THE APPLICATION OF DROUGH INDEX FOR SELECTION OF MAIZE FAMILIES

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ABSTRACT

Maize which is tolerance under drought condition was could be founded of yield by less contain of water under capacity in the soil. Lamuru and Anoman 1 were two opv's good adapted in dry area. The experiment were conducted to find out of inbred superior tolerance under drought condition, families to selected by drought index (DI) of Fisher *et al* (1981), if DI>1,0 means families were tolerance under drought. Two sets experiment were conducted in Muneng Probolinggo experimental farm on second season 2015 by generate S1 families of two population's (GML and LMR) with 30 entries as treatment included two check's Bisma.C0 and Lamuru.C0. Set I was normal water irrigated and Set II water be arranged until vegetative stage, 55 dap was stopped and plant to stressed water. The result shown that line of LMR(S0)C0-4 founded of yield 4.79 ton ha^{-1} under normal wáter condition than GML(S1)-3 was 4.09 ton ha^{-1}, under drought condition line of LMR(S0)C0-5 founded 2.27 ton ha^{-1} and GML(S1)C1-10 was 2.41 ton ha^{-1}. The computed of DI>1,0 were selected 15 line's which five of Lamuru and 10 lines of GML. The implementation of this result was increase cycle of selection by inter crossed of 15 lines C(15,2), the bulk of seed's was promosing as new of opv which tolerance of drought

Key word : DI, h^2, selection

INTRODUCTION

We cannot grow maize without water. In agriculture drought can be difined was absence of soil water to provide condition to grow as a concequence of precipitation being less than normal. Maize tolerance drought was plant still founded of grain yield under field capacity of soil water is very low. Stressed of water is a complex and composite trait manifested in different ways and different growth stage of plant. Around 70% was main constrain of lower maize yielded include another food crops because of drought. Farming system of endogenous in eastern part of IND like in NTT, NTB, could't founded hight benefit because rainfed distribution was erratic and difficult to predicted. Farmer's in Sikka-Flores commonly planting maize two-three time becouse drought, after planting stressed of water was coming. Breeding program in ICERI Maros for founded of genetic material was tolerance under drought has ben conducted, variety of Anoman 1 was be founded yield 3 - 4 ton ha^{-1} under drought in plant stage of generative. CIMMYT population of Tuxpeno-Sequia. C6 1 was be selected under drought in generative stage in Probolinggo exprm farm, and founded eight superior inbred to be recombination C(8,2) to founded opv Anoman 1 (Yasin *et al*., 2015). Edmeages (1996), was conducted Drought Index (ID) for selected of

maize population in CYMMIT, the value was ID>1,0 define genetic material tolerance under drought and ID≤1.0 was susceptible. Local germ plasm under drought "*Masal-Sequia and Criollo*", founded 1.0-2.9 ton ha^{-1} in DI>1.0.

The objective of experiment was to select 8 - 10 inbred superior of normal maize by formula ID, the selected inbred would be generate of new population which tolerance under drought by inter crossed C(n,2).

MATERIAL AND METHODS

The first season generate families S1 in two population (GML.C0 : Great-Wall Maize lines, LMR.C0:Lamuru) GML:lines from Chine, LMR:Iceri population, C:Cycle). The experiment conducted in Maros experimental farm, 2015. Two population planting 1000 - 1200 plants space 75×20 cm in plot 5.0 m, fertilizer be applied Urea-Ponska (300 - 200) kg ha^{-1}. Plants were selected to selfing around 600 from sincronize flowering, health and same color of tassel and silk. In the harvested families selected 30 plants and seeds arranged for two sets experiment there are : (1) the experiment in normal environment wáter irrigated untill harvested and (2) in stress wáter for evaluated in drought environment, wáter irrigated was stopped in 55 dap in vegetative stage. The two sets experiment was arranged by planting in 75×20 cm in plot 5,0 m, fertilizer was applied Urea-Ponska (300 - 200) kg ha^{-1}. The method by used of Alfa Lattice design with two replication, four families were randomized (4×8) in sub plot. The data collected were statistical analysis following anova using MSTAT-C soft ware. The differences of inbred were separated according to LSD test at a significant level of 5% in normal and stressed of water condition. Mathematics model of Simple Alfa Lattice be used : $Y_i = \mu+\beta_i+\tau_j+\alpha_k+\varepsilon_{ijk} +\gamma_l+\varepsilon_{ijkl,}$ (Y_i = observed of variable), μ=means, β_i=block 1,2,τ_j=replication to j, α_k=the effect of families/uncorrection, γ_l=correction families, ε_{ijk}= *intra block error I)*, and ε_{ijkl}=error II *(effective error).*

