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The Response of Five Maize Varieties on Fertilizer Package Application in Suboptimal Land North Lombok, Indonesia

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Abstract:- Efforts to improve maize yield are a problem in suboptimal land due to biophysical constraints in the form of poor water, nutrients, and organic matter. This study aims to determine the yield response of five varieties of maize treated with organic fertilization packages (15 tons/ha of cattle manure), inorganic (Urea 300 kg/ha, and Phonska 200 kg/ha), and mycorrhizal biofertilizers (1.5 tons/ha). In the suboptimal land of North Lombok. The research was conducted in the West Pemenang Village, Pemenang District, North Lombok Regency. The experimental design used was a randomized block design with three repetitions and five treatments of maize varieties, namely V1 (P8IS variety), V2 (P8DPP variety), V3 (Gumarang variety), V4 (Lemuru variety), and V5 (Sukmaraga variety). Observation data were analyzed using analysis of variance (ANOVA) and further testing with the Honestly Significant Difference (HSD) at the 5% real level. The results showed that the Sukmaraga (V5) variety showed the best results in the application of organic, inorganic, and mycorrhizal biofertilizers in the suboptimal land of North Lombok.

Keywords:- *Maize, Fertilizer Package, Response, Suboptimal.*

I. INTRODUCTION

The maize food commodity is one of the three leading commodities of West Nusa Tenggara (NTB) as stated in the Regional Medium- Term Development Plan - NTB 2009-2014, known as PIJAR (cow, maize, and seaweed). Besides, the NTB region is also one of the target areas for increasing national maize production, as stated in the RPJM-Ministry of Agriculture 2010 - 2015, and NTB is expected to become a supplier of food (maize) to meet national needs. This effort was then strengthened by the special rice, maize, and soybean program (Upsus Pajale), which was carried out to achieve national food security by including technological innovations as stipulated in MOA 03/Permentan/OT.140/2/2015.

Therefore, to accelerate the implementation and achievement of the development of the food self-sufficiency sector optimally and sustainably on suboptimal land in NTB, it is necessary to develop and apply environmentally friendly technology in local conditions. This is following the elaboration in the Strategic Plan of the Faculty of Agriculture, the University of Mataram, which wants to create an internationally competitive Faculty of Agriculture to develop a sustainable agricultural system by 2025. For this reason, it is necessary to create a model of high yielding maize cultivation with the application of environmentally friendly technology that is integrated and synergistic—supported by optimal use of local resources.

On the other hand, the suboptimal land that dominates the NTB region (84%) has a biophysical limiting factor in low soil fertility, mainly characterized by low nutrient availability, poor soil organic matter content, and limited water availability for plants. [1]. Inadequate P availability is also one of the problems limiting maize yields in the suboptimal lands of North Lombok. Only about 8-13% of the given amount of P fertilizer is absorbed by the roots [2]. One way to solve the availability of P and other important nutrients is by utilizing arbuscular mycorrhizae (AM) to increase plant growth and yield.

Inoculation of AM in maize on sandy soils as a substitute for adding fertilizer is expected to have positive implications for soil properties, nutrient uptake, and yield [3]. Another study showed that soybean plants inoculated with MA increased P uptake and increased yields compared to those without MA inoculated on sandy soils [4]. AM is able to increase nutrient availability and nutrient uptake and increase root proliferation [5]. Inoculation with indigenous mycorrhizal seed coating can increase growth, plant production, uptake of plant N, P, and nutrient availability in the maize-sorghum cropping pattern in the suboptimal land of North Lombok [6]. The application of a mixture of inorganic fertilizers, organic fertilizers, and mycorrhizal biofertilizers can increase nutrient status, nutrient uptake, growth, and yield of maize in suboptimal land [7].

One of the efforts to optimize the productivity of suboptimal land can also be done by developing a maize plant cultivation system with the application of a fertilizer package mixture of inorganic fertilizers, organic fertilizers, and mycorrhizal biofertilizers. Maize is a C4 plant that requires direct sunlight and requires a large amount of nitrogen and phosphorus [8]. Also, the maize plant is one of the preferred host plants for mycorrhizal fungi, which can lead to enrichment of mycorrhizal content in the soil. For example, in the maize-soybean cropping pattern, maize plants can increase AM sporulation and infection in the maize plant's rhizosphere. This results in AM enrichment in

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the soil, which is very beneficial for plants in the next cropping cycle. The application of soybean maize cropping patterns increases the mycorrhizal population in the soil, which remains high in the next cropping cycle [9]. Application of the application of indigenous mycorrhizal-based fertilization packages and organic matter to the maize-sorghum cropping pattern in the suboptimal land of North Lombok can improve soil nutrient status, soil organic matter content, plant nutrient uptake, growth, yield, and mycorrhizal activity in the soil [10]. However, how big the response of the five wide yields superior to the application of mixed fertilization packages for inorganic fertilizers, organic fertilizers, and mycorrhizal biofertilizers in suboptimal land is still not much information that reveals it.

