ESH 2 Drytol

by Entis Halimi

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DEVELOPMENT OF ACID-SOIL TOLERANT CORN (*Zea mays* L.) WITH ABILITY TO COOP DRY CONDITION

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Abstract

The research was done to develop population and approach to grow corn in acid and dry soil condition, with additional treatment of manure and liquid organic fertilizer (LOF). The reasearch involved the Syn-1 and Syn-2 corn populations (V1, V2) derived from the cross of EWDMR and SA-8 accession. The manure was applied as a chicken manure (CM) of 2.5 ton/ha (K1) and 5.0 ton/ha (K2) combined with LOF of 20 cc/l (P1), 40 cc/l (P2) and no aplication (P0). The research was conducted at the farmland area at Pamulutan, Ogan Ilir, South Sumatera. The research was carried out according to the Factorial Experiment in a RCB design with three replications as blocks in plot size of 3 m x 4 m. Results indicated that growth and production of Syn-1 and Syn-2 populations were affected by the application of organic fertilizer. The effect of the CM, however seemed to be more dominant and the role might not be replaced by the LOF. The application of 5 ton CM/ha, in general resulted in the yield of 2.18 – 3.09 tons of dry seed/ha. Further investigation indicated that the Syn populations showed good stability for many major agronomic traits, responsive, to application of organic fertilizer, and interestingly, the yield potential still tends to increase from Syn-1 to Syn-2.

Keywords: Corn, tolerance, acid-dry-soil.

I. Introduction

A. Background

Corn is an important crop in Indonesia. The productivity, especially in lowland area with acidity problem is still very low due to lack of the varieties, and menagement (Sanches, 1976; Djafar and Halimi, 1988). Approaches to increase corn production in Indonesia is done by both intensification and extensification program. Adisarwanto and Widyastuti (2000), stated that one important component in intensification and extensification program to increase corn productivity in lowland area in Indonesia is the availability of acid-soil tolerant varieties with ability to coop with dry soil condition. This is because most lowland area available for the program, consider to be acid and expose to annually wet and dry conditions.

Efforts to develop acid-soil tolerant corn has been done by many scientists in many countries, since problem of acid-soil occurs in many countries (Granados, et al., 1993; Bahar et., al., 1994; Kasim et.al., 1993; Soewarno et. Al., 1992). But, very litle research program reported their works in combination of the acid-soil tolerance and the ability to coop dry soil condition (Fehr, 1987).

Kusdiantari (1999) innitiated the research by making top crossed between acid-soil tolerant accession of SA-8 to dry-soil tolerant corn acession of EWDMR. The SA-8 accession was develoved by the CYMMIT, Mexico (Granados, et.al., 1995) and introduced to Indonesia in 1996, while EWDWR acession was developed by AVRDC, Taiwan and

introduced to Indonesia through BPTP, Bogor (Halimi, 2000). Later research by Amran (2001) was to make selection and polycrossing of selected parents to establish Syn-1 and Syn-2 populations originated from the cross of EWDMR x SA-8. The selection method was incorporated a modified water culture technique which was originally developed by Rhue and Grogan (1977).

As stated above, problem to solve acid and dry soil involved both tolerant variety and management and the use of manure as an organic fertilizer has been applied by the farmer to solve acidity and dry condition. Many researches (Hakim et al.,1996; Gyles et al.,1997; Nyakpa et al.,1988; Power and Papendick, 1997; and Soepardi, 1983) reported that the use of manure increase soil nutrition, improve soil structure, promote the activitiy of many useful microorganisme, as well as pH neutralization. On the other hand, in reality, there is a limitation to use manure, which is the transportation problem to carry a bulky of manure to the field. Recent development in fertilizer technology, is the use of Liquid Organic Fertilizier (LOF). This is a commercially concentrate packed in handy packaging and therefore easy to take to the remote field.

B. Objectives

The objective of this research was (a) to make further investigation in plant breeding program to develop corn variety that tolerant to soil acidity and dry condition and (2) to recognize the use of manure in combination with liquid organic fertilizer (LOF).