Families was selected under drought condition by used DI formula of Fisher *et al*. (1981)

$$DI = (Y_s/Y_n)/(Y_{sp}/Y_{np})$$

DI : drought index
Y_s dan Y_n : average yield of family under drought condition (set II) and normal water condition (set I)
Y_{sp} dan Y_{np} : average yield of population under drought (set II) and normal water condition (set I)
DI>1.0 family was selected tolerance under drought condition
DI≤1.0 familyunselected and susceptible under drought condition

The population improvement for each cycle of selection be computed : $(Y_i-Y_p)h^2$, *Y_i*: average yiedl of family selected, Y_p average yield of population, and h^2 : heritability. Heritability for maize family define increasing yield and other characters becouse by the effect of genetic factor was higher than environment factor (Stoskopf *et al.,* (1993).
Variable of yield be calculated by :

$$Y = [(10.000/LP) \times (100 - ka)/85] \times BP \times k$$

Y : yield (wc. 15 %), kg/ha
LP : size of sample, m^2
Ka : water content in harvested, %
BP : weight of ear in harvested, kg

k : shelling percentage of 5 ears
(CIMMYT define, k : 0,80)

The normal water and drought experiment was conducted in dry season 20 august - 5 December 2015 in Muneng experimental farm of Probolinggi East Java.

RESULTS AND DISCUSSION

The result observed of vegetative and generative stage which population be selfed shown in Table 1 for season 1. In season II (set 1) there are 15 families selected which the high yielded in table 2 under normal water condition. Six families was Lamuru population, and nine from GML population. The range of yield founded 3.20 ton ha^{-1} – 4.79 ton ha^{-1}, ear height 76.5 cm – 176.5 cm around middle of plant height. In (set 2) the families selected under stressed of water founded yield 1.94 ton ha^{-1} - 2.41 ton ha^{-1}.

Table 1. Characters of population which is be selfed in Maros exprm farm. season I 2015

Characters	Observed
Plant height, cm	150-190
Ear height, cm	70-85
Silking, days	52-55
Plant aspect, score	1-2
Husc cover, score	1
Ear aspect, score	1
Stalk lodging, %	3.0
Plant lodging, %	2.0
Uniformly, %	95
Harvested, days	105
Downy meldows, %	-
Water content, %	32-34
Tassel color	merah muda
Silk color	merah muda
Ear lenght, cm	17.0
Ear diameter, cm	3.7
Seeds lines	12-14
Number of seeds in line	22-30
Seeds color	Kuning
Seeds texture	mutiara
Seeds position	Lurus
Weight of seeds per ear, gr	14-25
Families S1 selected	30

In Table 2 shown that Lamuru was highly than Great Maize Line, the range of Lamuru founded 3.0 - 4.0 ton ha^{-1} or 15 - 20% more high than two check. In table 2 shown that families S1 of Lamuru could founded 2.30 ton ha^{-1} and not significant different with GML lines with yield 2.31 ton ha^{-1}, and could be assume that Lamuru more tolerance under drought than population GML. Mhofu (2016); Aslan *et al*., 2015) that maize could not founded yield under drought condition with ASI>6.0 days. In table 2 and table 3 founded heritability h^2>60.0% as long

as could be define that genetic factors was more dominant than environment to founded yield plant include other characters. Efendi (2015) founded that hybrid maize in Maros expm. farm under drought condition and 200 kg N ha^{-1} and h^2: 51.0 - 65.4%

Table 2. Yield, plant height and yield component of inbred selected under normal water condition, Muneng Expm Farm 2015

