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The selection of varieties of broccoli (*Brassica oleracea* var. *botrytis* L.) Planted in the rainy and dry seasons at lowland, the Island of Timor

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Abstract

Timor is one of the islands situated on the equator in the southern region of Indonesia which is adjacent to the continent of Australia. Timor has the potential for site-specific climate, the air temperature is relatively low, especially in the dry season. This potential for both growth and production of special varieties of adaptive broccoli. However, the cultivation of broccoli no one has done so very rare vegetable broccoli flowers in East including neighboring East Timor and several provinces in eastern Indonesia. The purpose of research is to obtain varieties that are adaptable to the high and low fluctuations in air temperature in the lowlands Timor. The method used in this study is a randomized block design (RBD), which consisted of 7 treatments varieties, namely (Green Magic, Diplomat, Royal Green, Lucky, Compact, Green Super and Green Bose) with four replications. The results showed that the best varieties of flowering is normal and has the wide adaptability to high and low fluctuations in air temperature during the rainy season are varieties of Green Super. Whereas in the dry season are varieties of Green Super, Kompok, Green Magic.

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Introduction

Broccoli plants very rare in several provinces in eastern Indonesia and NTT Province on the island of Timor. Timor island inhabited by people of the two countries, namely Indonesia and Timor-Leste. Broccoli flower vegetable needs are supplied from outside the island and imports. This is the only way to be done to meet the needs of consumers. The impact of this supply is the selling price of broccoli flower becomes very expensive, i.e USD. 80.000 s/d Rp. 105,000 kg^{-1} (Hypermart Kupang, 2016). While Java is only Rp. 8000 s/d Rp. 20,000/kg. In connection with these problems, and in an effort to utilize the land is still quite broad and fertile lowland island of Timor with the potential for a relatively low temperature for a few months, the research is very necessary.

Timor Island located in the Southern District of Indonesia and borders directly with the Australian continent has the potential air temperature relatively low and specific in the lowlands at altitudes below 400 m (meters above sea level) during the dry season on the island of Timor and winter on the continent Australia. The highlands of the island of Timor which had lower temperatures but the condition of the land has a very heavy barrier, the soil conditions are rocky and barren, a shortage of irrigation water and the slope of land above 30%. This situation brings a great danger of erosion. While lowland happens otherwise and has land suitability classes S1 (Highly suitable) for sustainable land use (Sys *et al.*, 1991). But the broccoli plant flowering process is also controlled by environmental factors, especially air temperature, and the lowland also has a very fluctuating temperature well on wet and dry seasons. However, there are several varieties of broccoli is still able to grow and produce flowers 2-12 ton ha^{-1} or superior varieties capable of producing an interest of 357.55 g $plant^{-1}$ at temperatures of 25-35 °C (Karistsapol *et al.*, 2013), Lehar *et al.*, 2016 stating that for get crop varieties that are resistant to high temperatures in the lowlands and uplands medium necessary varietal selection and environmental engineering to grow crops, in order to obtain varieties that are adaptable to high temperatures.

Therefore, based on the above problems, this study aims to produce broccoli varieties in accordance with the cultivation of broccoli in the lowlands.

Materials and methods

Of planting the first study conducted at the end of the rainy season in March 2016 and harvested in the dry season in June 2016. Meanwhile, a second study at the beginning of the dry season planting month of May 2016 and harvested at the peak of the dry season in August 2016. The research location in the Village District Baumata Kupang East Nusa Tenggara, Indonesia.

The location is geographically located at the coordinates 10° 11 'latitude and 123° 41' E in the altitude of 195 m above sea level. Data ground (Lab. Chemistry and Soil BPTP NTT Lab. Chemistry Soil Barawijaya University, 2016), as well as monthly climate data over the last 10 years (BMKG Lasiana, 2015) for a feasibility study site, are presented in Table 1.

Samples

The materials used in the research are broccoli seeds of 7 varieties, cow manure as much as 15 tons ha-1, urea fertilizer 200 kg ha^{-1}, NPK (16:16:16) 300 kg ha^{-1}, organic fertilizer complete biota plus With a dose of 3 liters ha-1 diluted 7 cc in 10 liters of water and 20 cc of vegetable pesticides in 15 liters of water (PTTA, 2015).