II.Research Methods

Research was conducted at farmland area at Pemulutan Ogan Komering Ilir, South Sumatera. Soil condition of the research area is consider acid (pH=4.0) with low organic material (4.83%) as folow:

Analysis	Values
pH (H_2O)	4.0
Oraganic content	4.83 %
N-total	0.33 %
P-Bray	4.95 M gg^{-1}
K-dd	0.32 cmol+kg^{-1}

Research was carried out according to the Factorial Experiment in a Randomized Complete Block (RBD) design with three replications as blocks and 54 experimental units as follows:

Factor I: Generation of crossed populations of EW-DMR x SA-8, which were the first generation of Syn-1 (V1) and second generation of Syn-2 (V2)

Factor II: The application of chicken manure (CM) of 50% (K1), 100% (K2) of the recommendation and no CM application (K0). Calculation to estimate CM application resulted in 2.5 ton/ha for K1 and 5.0 ton/ha for K2.

Factor III: The application of Liquid Organic Fertilizer (LOF) of 50% (P1), 100% (P2) of the recommendation and no LOF application (P0). Calculation to estimate LOF application resulted in 20 cc/l for P1 and 40cc/l for P2.

Before application, the CM was mixed together and sun-drying for 3 days and then spread through out the field. Result of laboratorium analysis on the composite sample of the CM indicated pH of 7.59 as follows:

Analysis	Value
pH (H_2O)	7.59
Organic content	5.75 %
N-total	1.02 %
P-Bray	68.25 M gg^{-1}
K-dd	53.49 cmol+kg^{-1}

As indicated on the label, the Liquid Organic Fertilizer (LOF) was developed form the extraction of the organic material derived from plant and animal waste. The composition of nutrient content of the LOF is as follows:

Nutrients	Content
Nitrogen (N)	5.2 %
Phosporous (P)	2430.7 ppm
Kalium (K)	233.6 ppm
Calsium (Ca)	1360.0 ppm
Magnesium (Mg)	10.1 ppm
Ferrium (Fe)	186.7 ppm
Natrium (Na)	45.7 ppm
Zinc (Zn)	10.1 ppm
Bronz (Cu)	14.9 ppm
Manganium (Mn)	21.6 ppm
Boron (B)	9.7 ppm
Chlorium (Cl)	6.9 ppm
Sulfur (S)	8.8 ppm

Data investigation was calculated based on the 10 unit samples of plant in a plot sized of 3m x 4m and planting space of 75cm x 25cm. Data analysis was carried based on the Analysis of Variance (ANOVA) followed by appropriate Least Significant Difference (LSD) analysis at α=0.05 (Gomez and Gomez, 1984). Statictical analysis was done by using computer program of Statistical Analysis System (SAS Institute, 1988).

III. Results and Discussion

In general, results of third research showed that growth and production of acid-soil telerant corn with ability to coop dry condition was effected by the application of organic fertilizer, especially in form of manure. Statistical analysis based on ANOVA (Table 1) showed that statistical differences mostly found on the effect of CM (K), no differences due to application of LOF (P), and few significant interactions for some variables. While the significant response differences of the population only observed on plant height and weigth of fresh ear. Although the use of LOF is practical, but this research confirmed the effect is less effective than application of CM. As showed by soil analysis, significant effect of CM was also indicated by the increase in organic content of the soil of 4.83% to be 8.76 % and 9.81% for the application 2.5 and 5 ton CM per ha, respectively. Unlike CM, LOF was applied through the surface of the leaf and therefore no barely additional nutrient to the soil. While the application of CM, as reported by many scientists (Hakim et al.,1996; Gyles et al.,1997; Nyakpa et al.,1988; Hower and Papendick, 1997; and

Soepardi, 1983) might increase soil nutrition, improve soil structure, promote the activitiy of many useful microorganisme, as well as pH neutralization. The role of CM to enhance performance of acid-soil tolerant corn with ability to coop dry condition seemed to too important to be replaced by LOF.

Table 1. F-value and Coefficient of Variation (CV) as the results from the Analysis of Variance (ANOVA) on the observed variables.