Plot no	Pedigree	Yield, ton ha^{-1}	Plant height, cm	Ear height, cm	Tasseling days	Shelling, %	Plant aspect, score
3	LMR(S0).C0-2	3.54	188.5	90.0	58.5	74.8	1.5
4	LMR(S0).C0-4	4.79	200.0	97.5	54.5	74.9	2.0
5	LMR(S0).C0-5	4.04	196.0	92.5	58.0	72.1	1.8
6	LMR(S0).C0-5	3.26	182.0	90.5	58.5	76.3	1.8
8	LMR(S0).C0-10	3.43	189.5	85.5	58.0	76.6	1.5
10	LMR(S0).C0-14	4.20	184.5	86.0	57.5	69.8	1.8
11	GML(S1)C0	3.62	181.0	83.0	57.5	74.6	1.8
13	GML(S1)C1-3	4.09	183.0	77.0	57.0	77.6	1.5
14	GML(S1)C1-4	3.20	176.5	76.5	58.5	77.6	2.3
18	GML(S1)C1-10	3.56	190.0	82.5	58.5	78.1	1.8
19	GML(S1)Syn.C2	3.68	184.5	81.0	58.0	76.8	1.8
21	GML(S1)C2-1	3.68	180.0	86.5	51.5	76.8	2.5
23	GML(S1)C2-4	3.33	182.5	85.5	51.5	77.7	2.0
25	GML(S1)C2-7	3.49	198.5	82.5	52.5	77.5	2.5
30	GML(S1)C2-15	3.55	185.5	78.0	51.5	72.2	2.0
32	Lamuru.C0	2.45	165.5	75.5	57.5	71.5	1.5
31	Bisma.C0	4.49	172.0	65.5	59.0	79.3	1.5
	F.cal	2.511	1.280	1.024	5,782	<1.0	2.663
	MS.error	0.275	123.632	110.879	2.743	16.006	0.082
	LSD 5%	0.571	12.114	11.472	1.804	4.359	0.571
	LSD 1%	0.804	17.040	16.137	2.538	6.131	0.804
	CV (%)	14.20	6.02	12.64	3.00	5.30	15.56
	h^2(%)	72.4	63.0	80.6	65.8	70.4	-

The result of DI shown in Table 4. There are 15 families selected which computing DI>1.0 five of S1 family Lamuru and 10 families GML. The new population with tolerance under drought could be conducted by inter crossed of C(15,2):105 F1. Bazinger *et al*., (2000); Kasim *et al*., (2010) that intercerossed of families with DI>1.0 would founded tolerance under drought condition, the population "Tuxpeno Sequia" grain white color from CIMMYT could be result of yield 4.0 ton ha^{-1}. The result of Efendi (2015) that there are inbred lines of normal maize was founded no yield in stressed water condition. Yasin *et al*., (2016) that early maturiry of local entries *(landrace)* like waxy maize more tolerance under drought than opv population QPM yellow grain. The lower loss yield under drought tolerance founded in LMR(S0). C0-8 there are 1.1% only and the highest yield losses in Bisma.C0 (check) were 61.8%. In Table 4 could be concluded that average yield lossed under stressed of water was founded 36.9%.

Table 3. Yield, plant height and yield component of inbred selected under drought condition, Muneng Expm Farm 2015

Plot	Pedigree	Yield, ton ha^{-1}	Plant height, cm	Ear height, cm	Tassel-ing, days	Shelling %	Plant aspect score
1	LMR(S0).C0	2.10	183.0	83.5	56.0	76.3	1.5
3	LMR(S0).C0-2	2.30	204.5	101.0	54.0	75.8	1.5
4	LMR(S0).C0-4	1.83	199.5	103.0	56.5	66.0	2.3
5	LMR(S0).C0-5	2.27	194.5	97.5	54.0	75.7	1.8
8	LMR(S0).C0-10	2.18	188.5	68.5	55.0	78.5	1.8
11	GML(S1)C0	2.09	201.5	100.0	56.5	74.1	1.5
13	GML(S1)C1-3	2.31	187.5	86.0	55.0	77.7	1.8
14	GML(S1)C1-4	2.17	183.0	80.0	54.5	80.2	2.0
17	GML(S1)C1-9	2.20	207.5	99.5	55.0	76.7	2.0
18	GML(S1)C1-10	2.41	189.5	89.5	54.5	76.9	2.3
19	GML(S1)Synt.C2	1.87	207.0	105.5	55.0	77.4	1.8
20	GML(S1)C0	2.23	205.0	103.5	55.0	78.9	1.8
21	GML(S1)C2-1	1.95	203.0	81.5	54.0	76.6	1.8
25	GML(S1)C2-7	1.94	195.0	96.0	55.5	78.3	2.0
26	GML(S1)C2-9	2.10	197.0	80.0	54.0	79.6	1.8
31	Bisma. C0	2.57	196.0	92.5	54.5	73.0	1.5
32	Lamuru. C0	1.52	192.0	85.0	54.5	67.7	1.8
	F.cal	<1.0	2.00	<1.0	2.00	1.82	1.05
	MS.error	0.1528	64.5588	232.6176	1.1948	16.4031	0.1075
	LSD 5%	0.426	8.754	16.617	1.191	4.413	0.426
	LSD 1%	0.599	12.313	23.373	1.675	6.207	0.599
	CV (%)	18.45	5.00	16.70	2.09	5.34	18.28
	h^2(%)	62.8	59.3	74.6	45.9	68.4	-

Anoman 1 released 2008 from population Tuxpeno Sequia of CIMMYT was opv highly tolerance under generative stage and would be founded yield 3.0 ton ha^{-1}. Anoman 1 was planted around 10,000 ha cumulative since released on 2008. (Edmeages, 1993) that population *Tux.Seq*. selected by families S1 and increased of cycle per se 8.9 – 9.3%.