This study aims to determine the yield response of five varieties of maize (Zea mays L.) to the application of NPK fertilization packages, organic matter, and mycorrhizal biofertilizers in suboptimal land of North Lombok.

II. MATERIALS & METHODS

➢ *Time and Place of Experiment.*

This research will be carried out from May to August 2020, located in West Pemenang village in Pemenang district of North Lombok. Observation of mycorrhizae and soil nutrient status was carried out at the Soil Microbiology and Chemistry Laboratory, Faculty of Agriculture, University of Mataram.

➢ *Experimental Design*

The experimental design used was Randomized Block Design (RBD) with the treatment of five treatments of maize varieties, namely V1 (P8IS variety), V2 (P8DPP variety), V3 (Gumarang variety), V4 (Lemuru variety), and V5 (Sukmaraga variety). Each treatment three times so that as many as 15 experimental plots were obtained.

➢ *Inoculum MA Indigenous*

AM indigenous inoculum, which will be used in this experiment, results from a private collection named MAA01 mycorrhizae isolate, which is the best collection of indigenous mycorrhizal isolates from North Lombok (Collection Dr. Ir. Wahyu Astiko MP).

➢ *Conduct of experiments*

The soil used in this study is a type of sandy soil (69% sand, 29% dust, and 2% clay, containing an average of 421 AM spores per 100 g of soil), typical of North Lombok. The soil is geographically located -8.221650, 116.350283, and contains 13.82 mg/kg available P, 0.01% total N, 0.57 cmol/kg available K, 7.31 cmol/kg Ca, and 1, 21% C-organic. The soil is processed using a tractor to make it lose and clean from weeds. The soil was then made into 15 plots with plot sizes of 5 m x 4.5m based on the plot layout of a randomized block design.

The indigenous mycorrhizal fungi inoculum used were *Glomus mosseae* (MAA01 mycorrhizal isolate mixture of soil, hyphae, and mycorrhizal spores), which was initially isolated from suboptimal land (1,500 spores per 20 g of soil) in Akar-Akar Village, North Lombok. AM inoculation and application of cattle manure (1 ton/ha and 15 ton/ha) were carried out at planting time by evenly placing the manure and MA inoculum at a depth of 10 cm to form a layer under the seeds of 20 g per planting hole. Maize seeds are planted by cutting two seeds per planting hole at a spacing of 60 cm x 20 cm.

Cattle manure used in this experiment contained 3.08% total N, pH 6.66, 17.70 mg/kg available P, available K 2.31 cmol/kg K, C/N ratio 10.45, and 32.2% C-organic. The inorganic fertilizers given are the recommended fertilizer dosage, namely Urea 300 kg/ha and NPK Phonska 200 kg/ha (Astiko et al., 2015). The first fertilization was carried out seven days after planting (dap) with a dose of 100 kg/ha of Urea and 100 kg/ha of NPK Phonska fertilizer. The second fertilization with Urea and Phonska fertilizer was given at 21 dap at a dose of 100 kg/ha, and the third fertilization with Urea was given at a dose of 100 kg/ha at 28 dap afterward. Fertilizer is applied in a 5 cm groove next to the plants' rows at a depth of 5-7 cm. After applying fertilizer, the soil is covered with husk ash.

Plant protection is carried out by spraying "OrgaNeem" (organic pesticide extracted from Azadirachtin plants) with a concentration of 5 ml of OrgaNeem per liter of water. OrgaNeem has applied from the age of 10 to 40 days afterward with a spraying interval of 3 days.

➢ *Observation of Parameters*

Observation of research parameters was carried out on wet and dry biomass weight of shoots and roots at 40 and 92 dap, a number of spores and percentage of root colonization at 92 dap, the yield of harvested dry ear weight, oven-dry ear weight, ear length, ear meter, dry shell weight. Seeds per plant, yield of harvested dry ear weight, dry ear weight in the sun, dry weight of dry seeds per plot, and weight of 1000 seeds.

The extraction of MA spores from soil (100 g soil samples) was carried out using wet sieving and decanting wet sieving techniques [11]. The filter results in the last filter (38 µm) are washed with running water until clean. The supernatant was then taken, then added with a 60% sucrose solution, and then spun in a centrifuge at 3000 rpm for 10 minutes [12]. The spores obtained were placed in a Petri dish to count their population per 100 g of soil under a stereo microscope with a magnification of 40 times. The variable percentage of colonization was calculated using the clearing and staining methods [13]. The percentage of infection was calculated using the gridline intersect technique under a stereomicroscope [14].