Variables	F-values							CV
	V	K	P	VxK	VxP	KxP	VxKxP	%
Plant height	7.24*	162.53*	3.24	2.26	1.40	2.32	0.25	15.51
Weight of fresh ear	6.48*	198.72*	3.11	2.07	0.97	1.18	4.15*	23.98
Weight of fresh cob	2.08	178.19*	1.52	0.77	0.44	2.70*	1.95	25.53
Weight of dry cob	1.21	128.11*	0.99	0.82	1.28	2.34	1.40	29.80
Length of cob	0.03	183.54*	0.26	0.51	0.71	0.53	2.18	24.09
Diameter of cob	0.46	694.66*	0.64	0.75	3.22	1.75	3.79*	12.27
Weigth of dry seed per plant	0.26	144.08*	1.45	0.14	0.98	2.60	1.31	28.68
Dry weight of 100 seeds	1.20	283.26*	0.09	0.42	1.51	0.86	1.53	19.40
F-tabel α= 0.05	4,12	3,28	3.28	3.28	3.28	2,65	2.65	

*= Significantly effect at α= 0.05.

Compared to the growth and development of corn planted by the farmers in fertile soil, the growth of corn on this research was litle bit small as the soil used in this research considered as a problem soil, acid, dry, and less fertile. Visual observation indicated that leave color of many plants in this research was light green to yellowish. These condition found more severe on the plots with no CM application. In this research the plant height was about 36cm to 104cm. The avarage of plant height was about 79cm of Syn-1 significant taller than Syn-1 population of 70 cm.. Meanwhile, the average plant height on the plots with no CM application was less than 36 cm and the average plant height on the plots with 5.0 ton CM/ha reached more that 100 cm. This fact was a clear evidence for the importance of CM to enhance the ability of acid-soil tolerant corn to coop with dry condition.

Statistical analysis on the variables related to the yield and production indicated the same, that significant differences mostly found on the effect of CM application, no differences found on the effect of LOF and few differences on the interaction. While the differences between populations only found on the weight of fresh ear (Table 1). The dry weight of seeds per plant, as a main yield variable, was 2.27 g on plots with no application of CM and 50.49 g on plots with application of 5.0 ton CM/ha. Based on the assumption of population density of 53 000 plants/ha, might be estimated that the average yield increased in any populations from 0.10 to 0.13 ton/ha for K0, and 2.61 to 2.73 ton/ha for K2 (Table 2). This was considered to be a good indication that both Syn-1 and Syn-2 populations were responsive to the application of CM. Furthermore, response curve to identify interaction CM (K) and LOF (P) as shown on Figure 1, indicated the same, that application of CM increased diameter of corn cob, in any application of LOF both for Syn-1 and Syn-2 populations.

Table 2. Average yield potential (ton dry seeds/ha) of Syn-1 and Syn-2 corn population with application of CM (K), and LOF (P)

Population	Chiken manure (CM)	Liquid Organic Fertilizer (LOF)			Yield average
		P_0	P_1	P_2	
Syn-1	K_0	0.10	0.30	-	0.13
	K_1	2.10	2.65	2.02	2.26
	K_2	2.18	2.87	2.78	2.61
Syn-2	K_0	-	-	0.31	0.10
	K_1	3.00	2.26	1.88	2.38
	K_2	2.26	3.09	2.83	2.73

- : No yield observed. Estimated potential yield based on population density of 53.000 plants/ha.

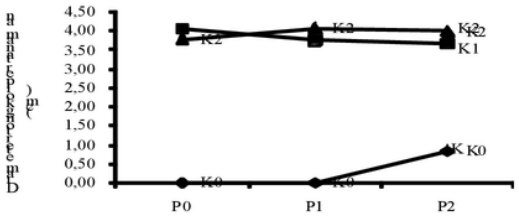

Figure 1. Respose curve of diameter corn cob in application of CM (K) dan LOF (P).

Further investigation to develop corn variety that tolerant to soil acidity and dry condition indicated that Syn-1 and Syn-2 populations showed stability for many agronomic traits except for the plant height, ear weight and yield. Statistical analysis by the use of Contrast Analysis (Table 3) indicated the average value of many variables were not significantly different except for plant height and weight of fresh ear which was tend to decrease form Syn-1 to Syn-2. Interestingly yield potential of syn-1 and syn-2 tend to increase from 1.67 to 1.74 ton dry seeds per ha. This production is less than corn production planted by the farmer at fertile soil. Kasim *et al,* (1993) stated that one requirement for new corn variety for dry-acid tolerant should be able to produce about 4 ton dry seeds per ha while for fertile soil should be able to produce about 8 ton seeds per ha. As reported by some researchers, organic fertilizer promotes vegetative as well as generative growth. During period of this research, rainfall was low and the temperature was relatively high which were intented to investigate the ability of plant to coop dry condition. This condition seemed to be the subject to cause lower yield. Ridwan and Jamin (1994), stated that dry condition might lower the yield up to 30%.