ASI **(**Anthesis Silking Interval)*.* The range of silking to tasseling stage define anthesis silking interval (ASI). Maximum ASI for maize is six days (Kasim dan Yasin, 2002: David *et al.,* 2014). ASI was mainly variable to found of máximum yield. Data of ASI could be collected in the first of experiment in Maros farm and shown the simple correlated of ASI and yield founded exponential model in Figure 1.

Tabel 4. Pooled yield of families under normal and drought condition and DI value

Plot	Pedigree	Environment**)		Total	Average	Yield losses (%)	Drought indeks
		Normal	Drought				
29	GML(S1)C2-13	4.49	2.57	7.06	3.53	42.8	0.937
31	Bisma.C0 (check)	4.79	1.83	6.62	3.31	61.8	0.625
4	LMR(S0).C0-4	4.09	2.31	6.40	3.20	43.5	0.924
13	GML(S1)C1-3	4.04	2.27	6.31	3.16	43.8	0.920
5	**LMR(S0).C0-5**	3.56	2.41	5.96	2.98	32.3	1.108
18	GML(S1)C1-10	4.20	1.73	5.92	2.96	58.8	0.674
10	**LMR(S0).C0-14**	3.54	2.30	5.84	2.92	35.0	1.063
3	LMR(S0).C0-2	3.62	2.09	5.71	2.85	42.3	0.945
11	GML(S1)C0	3.68	1.95	5.62	2.81	47.0	0.867
21	**GML(S1)C2-1**	3.43	2.18	5.61	2.80	36.4	1.040
8	LMR(S0).C0-10	3.68	1.87	5.56	2.78	49.2	0.832
19	GML(S1)Synt.C2	3.49	1.94	5.42	2.71	44.4	0.910
25	**GML(S1)C2-7**	3.20	2.17	5.37	2.68	32.2	1.110
24	GML(S1)C2-4-1	3.55	1.77	5.32	2.66	50.1	0.816
14	GML(S1)C1-4	3.33	1.84	5.18	2.59	44.7	0.904
30	**GML(S1)C2-15**	2.78	2.23	5.02	2.51	19.8	1.313
23	GML(S1)C2-4	2.81	2.20	5.00	2.50	21.7	1.281
20	GML(S1)C0	3.26	1.60	4.86	2.43	50.9	0.803
17	**GML(S1)C1-9**	2.67	2.10	4.77	2.38	21.3	1.287
6	**LMR(S0).C0-6**	2.52	1.55	4.07	2.04	38.5	1.007
1	LMR(S0).C0	2.10	1.97	4.07	2.03	6.2	1.745
9	LMR(S0).C0-12	2.56	1.47	4.03	2.02	42.6	0.940
26	**GML(S1)C2-9**	2.45	1.52	3.97	1.98	38.0	1.015
2	**LMR(S0).C0-1**	2.02	1.59	3.61	1.81	21.3	1.288
32	**Lamuru.C0 Check)**	2.16	1.45	3.60	1.80	32.9	1.099
7	**LMR(S0).C0-8**	1.81	1.79	3.60	1.80	1.10	1.655
28	**GML(S1)C2-12**	2.13	1.46	3.60	1.80	31.5	1.122
12	GML(S1)C0	2.23	1.33	3.57	1.78	40.4	0.976
22	**GML(S1)C2-3**	1.91	1.58	3.50	1.75	17.3	1.354
27	GML(S1)C2-11	2.08	1.22	3.29	1.65	41.3	0.960
15	GML(S1)C1-4-1	1.75	0.98	2.73	1.36	44.0	0.917
16	GML(S1)C1-7	1.46	0.78	2.25	1.12	46.6	0.874
	Population						
	- Total	95.25	58.17	153.44	-	1179.7	-
	- Average	2.98	1.82	4.795	-	36.9	-

DI>1.00 : tolerance under drought
**) yield data be sorter

The exponential model could be shown that highes of yield under family S1 with ASI:0-1 day, this value were very sincronice for flowering, and yield be decreASIng if ASI was increased. Gambin *et al.*, (2007) that size of kernel decrease in stressed of wáter and yield losses 60-70% if ASI>6.0 days family not be selected which founded ASI >6.0 days

