2. Linear graph of fresh stover weight per plant for both mass selection techniques.

The magnitude of the response

The magnitude of the response in the observed characters is highly dependent on heritability and genetic variance. Genetic variance is expressed in the CGV. The magnitude of broad-sense heritability (H^2) and the values for the CGV are presented in Table 2.

Table 2. Heritability value (H^2) and the coefficient of genetic variation (CGV) for each trait under the DPP and IS techniques.

No.	Observed parameters	DPP Technique			Base Index Technique		
		H^2 (%)	Classification	CGV (%)	H^2 (%)	Classification	CGV (%)
1	Plant height	35.79	Moderate	2.54	10.46	Low	3.59
2	Number of leaves per plant	44.94	Moderate	2.43	57.56	High	3.59
3	Cob dry weight at harvest per	38.24	Moderate	7.18	59.47	High	7.66

	plant						
4	Cob length (cm)	1.86	Low	0.63	13.07	Low	2.41
5	Cob diameter (cm)	49.39	Moderate	1.96	29.13	Moderate	1.54
6	Yield (dry weight of seeds per plot)	51.95	High	8.56	60.32	High	11.29
7	Weight of 1,000 seeds (g)	70.19	High	4.82	67.13	High	6.66
8	Number of fresh leaves per plant at harvest	55.76	High	8.16	57.71	High	8.08
9	Fresh stover weight per plant	40.08	Moderate	14.24	65.61	High	14.50

Based on Table 2, the weight of 1,000 seeds and the number of fresh leaves at harvest had high heritability under DPP. Moreover, the plant height, number of leaves per plant, dry weight of harvested cobs per plant, diameter of cobs, and weight of fresh stover per plant were classified as having moderate heritability. Low heritability was found for the length of the cob. Under IS, the heritability was high for the number of leaves per plant, weight of dry ears harvested per plant, yield, weight of 1,000 seeds, number of fresh leaves at harvest, and weight of fresh stover.

Selection can cause changes in the population averages and magnitude for each population according to the selection cycle (Table 3). All selected populations (P_1-P_7) under DPP and IS, as well as the Gumarang variety, were compared with the initial population (P_0) for each observed trait.

Table 3. The average of all observed properties for each treatment during mass selection.

Treatment	Average *)				
	1 **)	2	3	4	5
P_0	219.33	11.75 a	138.03 a	13.27 a	4.43 a

P_1DPP	238.58	12.17 a	144.53 a	13.48 a	4.37 a
P_2DPP	240.25	12.50 b	161.48 b	13.77 a	4.53 a
P_3DPP	224.92	12.33 a	160.29 b	13.98 a	4.53 a
P_4DPP	249.83	12.58 b	163.94 b	14.02 a	4.56 a
P_5DPP	238.58	12.42 b	170.44 b	14.11 a	4.60 a
P_6DPP	239.58	12.50 b	172.09 b	14.15 a	4.66 b
P_7DPP	255.92	13.00 b	172.09 b	14.15 a	4.66 b
P_1IS	231.67	11.92 a	161.33 b	14.05 a	4.54 a
P_2IS	249.83	12.17 a	172.15 b	14.11 a	4.63 b
P_3IS	247.75	12.42 b	172.35 b	14.15 a	4.63 b
P_4IS	230.83	12.08 a	172.51 b	14.27 a	4.65 b
P_5IS	239.58	12.58 b	179.67 b	14.49 b	4.67 b
P_6IS	237.67	12.50 b	173.36 b	15.17 b	4.72 b
P_7IS	249.83	13.17 b	194.93 b	15.15 b	4.72 b
Gumarang	240.75	14.25 b	165.10 b	14.23 a	4.40 a
$LSD_{0.05}$	-	0.58	21.92	1.18	0.17

Treatment	Average *)			
	6	7	8	9
P_0	2426.67 a	178.33 a	6.25 a	216.50 a
P_1DPP	2960.33 b	205.60 b	6.67 a	321.50 b
P_2DPP	2982.50 b	206.03 b	6.42 a	297.13 a
P_3DPP	3170.17 b	205.63 b	7.17 b	319.81 b
P_4DPP	2986.33 b	205.60 b	7.00 a	306.50 a
P_5DPP	3159.33 b	205.00 b	7.17 b	346.91 b
P_6DPP	3023.17 b	208.10 b	7.75 b	316.93 b
P_7DPP	3481.33 b			387.99 b
		213.07 b	8.17 b	
	(43.46%) ***)			(79.21%) ***)