Table 3. Statistical Contrast Analysis on some variables on Syn-1 dan Syn-2 populations

Variables	Average		F-value
	Syn-1	Syn-2	
Plant height(cm)	79.21	70.69	7,24*
Weight fresh ear (g/plant)	56.11	66.28	6,48*
Weight of fresh cob (g/plant)	47.08	52.05	2,08
Weight of dry cob (g/plant	41.28	45.13	1,21
Length of cob (cm)	8.54	8.44	0,03
Diameter of cob(cm)	2.67	2.68	0,46
Weight of dry seeds (g/plant	31.57	32.85	0,26
Weight per 100 dry seeds (g)	16.15	15.24	1,20
Yield potential (ton/ha)	1.67	1.74	0,26

* Significantly different at $\alpha = 0.05$.

IV. Conclussion and Recommendation

A. Conclussion

The conclussion of this research is as follows:

1. Performance of acid-soil tolerant corn to coop dry condition were affected by the application of organic fertilizer. The effect of the chicken manure (CM) seemed to be more dominant and the role might not be replaced by the liquid organic fertilizer (LOF)
2. Further investigation in plant breeding program to develop corn variety that tolerant to soil acidity and dry condition showed great improvement that Syn-1 and Syn-2 population have been shown good stability for many major agronomic traits, responsive, to the application of organic fertilizer, and the yield still tends to increase from Syn-1 to Syn-2.

B. Recommendation

Growing corn in problem soil, acid, dry, and less fertile need to incorporate organic fertilizer, although the variety used considered as tolerant cultivar.

Aknowledgement

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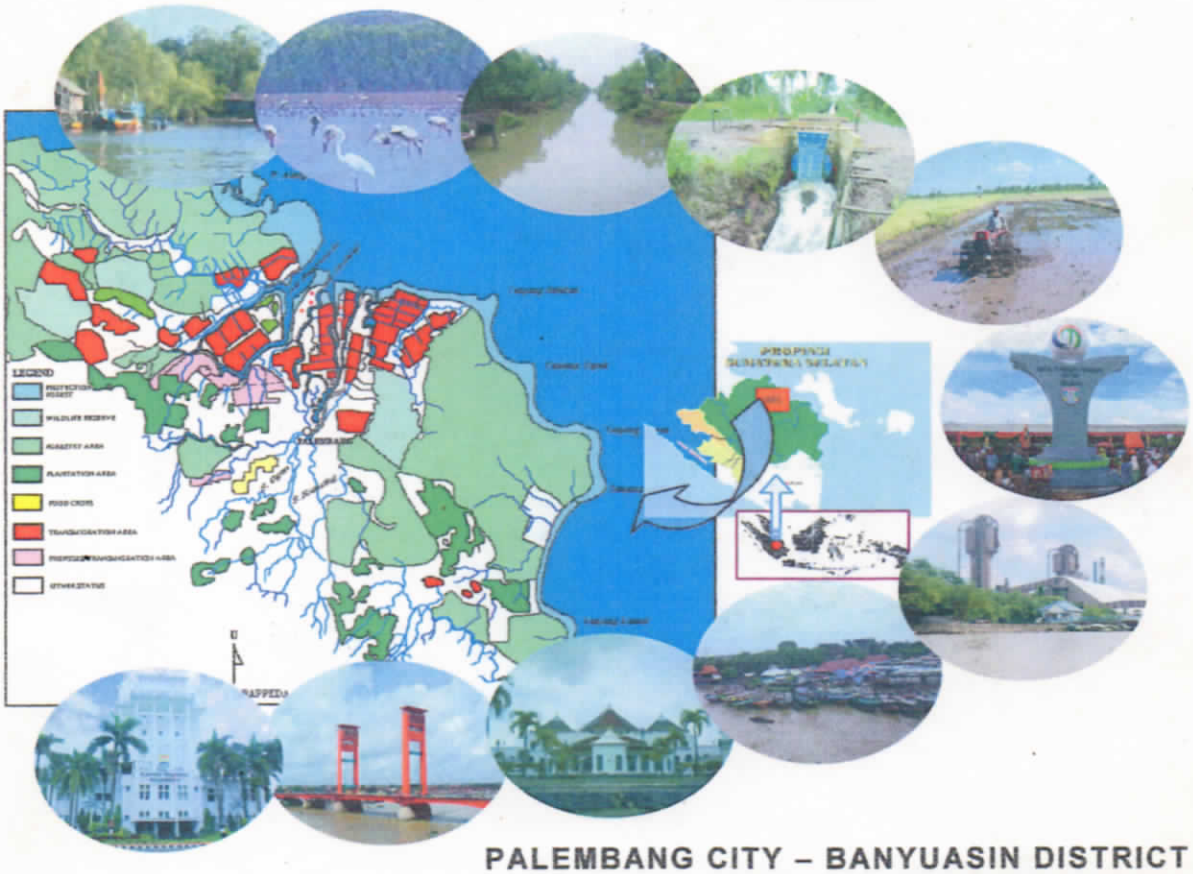