Research design

The design used in research both on a wet and dry season is RAK (Random Group) consisting of 7 treatments and 4 replicates varieties. Each treatment was Varieties Green Magic (GM), Diplomat (Di), Royal Green (RG), Lucky (Lu), Compact (Ko), Green Super (GS) and Green Bose (GB). Some variables were observed in either the dry or wet season is the growth the number of leaves formed per plant were counted up while removing the flowers, the number of leaf buds (pieces) that grows around the surface of the flower, flowering date (day), Traffic flowering normal (%), flower weight (g) and chlorophyll content (mg g-1),vitamin C (%) and protein (%).

Statistical analysis

Data analysis was conducted using Ms. Excel 2010 version with analysis of variance test (F-test with a standard error of 5%). If there is the significant influence on treatment, then do further tests using the Test Honestly Significant Difference (HSD) at 5% level to find out the real differences between the treatments.

Results and discussion

Selection of varieties planted rainy season

The average growth in the number of leaves, leaf buds growing number around the surface of flowers, crops, chlorophyll, vitamin C, and protein from the 7 varieties of broccoli that are selected on planting in the rainy season are presented in Table 2.

The observation of the growth and yield (Table 2) showed that the number of leaves that form most of the seven varieties is selected sequentially in the treatment of GM varieties is 29 strands of plant^{-1}, Lu and GS respectively 28 strands of plant^{-1} and not significantly different. But significantly different with the 4 other varieties.

While the number of leaves that form at least there are varieties At just 24.25 piece plant^{-1} and significantly different with GM varieties. 26.25 piece plant^{-1}.A number of leaf buds that grow on the surface of most interest are the amount of 53.25 GB varieties strands plant^{-1} significantly different with all other varieties. A number of second largest leaf buds that is RG 36.50 piece plant^{-1} and significantly different with GS. A number of leaf buds that grow at a rate of at least 19.75 piece plant^{-1} varieties GS and not significantly different from the varieties Ko 20.50 piece plant^{-1}, strands GM -121.75, at 22.00 piece plant^{-1} and Lu 28.00 piece plant $^{-1}$.This is expected because the productivity differences of each variety/cultivars depend not only on nature but also influenced by the situation and environmental conditions. Olesen and Grevsen (1997) states that the environmental conditions with high-temperature pressure during the day and low temperatures at night will help compactness broccoli flower formation in plants and tuber formation of potato (Lehar *et al.*, 2016).

Table 1. Condition of land eligibility before research climate and the potential spread of the last 10 years (2006-2015) around the sites.

Result analysis of Soil	pH	Organic C	N total	P available	Kavailable	CEC	Base saturation	Texture
Parameter Value	7.7	2.3%	0.26	5.5%	0.11%	11.78	98%	clay dusty
Climate Data	Air Temperature (°C)			Light intensity (%)	Humidity (%)	Rainfall (mm)	Evaporation (mm)	Wind Speed (knots)
	Max	Min	average					
March	31.4	23.5	27.4	66	85	249	151	4
April	33.0	23 , 4	28.2	78	79	94	164	7
May	32.6	23.6	28.1	87	74	20	187	8
June	31.0	20.2	25.6	87	72	10	177	9
July	30.9	18.9	24.9	87	69	3	202	9
August	32.2	19.1	25.6	92	67	1	225	8

Potential distribution of climate/weather since the implementation of the research of the month from March to August 2016 are presented in Table 3.

Table 3 shows the monthly air temperature relatively hot with a minimum temperature range of 21.8 to 24.2 °C and maximum 32.9 to 34.5°C during the study were planted in the rainy season until the end date of March 24 harvest June 30, 2016. With this temperature range produces the dominance of vegetative growth that is the number of leaves on GM varieties as well as the number of leaf buds that grow on the surface of the flower varieties GB and RG. Results showed that the vegetative growth phase of domination that almost occurred in all varieties, except for GM varieties.

It is suspected that the vegetative growth of the plants is more dominant then fotosintat results will not be stored or used for vegetative growth. Haryadi (1989) states that if the vegetative phase of the plant growth is more dominant than the generative phase fotosintat will be more widely used than is stored in a storage organ for the formation of flowers and fruit/seeds.

Table 2. Average growth vegetative and generative, yield, chlorophyll, vitamin C and protein in broccoli varieties grown 7 rainy season.