P_1IS	3212.83 b	215.33 b	6.75 a	269.09 a
P_2IS	3221.17 b	211.93 b	7.25 b	344.10 b
P_3IS	3230.67 b	215.23 b	7.33 b	346.51 b
P_4IS	3419.67 b	218.37 b	7.17 b	357.58 b
P_5IS	3451.33 b	219.67 b	8.00 b	363.05 b
P_6IS	3451.00 b	221.03 b	7.58 b	370.51 b
P_7IS	3878.17 b			440.51 b
		230.53 b	8.33 b	
	(59.81%) ***			(103.47%)***)
Gumarang	3394.17 b	212.40 b	6.75 a	302.76 a
$LSD_{0.05}$	463.05	12.79	0.85	91.97

Note: *) The numbers followed by the same letter in the same column are not significantly different from the initial population with the $BNT_{0.05}$ test. **) There is no BNT value because the ANOVA showed a nonsignificant difference. 1: Plant height (cm); 2: number of leaves per plant (strands); 3: weight of dried cobs harvested per plant (g); 4: length of the cobs (cm); 5: diameter of the cobs (cm); 6: yield (dry weight of seeds per plot) (g); 7: weight of 1,000 seeds (g); 8: number of fresh leaves per plant at harvest (strands); and 9: fresh stover weight per plant (g). ***) Percentage increase compared to the initial population (P_0).

Table 3 shows that the average yield of the seventh cycle was greater than that of the initial population under DPP, similar to the previously studied population. IS mass selection caused a higher yield from the first cycle to the seventh cycle. The fresh stover weight of the population at the seventh cycle under DPP was higher than that of the initial population, and a similar result was observed for IS. The yield values for the initial population, the seventh cycle under DPP, and the seventh cycle under IS were 2426.67 g/plot (5,056 t/ha), 3481.33 g/plot (7,253 t/ha), and 3878.17 g/plot (8,080 t/ha), respectively.

The correlation between characters and yield or fresh stover

The improvements in yield and fresh stover were obtained through selection on plant height and the number of leaves under DPP and through selection on the weight of dried cobs harvested and fresh stover under IS. The magnitude of the change in the quality was corrected based on the closeness of the relationship with the selected trait. The correlation was calculated using the average data for each block. Each technique was examined separately, as shown in Table 4, with the number of correlated data points for each trait being 24 (treatment = 8 and block = 3).

Table 4. The correlation coefficient values between observed traits and yield or fresh stover weight per plant (BBS) under both techniques

No.	Observed parameters	DPP Technique		IS Technique	
		Yield	BBS	Yield	BBS
1	Plant height	0.36 ns	0.25 ns	0.37 ns	0.28 ns
2	Number of leaves per plant	0.51 s	0.17 ns	0.23 ns	0.44 s
3	Dry cob weight at harvest per plant	0.65 s	0.54 s	0.87 s	0.61 s
4	Cob length (cm)	0.52 s	0.46 s	0.69 s	0.53 s
5	Cob diameter (cm)	0.58 s	0.59 s	0.60 s	0.32 ns
6	Yield (dry weight of seeds per plot)	1.00	0.53 s	1.00	0.56 s
7	Weight of 1,000 seeds (g)	0.75 s	0.65 s	0.78 s	0.47 s
8	Number of fresh leaves per plant at harvest	0.53 s	0.52 s	0.48 s	0.68 s
9	Fresh stover weight per plant	0.53 s	1.00	0.56 s	1.00

Note: s = significantly different at the 5% significance level. ns = not significantly different.

There was a correlation between the observed parameters and the yield across all traits, except plant height under DPP. Moreover, plant height and the number of leaves per plant were not correlated under IS. The weight of fresh stover per plant was correlated with all traits, except plant height and the number of leaves per plant under DPP and plant height and cob diameter under IS. The highest correlation coefficient value related to yield was obtained for the weight of dried cobs harvested per plant under IS and the weight of 1,000 seeds under DPP. For fresh stover, there were five characters with a coefficient value higher than 0.50 under DPP, namely, the number of fresh leaves per plant, the weight of 1,000 seeds, yield, cob diameter, and the dry weight of harvested cobs per plant. On the other hand, there were four characters with coefficient values higher than 0.50 under IS: dry weight of harvested cobs per plant, cob length, yield, and the number of fresh leaves per plant.

Discussion

The potential yield showed linear progress under both mass selection techniques up to the seventh cycle. The average increase in fresh stover weight under selection also showed a significant linear relationship under both techniques. This means that until the seventh cycle, the two mass selection techniques are effective at increasing the yield and fresh stover weight. A similar result for yield was obtained by Baktash (2016), who stated that their mass selection technique was effective for enhancing yield and corn yield components. Other studies also supported these findings. Shrestha et al. (2018) stated that mass selection was effective for improving the agronomic characters of maize plants after five cycles by producing higher yields and reducing plant height compared to the initial population. A study conducted by Govind and Mani (2016) revealed significant progress in mass selection for the number of cobs per plant, cob diameter, number of rows per cob, weight of seeds per cob, and yield. The difference in the selection responses per cycle for yield can also be seen in the linear regressions of the two selection techniques (Fig. 1).