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C2. Development of Acid-Soil Tolerant Corn *(Zea mays L.)* with Ability to Coop Dry Condition *(E.S. Halimi)*

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The objective of this research was (a) to make further investigation in plant breeding program to develop corn variety that tolerant to soil acidity and dry condition and (2) to recognize the use of manure in combination with liquid organic fertilizer (LOF).

RESEARCH METHODS

Research was conducted at farmland area at Pemulutan Ogan Komering Ilir, South Sumatera. Soil condition of the research area is consider acid (pH=4.0) with low organic material (4.83%) as folow:

Analysis	Values
pH (H_2O)	4.0
Oraganic content	4.83 %
N-total	0.33 %
P-Bray	4.95 M gg^{-1}
K-dd	0.32 cmol+kg^{-1}

Research was carried out according to the Factorial Experiment in a Randomized Complete Block (RBD) design with three replications as blocks and 54 experimental units as follows:

Factor I: Generation of crossed populations of EW-DMR x SA-8, which were the first generation of Syn-1 (V1) and second generation of Syn-2 (V2)
Factor II: The application of chicken manure (CM) of 50% (K1), 100% (K2) of the recommendation and no CM application (K0). Calculation to estimate CM application resulted in 2.5 ton/ha for K1 and 5.0 ton/ha for K2.
Factor III: The application of Liquid Organic Fertilizer (LOF) of 50% (P1), 100% (P2) of the recommendation and no LOF application (P0). Calculation to estimate LOF application resulted in 20 cc/l for P1 and 40cc/l for P2.

Before application, the CM was mixed together and sun-drying for 3 days and then spread through out the field. Result of laboratorium analysis on the composite sample of the CM indicated pH of 7.59 as follows:

Analysis	Value
pH (H_2O)	7.59
Organic content	5.75 %
N-total	1.02 %
P-Bray	68.25 M gg^{-1}
K-dd	53.49 cmol+kg^{-1}

As indicated on the label, the Liquid Organic Fertilizer (LOF) was developed form the extraction of the organic material derived from plant and animal waste. The composition of nutrient content of the LOF is as follows:

Nutrients	Content
Nitrogen (N)	5.2 %
Phosporous (P)	2430.7 ppm
Kalium (K)	233.6 ppm
Calsium (Ca)	1360.0 ppm
Magnesium (Mg)	10.1 ppm
Ferrium (Fe)	186.6 ppm
Natrium (Na)	45.7 ppm
Zinc (Zn)	10.1 ppm
Bronz (Cu)	14.9 ppm
Manganium (Mn)	21.6 ppm
Boron (B)	9.7 ppm
Chlorium (Cl)	6.9 ppm
Sulfur (S)	8.8 ppm

Data investigation was calculated based on the 10 unit samples of plant in a plot sized of 3m x 4m and planting space of 75cm x 25cm. Data analysis was carried based on the Analysis of Variance (ANOVA) followed by appropriate Least Significant Difference (LSD) analysis at α=0.05 (Gomez and Gomez, 1984). Statictical analysis was done by using computer program of Statistical Analysis System (SAS Institute, 1988).