Vegetative growth and generative							
Varieties	Number of Daum	Varieties	Number shoots leaves on the flower	Varieties	Flowerage	Varieties	Flower normal
RG	29.00 a	GB	53.25a	GM	69.25 a	GS	68.34 a
Lu	28.50 a	RG	36.50 b	Lu	66.75ab	Ko	48.34 b
GS	28,50 a	Lu	28,00bc	At	63,00 bc	GM	25.00c
GM	26.25b	Di	22.00bc	Ko	59.75cd	Lu	21.67c
GB	26.00bc	GM	21.75bc	RG	59.00cd	In	18.33 c
Ko	25,00bc	Ko	20,50 bc	GS	56.25 d	RG	10.00 c
in	24.25 c	GS	19.75 c	GB	54.50 d	GB	8.34c
Crops, content of chlorophyll, Vitamin C and Protein							
Varieties	Weightflower	Varieties	Chlorophyll	Varieties	Vitamin C	Varieties	Protein
GS	557.5 a	GS	0.203 a	Lu	0.0253 a	Ko	7.02 a
Ko	437.5 b	Ko	0.190 a	Ko	0.0248a	GM	6.54ab
GB	422.5 b	in	0.187a	GS	0.0230a	Lu	6.29abc
GM	417.5 b	RG	0.177 a	GB	0.0231a	GB	5.88abc
At	342.5bc	GB	0.177 a	At	0.0224 a	RG	5.38 bcd
Lu	325.0bc	GM	0.123 a	GM	0.0211 a	In	5.31cd
RG	265.0c	Lu	0,113 a	RG	0.0197 a	GS	4.84 d

Description: Numbers are accompanied by the same letters in the same column are not significantly different shows based on test HSD 5%.

Relatively high temperatures ranging from the planting of the third decade of March until the decade of II Mayor for 50 days, showing the daily temperature on date of May 27, 2016, reached the highest temperature 36°C during the day it is suspected flowers of broccoli can not be fully formed as a result of pressure and temperature high.

The high temperatures cause the reproductive phase of slowing growth and development of broccoli flowers from 35-45 days to 54.5 to 69.25 days (Table 2). The delay in flowering date this has also resulted in a slowdown in the age of 48-70 days to harvest from 69.25 to 83, 5 days (Deptan, 2017;SSC, 2013 and Kementan. 2011).

Late flowering varieties in hot temperatures that planting in the rainy season which GM varieties 69.25 today and Lu.

Lu varieties which should begin flowering at the age of 35 days after planting has been delayed flowering becomes 66.75 days. This variety is not significantly different from GM but significantly different with the 4 other varieties. The fastest flowering varieties are 54.5 GB varieties days after planting despite these shortcomings experienced many normal, not flower formation. GB different varieties flowering date real At 63 days, Lu and GM, but together with RG 59 days of flower production is also more abnormal. Varieties of flowering age GS Ko 56.25 and 59.75 days (Fig. 1) more normal flowering was also not significantly different from GB varieties (Fig. 2) which generate a lot of interest is not normal.

Of normal broccoli flower production, most varieties produced by GS for 68.34% of the total sample of 15 plots Plant^{-1} weighted interest yields 557.5 g plant^{-1}

percentage and weight is significantly different from other varieties. The amount of normal flower production achieved by the best two varieties Ko 48.34% by weight of 437.5 g taninterest-1.

Normally the least interest generated by GB varieties of 8.34% and was not significantly different with 25% GM varieties, Lu 21.67%, Di, 18.33% RG 10%. Between 5 GB varieties of these varieties were not significantly different.

Table 3. Distribution of potential climate/weather during the study occurred in 2016.

Month	Temperature Air(°C)			Light intensity (%)	Humidity (%)	Rainfall rain (mm)
	Max	Min	average			
March	33.0	24.2	28.1	61	85	227.3
April	34.5	23.7	28.9	77	73	134
May	33.1	23.8	27.9	71	78	102
June	32.9	23.2	27.7	73	71	2.5
July	32.1	22.3	27.0	74	67	26.5
August	32.2	21.8	26.7	75	64	0

Source: Meteorological and Geophysics, Stasium Climatology Lasiana, 2016.