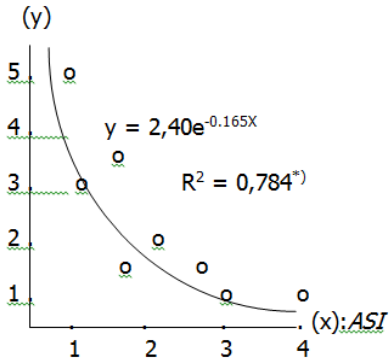

Figure 1. Exponential model of ASI (y:ton ha^{-1}) and ASI (x:days) under families S1 on two populations

CONCLUSION

1. In the first season family generate by selfed scored of plant aspect by score 1 - 2
2. Grain yied under normal condition be founded 3.20 - 4.79 ton ha^{-1} and lines of Lamuru was the best yielded "LMR(S0)C0-4" in tasseling stage 54 days and shelling 75%
3. Under drought tolerance population of Lamuru and GML were shown same of yieled productivity 2.30 ton ha^{-1}, plant aspect 1 - 2 and shelling 78 - 80%
4. The result computing of DI>1.0 founded 15 lines tolerance under drought, five from Lamuru population and 10 lines of GML. The DI>1,0 LMR(S0).C0 founded 2.10 ton ha^{-1} and yiled lossed under drought 36.9%
5. The implication of result that new population in inter crossed of 15 lines C(15,2):105F1 could be generate of new variety was tolerance under drought

REFERENCES

Aslan, M., M A. Maqbool. R. Chngiz. R., 2015. Effect of Drought on Maize. Springer Briefs in Agriculture. DOI. Soft Cover. USA

Banzinger, M., G.O. Edmeades., D. Beck., M. Bellon. 2000. Breeding for Drought and Nitrogen Stress Tolerance in Maize. From Theory to Practice. Maize Breeding Devision. Collected of Training Lectures in CIMMYT, March 1998. El Batan Mexico.

David, B.L., M.J. Robert, W. Schlenker, N. Braum, B.B. Little, R.M. Rejesus, G.L. Hammer, 2014. Greater sensitivity to drought accompanies maize yield increase in the U.S. Midwest Science. 344:

Edmeages, G.O., J. Bolanos, S.C. Chapman, 1996. Value of secondary traits in selecting for drought tolerance in tropical maize. Proceedings of a Symposium. Developing Drought and Low N Tolerant Maize. March 25-29, 1996. CIMMYT El Batan, Mexico.

Efendi, R., 2015. Perakitan Varietas Jagung *(Zea mays* L.*)* Hibrida dan Sintetik Toleran Cekaman Kekeringan dan Nitrogen Rendah. Disertasi. Program Pasca Sarjana, Universitas Hasanuddin. Makassar.

Fisher, K.S., E.C. Johnso., G.O. Edmeades, 1981. Breeding and selection for drought resistance in tropical maize. Maize Physiologist, CIMMYT. Asian Regional Maize Program.G.P.O. Box 2453. Bangkok. Thailand.

Gambin, B.L., L. Barras., M.E. Otegui, 2007. Is maize kernel size limited by its capacity to expand. MAYDICA. A Journal Devoted to Maize and Allied Species. Instituto Sperimentale pe la Cerealicoltura Section of Bergamo. Italy. Vol. 52 No. 4.

Kasim. F., Yasin H.G.M. 2002. Seleksi populasi jagung "maros sintetik 1" untuk lingkungan kahat n. jurnal stigma. Fakultas Pertanian Universitas Andalas. X(2):97-101.

Kasim. F., Yasin HG. M dan AT Dewi. 2010. Model *ASI* populasi jagung pool2 dan amatl tercekam kekeringan dan lahan PMK. Kumpulan populasi jagung khusus. Balitsereal Maros. Kelti Pemuliaan dan Plasma Nutfah. Balitsereal Maros.

Mhofu S., 2016. High Nutrition Seed to aid Recovery from Drought. CIMMYT-Kenya. IITA.

Stoskopf, N.C., D.T. Tomes, B.R. Christie, 1993. Plant Breeding. Westview Press. Oxford.

Yasin, H.G.M., M.J. Mejaya, 2016. Rancangan Statistik Khusus Pemuliaan Jagung (Kasus Jagung Fungsional QPM, Provit A, dan Pulut). IAARD Press. Badan Litbang Pertanian, Jakarta.

Yasin H.G.M., Sumarno, A. Nur. 2015. Perakitan varietas unggul jagung fungsional. Puslitbangtan Tanaman Pangan, Bogor. Badan Penelitian dan Pengembangan Pertanian.