RESULTS AND DISCUSSION

In general, results of third research showed that growth and production of acid-soil telerant corn with ability to coop dry condition was effected by the application of organic fertilizer, especially in form of manure. Statistical analysis based on ANOVA (Table 1) showed that statistical differences mostly found on the effect of CM (K), no differences due to application of LOF (P), and few significant interactions for some variables. While the significant response differences of the population only observed on plant height and weigth of fresh ear. Although the use of LOF is practical, but this research confirmed the effect is less effective than application of CM. As showed by soil analysis, significant effect of CM was also indicated by the increase in organic content of the soil of 4.83% to be 8.76 % and 9.81% for the application 2.5 and 5 ton CM per ha, respectively. Unlike CM, LOF was applied through the surface of the leaf and therefore no barely additional nutrient to the soil. While the application of CM, as reported by many scientists (Hakim et al.,1996; Gyles et al.,1997; Nyakpa et al.,1988; Hower and Papendick, 1997; and Soepardi, 1983) might increase soil nutrition, improve soil structure, promote the activitiy of many useful microorganisme, as well as pH neutralization. The role of CM to enhance performance of acid-soil tolerant corn with ability to coop dry condition seemed to too important to be replaced by LOF.

Table 1. F-value and Coefficient of Variation (CV) as the results from the Analysis of Variance (ANOVA) on the observed variables.

Variables	F-values							CV
	V	K	P	VxK	VxP	KxP	VxKxP	%
Plant height	7.24*	162.53*	3.24	2.26	1.40	2.32	0.25	15.51
Weight of fresh ear	6.48*	198.72*	3.11	2.07	0.97	1.18	4.15*	23.98
Weight of fresh cob	2.08	178.19*	1.52	0.77	0.44	2.70*	1.95	25.53
Weight of dry cob	1.21	128.11*	0.99	0.82	1.28	2.34	1.40	29.80
Length of cob	0.03	183.54*	0.26	0.51	0.71	0.53	2.18	24.09
Diameter of cob	0.46	694.66*	0.64	0.75	3.22	1.75	3.79*	12.27
Weigth of dry seed per plant	0.26	144.08*	1.45	0.14	0.98	2.60	1.31	28.68
Dry weight of 100 seeds	1.20	283.26*	0.09	0.42	1.51	0.86	1.53	19.40
F-tabel α= 0.05	4,12	3,28	3.28	3.28	3.28	2,65	2.65	

*= Significantly effect at α= 0.05.

Compared to the growth and development of corn planted by the farmers in fertile soil, the growth of corn on this research was litle bit small as the soil used in this research considered as a problem soil, acid, dry, and less fertile. Visual observation indicated that leave color of many plants in this research was light green to yellowish. These condition found more severe on the plots with no CM application. In this research the plant height was about 36cm to 104cm. The avarage of plant height was about 79cm of Syn-1 significant taller than Syn-1 population of 70 cm.. Meanwhile, the average plant height on the plots with no CM application was less than 36 cm and the average plant height on the plots with 5.0 ton CM/ha reached more that 100 cm. This fact was a clear evidence for the importance of CM to enhance the ability of acid-soil tolerant corn to coop with dry condition.

Statistical analysis on the variables related to the yield and production indicated the same, that significant differences mostly found on the effect of CM application, no differences found on the effect of LOF and few differences on the interaction. While the differences between populations only found on the weight of fresh ear (Table 1). The dry weight of seeds per plant, as a main yield variable, was 2.27 g on plots with no application of CM and 50.49 g on plots with application of 5.0 ton CM/ha. Based on the assumption of population density of 53 000 plants/ha, might be estimated that the average yield increased in any populations from 0.10 to 0.13 ton/ha for K0, and 2.61 to 2.73 ton/ha for K2 (Table 2). This was considered to be a good indication that both Syn-1 and Syn-2 populations were responsive to the application of CM. Furthermore, response curve to identify interaction CM (K) and LOF (P) as shown on Figure 1, indicated the same, that application of CM increased diameter of corn cob, in any application of LOF both for Syn-1 and Syn-2 populations.