The success of indirect selection is highly dependent on the level of genetic correlation between the selected trait and the improved trait (Soemartono, et al., 1992; Basuki, 2005). The improved yield obtained using both techniques may also be due to indirect mass selection; the selection response is very dependent on the close relationship between the selected and corrected characters. Mass selection by pollination control used plant height and the number of leaves as the selected characters, while the dry weight of the harvested cobs was used in the base index technique. A significant positive correlation coefficient was obtained between the weight of the dried cobs and the yield (0.65 for DPP and 0.87 for IS), which may be why the base index selection response was greater than that of pollination control. The same is true for the correlation between yield and dry cob weight in a study by Abdalla et al. (2010), who revealed a positive correlation between these characters. Subaedah et al. (2016) showed that a longer cob or a higher number of seeds will increase yield. The correlation coefficient was higher for plant height (0.36) and the number of leaves (0.51) under DPP that that under IS, a 0.37 and 0.23, respectively (Table 4). It is possible that the selection response under the base index technique produced a higher yield compared to that under pollination control.

The heritability value of the selected characters also determines the magnitude of the selection response. Cob dry weight has high heritability under the base index technique, while plant height and the number of leaves were classified as moderate. This trend can also be found for the selection response for the number of leaves; the base index technique showed a greater selection response per cycle than the pollination control technique despite the number of leaves per plant being a selection criterion for pollination control technique. This difference occurred because the number of leaves per plant under base index selection had a higher heritability than that under pollination control (Table 2). The heritability value for the number of leaves per plant under the pollination control technique was 44.94% (moderate), while that under the base index technique was 57.56% (high). The coefficient of genetic variation also influences the selection response. The number of leaves per plant has a coefficient of genetic variation of 3.59% and 2.54% under the two mass selection techniques. This difference can also affect the size of the selection response per cycle.

The linear increases in fresh stover weight under both techniques showed that the base index technique had a higher value in the third cycle than pollination control (Fig. 2). The difference is even greater with a higher number of selection cycles. This can occur because fresh stover weight is selected directly by the base index technique. The pollination control technique uses plant height and the number of leaves as selected traits to increase the weight of fresh stover, so the selection response depends on the close relationship between the two traits and fresh stover weight. Taller plants had low heritability, while the heritability of the leaf number was classified as high. However, both characters had a correlation coefficient that was not high (<0.50) and were not significant under the pollination control technique (Table 4). Therefore, the impact on the selection progress was smaller than that of the base index technique. Similarly, Basuki (2005) stated that the size of the indirect response greatly depends on the heritability value and the closeness of the relationship between the two characters.

Increased yield and fresh stover weight can occur due to an increase in gene frequency and genotype frequency. Soemartono *et al.* (1992) showed that selection causes an increase in the gene and genotype frequencies for the selected and improved characters. Increased gene and genotype frequencies can be seen from the increase in the averages of the selected population compared to the initial population. The increase in yield due to mass selection for seven cycles under pollination control and the base index was quite large, accounting for 43.46% and 59.81%, respectively. This increase in yield is higher than that obtained by Sutresna (2010), who observed a 44.04% increase after index selection. The weight of fresh stover per plant increased by 79.21% for selection under pollination control and 103.47% for the base index after seven cycles. This occurs because the selection response of yield and fresh stover weight under the base index technique is higher than that under pollination control. The response of fresh stover weight was 11.50 g/plant/cycle under the base index technique, while the response under pollination control was 7.82 g/plant/cycle (Table 1). Shrestha et al. (2018) said that the significant increase in grain yield of the selected population may be attributed to improvements in other physiological and yield-related traits. Furthermore, the existence of a significant linear selection response for both mass selection techniques indicates that both should be continued into the next cycle. Based on the magnitude of the selection response, the base index technique is better for increasing the yield and fresh stover of corn in dry land.

Conclusions

1. The response of mass selection under pollination control was smaller than that under the base index technique for yield and fresh stover weight. Both responses followed a simple linear regression model.
2. The increases in yield and fresh stover weight were lower under pollination control than under the base index technique after seven cycles. Yield increases of 43.46% and 79.21% in fresh stover weight were obtained after seven cycles of pollination control, while compared to the initial population, the base index technique produced an increase in yield by 59.81% and 103.47% in fresh stover weight.
3. Mass selection based on the base index technique should be continued into the next cycle to obtain higher yield and fresh stover.

Authors' Contributions

Sudika carried out the experiments and drafted the manuscript. Soemeinaboedhy conceived the study and helped in manuscript drafting. All authors read and approved the final manuscript.

Conflict of Interest

The authors state that there are no conflicts of interest in this study.

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The improvement of corn yield and fresh stover weight through two mass selection techniques in dry land

Running Title: The Improvement of Yield and Corn Fresh Stover

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