The weight of the smallest interest generated by GM varieties at 265 g plant^{-1} which are not significantly different from 325 g plant Lu-1 Di 342.5 and plant^{-1}. Di and Lu also showed no significant difference with 422.5 g of plant GB-1 and GM 417.5 g plant^{-1}.

The results of this research in the flowering process shows that high temperatures produce an inverse relationship between the number of normal broccoli flower with leaves growing a number of buds on the surface of interest.

The more the number of leaf buds is formed on the surface of the amount of the interest rate the less normal. This is evidenced by the variety of GB, RG, Lu and Di. The opposite occurs in Variety GS, Ko, and GM.

Table 4. Average growth and yield, chlorophyll, vitamin C and protein at 7 treatments broccoli varieties grown dry season.

Vegetative growth and generative							
Varieties	Number ofDaum	Varieties	Number shoots leaves on the flower	Varieties	Flowerage	Varieties	Flower normal
Lu	26.25 a	GB	19.50 a	Lu	58.50 a	GS	90.00 a
At	25.75 a	RG	7.50 b	GM	57.75 a	Ko	86.67ab
RG	24.25ab	In the	3.00c	On	55.75 abc	GM	75,00bc
GS	24,25 ab	Lu	2.75 c	GS	53.55abc	Di	75.00bc
Ko	23.25b	GM	2.50 c	Ko	52.50bcd	Lu	70.00c
GB	23.00 b	Ko	1.50c	RG	51.50cd	GB	51.67d
GM	22.75 b	GS	1.25c	GB	48.25d	RG	48.33d
Including Harvest Ingredients Chlorophyll, Vitamin C and Protein							
Varieties	Weightflower	Varieties	Chlorophyll	Varieties	Vitamin C	Varieties	Protein
GB	730.0a	Ko	1.20 a	Lu	0.021 a	Ko	5.71 a
GS	627.5b	Lu	0.81ab	Ko	0,020ab	RG	5.58 a
GM	530.0 c	GS	0.74ab	GB	0,020ab	GS	5,57 a
At	505.0 cd	RG	0,73ab	At	0,019 abc	Di	5.45 a
Ko	480.0cd	In	0.68 b	GS	0,018 bc	GB	5.22 a
RG	440.0 d	GM	0.65b	RG	0.018bc	GM	5.02 a
Lu	425.0d	GB	0.55 b	GM	0.017 c	Lu	4.90 a

Description: Numbers are accompanied by the same letters in the same column are not significantly different shows based on test HSD 5%.

The fewer the number of leaf buds that grow on the surface of the percentage of the normal interest rate increases. In general, it can be stated that many flowers are not normal. Abnormal flower shape is the characteristic plant in responding to environmental adaptation to protect the interest that will be formed from high-temperature stress which does not correspond to the phases of the formation of flowers. It is suspected that the broccoli plants generally bloom in the highlands to the lowland but can also be flowering but not normal, much damaged. Hatfield and Pruegar (2015) states that temperature is the main factor affecting the rate of development of the plant, where high temperatures or temperature extreme will have an impact on plant productivity. Pollination is one of the most sensitive phenological stages to temperature extremes in all plant species, and during the vegetative growth stage running, extreme temperatures during the day will greatly influence the formation of flowers and crop production (Hatfield *et al.*, 2014). Furthermore, Sulistyaningsih (2006) reported that onion plants generally bloom in the highlands but now the onion crop in the lowland also be flowering, although the number is still small stalk flowers and many are damaged by high-temperature pressure.

Fig. 1. Interest leaf buds normal without abnormal.

Relation to temperature stress on flowering broccoli then the process of growth and development of broccoli flowers enactment into 5 phases, namely the phase vegetative transition, straightened, early reproductive, bowed and crown. Characteristic of the phase transition vegetative that leaves which are formed in the form of a transition or phase leaf primordia begin the formation of flowers on the apical meristem. Followed phase straightened is a transition from the reproductive to the floral primordia flower form flower branch. The specific phase which is very critical with high air temperatures phase. early reproductive In this phase deviation abnormal production of flowers on top just happens when a hot air temperature higher than 30°C. Then entered a phase bowed that branches formed a continuous flower and floral primordia do not exist anymore. While the crown is a phase that is very tolerant to high temperatures above 30°C. Interest continues to develop normally after passing the phase of early reproductive (Bjorkman and Pearson, 1989).