Table 2. Average yield potential (ton dry seeds/ha) of Syn-1 and Syn-2 corn population with application of CM (K), and LOF (P)

Population	Chiken manure (CM)	Liquid Organic Fertilizer (LOF)			Yield average
		P_0	P_1	P_2	
Syn-1	K_0	0.10	0.30	-	0.13
	K_1	2.10	2.65	2.02	2.26
	K_2	2.18	2.87	2.78	2.61
Syn-2	K_0	-	-	0.31	0.10
	K_1	3.00	2.26	1.88	2.38
	K_2	2.26	3.09	2.83	2.73

- : No yield observed. Estimated potential yield based on population density of 53.000 plants/ha.

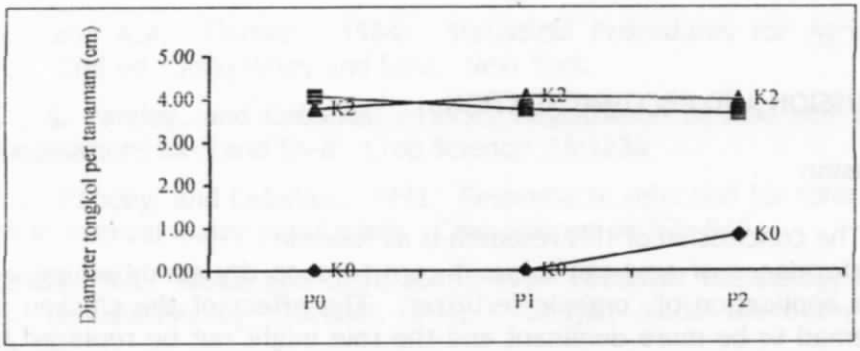

Figure 1. Respose curve of diameter corn cob in application of CM (K) dan LOF (P).

Further investigation to develop corn variety that tolerant to soil acidity and dry condition indicated that Syn-1 and Syn-2 populations showed stability for many agronomic traits except for the plant height, ear weight and yield. Statistical analysis by the use of Contrast Analysis (Table 3) indicated the average value of many variables were not significantly different except for plant height and weight of fresh ear which was tend to decrease form Syn-1 to Syn-2. Interestingly yield potential of syn-1 and syn-2 tend to increase from 1.67 to 1.74 ton dry seeds per ha. This production is less than corn production planted by the farmer at fertile soil. Kasim *et al*, (1993) stated that one requirement for new corn variety for dry-acid tolerant should be able to produce about 4 ton dry seeds per ha while for fertile soil should be able to produce about 8 ton seeds per ha. As reported by some researchers, organic fertilizer promotes vegetative as well as generative growth. During period of this research, rainfall was low and the temperature was relatively high which were intented to investigate the ability of plant to coop dry condition. This condition seemed to be the subject to cause lower yield. Ridwan and Jamin (1994), stated that dry condition might lower the yield up to 30%.

Table 3. Statistical Contrast Analysis on some variables on Syn-1 dan Syn-2 populations

Variables	Average		F-value
	Syn-1	Syn-2	
Plant height(cm)	79.21	70.69	7,24*
Weight fresh ear (g/plant)	56.11	66.28	6,48*
Weight of fresh cob (g/plant)	47.08	52.05	2,08
Weight of dry cob (g/plant	41.28	45.13	1,21
Length of cob (cm)	8.54	8.44	0,03
Diameter of cob(cm)	2.67	2.68	0,46
Weight of dry seeds (g/plant	31.57	32.85	0,26
Weight per 100 dry seeds (g)	16.15	15.24	1,20
Yield potential (ton/ha)	1.67	1.74	0,26

* Significantly different at $\alpha = 0.05$.

CONCLUSSION AND RECOMMENDATION

Conclussion

The conclussion of this research is as follows:

1. Performance of acid-soil tolerant corn to coop dry condition were affected by the application of organic fertilizer. The effect of the chicken manure (CM) seemed to be more dominant and the role might not be replaced by the liquid organic fertilizer (LOF)
2. Further investigation in plant breeding program to develop corn variety that tolerant to soil acidity and dry condition showed great improvement that Syn-1 and Syn-2 population have been shown good stability for many major agronomic traits, responsive, to the application of organic fertilizer, and the yield still tends to increase from Syn-1 to Syn-2.

Recommendation

Growing corn in problem soil, acid, dry, and less fertile need to incorporate organic fertilizer, although the variety used considered as tolerant cultivar.

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