The results of laboratory analysis of chlorophyll and vitamin C content of the crop was not significantly different between varieties with each other. It's just visually that the content of chlorophyll and vitamin C each contained in the GS varieties as much as 0.203 mg/g and Lu 0.025%. While the content of chlorophyll and vitamin C are the lowest respectively Lu varieties produced by as much as 0,113 mg / g and RG 0.0197%. While the formation of the protein has a different response between two or more varieties planted rainy season. High protein content produced by Ko varieties worth 7.02% and did not differ significantly with GM's 6.54%, 6.29% and GB Lu 5.88%. Low protein content generated by GS varieties worth of 4.84%. Low protein in these varieties may be related to lack of leaf buds that grow on the surface of interest when compared with other varieties.

Because the leaf buds that grow on the surface of broccoli flowers can only function as a protective interest when a temperature raises that is not in accordance with the growth and development of flowers. Solar radiation and the temperature is hot enough during the day can result in reduced protein content in broccoli interest because of protein denaturation. Less growth of leaf buds on the flower heads that there are varieties GS is also in line with the reduced content of a protein produced.

Selection of varieties grown drought

Average growth in the number of leaves, leaf buds growing number around the surface of flowers, crops, chlorophyll, vitamin C, and protein from the 7 varieties of broccoli that are selected on planting in the dry season are presented in Table 4.

The observation of the growth and harvest drought and analysis (Table 4) show that the number of leaves that form is still dominated by a heat-resistant variety when grown rainy season. Varieties that many numbers of leaves that are as much as 26.25 piece Lu-plant^{-1} were not significantly different with strands^{-1}of that 25.75 and GE and GS which has the same number of leaves which strands 24,25. But significantly different strands 23.25 Ko-plant $^{-1}$, GB 23 strands plant^{-1} and strands of plant GM -122.75. Similarly, the number of leaf buds that grow and appear on the surface of interest is still dominated by varieties that are not heat resistant. The most prominent varieties of leaf buds growing number occurred in GB varieties and RG respectively 19.5 strands of plant^{-1} and 7.5 strands often^{-1} different real and all other varieties. Some cultivars of broccoli are believed that the increase in temperature from 13 °C to 29 °C in a certain time may affect the flowering process quantitatively and increase the number of leaves formed of 18 pieces of 24 pieces (Tan, 1999; Dalmadi, 2010).

Fig. 2. Flower bud leaves a lot.

Age started flowering varieties GB and RG is the most rapid. Each 48.25 days and 51.5 days and were not significantly different between the two.

The decline in the number of leaf buds that form on the surface of the flowers planted drought than when planted rainy season, increased crop yields normal rate of 8.34% to 5.67% (GB) and from 10% to 48.33% (RG), although both of these varieties produce normal flowers that at least when compared with the five varieties sharing. A number of normal flower varieties GB and RG are not significantly different and significantly different from the five other varieties. Only harvests of interest between GB weighing 730 g plant^{-1} largest and most significant difference with RG 440 g plant^{-1}. The production of normal flowers best is worth 90% of GS varieties were significantly different with all other varieties. Ko followed by 86.67%, GM 75% and 75% in each of the three varieties of normality is not significantly different from the production of flowers. The high percentage of normal interest value GS is one of the most important variables in the selection of indicators of excellence which is also in line with the increased weight of the flower crop yields of 627 g of Plant $^{-1}$ in this study and are second from GB flower weights. But the weight of the highest interest generated GB are not supported by the quality of the view that the low-interest normalcy. It also happens to GM varieties, Lo and Di.

Conclusion

The results of varietal selection in this study show that there is one of the best adaptive varieties is planted in the rainy season in the lowlands of Green Super. Normal flower production performance 68.34% by weight of 557.5 g per tan flower-1. When planting is suitably carried out in March with an average temperature of 28.1 °C and the fall harvest in June, with temperatures of 27.7 °C, while the adaptive varieties best in the dry season there are three varieties with normal flower production performance and the weight of the respective interest of Green Super 90% and 627.5 g. Plant $^{-1}$, Compact 86.67% and 860 g. Plant^{-1} and Green Magic 75% and 530 g. Plant $^{-1}$. The most appropriate planting time in the dry season is from May with an average temperature of 27.9 °C and harvested in August, with temperatures of 26.7 °C.

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