The shoots and root dry weight at the age of 40 dap was measured by drying the crown and roots using an oven at 60ºC for 48 hours until they reached a constant weight.

➢ *Data Analysis*

Data were analyzed using a two-way analysis of variance (ANOVA) and Tukey's HSD (Honestly Significant Difference) means-tested at a 5% level of significance.

III. RESULTS AND DISCUSSION

➢ *Plant Biomass Weight*

The results of the analysis of variance showed that the use of the Sukmaraga variety had a significant effect on the increase in wet and dry biomass weight of the plant shoots and roots compared to the use of the P8IS variety (Table 1). The HSD test results at the 5% level showed that the use of the Sukmaraga variety compared to the P8IS variety could significantly increase the plant shoots and roots' wet and dry biomass weight, both at the age of 40 and 92 dap.

Variety	Biomass weight				
	Shoots (g) 40 dap	Shoots (g) 92 dap	Root (g) 40 dap	Root (g) 92 dap	Per plot (kg)
Wet biomass weight					
V1 (P8IS)	156.5^{b}	217.0^{b}	21.27^{b}	94.54^{bc}	11.10^{b}
V2 (P8DPP)	168.5^{b}	119.5^{c}	23.54^{b}	80.73^{bc}	11.46^{b}
V3 (Gumarang)	186.5^{ab}	154b^{c}	27.22^{ab}	34.38^{c}	14.06^{b}
V4 (Lamuru)	255.5^{ab}	326.0^{a}	28.77^{ab}	116.78^{b}	22.23^{a}
V5 (Sukmaraga)	301.0^{a}	366.5^{a}	43.55^{a}	190.00^{a}	23.43^{a}
HSD 5%	86.74	48.52	13.21	47.82	4,959
Dry biomass weight					
V1 (P8IS)	9.97^{c}	82.98^{ab}	5.76^{b}	48,825^{bc}	9.46^{b}
V2 (P8DPP)	15.87^{bc}	53.73^{b}	9,37^{ab}	45.49^{bc}	9.8^{b}
V3 (Gumarang)	21.65^{abc}	55.94^{b}	10.34^{ab}	17.75^{c}	9,53^{b}
V4 (Lamuru)	25,80^{ab}	95.91^{a}	9.82^{ab}	75,425^{ab}	16.27^{a}
V5 (Sukmaraga)	34.55^{a}	111.73^{a}	15.25^{a}	100.61^{a}	19.50^{a}
HSD 5%	8.687	20.63	5.391	32.66	2.964

Table 1: - Wet and Dry Biomass Weight of Shoots and Roots in Various Maize Varieties
(Figures followed by the same letters in the same column show results not significantly different according to HSD test 5%)

Wet and dry plant biomass weights were thought to have a positive correlation with leaf area formed, which was always followed by an increase in shoot biomass and root biomass weights. This is because the leaf area is a plant organ that significantly contributes to plant life. After all, the photosynthesis process takes place in the leaves. The existence of differences in leaf area in each variety will impact the ability of these plants to form photosynthate, which will be distributed to all parts of the plant, including for the formation of plant shoot and root biomass [15]. The crown's width will also affect the reception of solar light, further, it will affect the results of synthesis (glucose), and the final estuary will affect the overall results. Sukmaraga maize variety has a broader leaf area than other maize varieties; this has a positive contribution to the availability of nutrients, water, and sunlight absorbed by plants to form plant organs [16].

➢ *Mycorrhizal Development*

The results of the analysis of variance the effect of the treatment of the Sukmaraga variety showed a significant difference (HSD 5%) compared to the P8IS variety in the number of spores of AM and the percentage of root colonization at 92 dap (Table 2). The highest value of the number of spores and the percentage of colonization was found in the treatment of Sukmaraga variety, namely 752 spores/100 g soil and 97.5 percent colonization. The lowest value of the number of spores and the percentage of colonization was found in the treatment of P8DPP varieties, namely 428 spores/100 g soil and 85 percent colonization.

Variety	Number of spores	Colonization
V1: P8IS varieties	464^{c}	86.25^{c}
V2: P8DPP varieties	428^{c}	85.00^{c}
V3: Gumarang varieties	541^{bc}	88.75^{bc}
V4: Lemuru variety	649^{ab}	93.25^{ab}
V5: Sukmaraga Varieties	752^{a}	97.50^{a}
HSD 5%	142.57	4.988

Table 2: - Average number of spores (spores per 100 g of soil) and colonization value (% -colonization) of mycorrhizae at 92 dap for each maize variety (numbers followed by the same letters in the same column show results not significantly different according to HSD test 5%)

The high number of spores and colonization in the roots of the maize variety Sukmaraga indicated that the inoculated AM was able to adapt to climatic and to the existing technical culture conditions of the plant. Mycorrhizal indigenous have a favorite host and can adapt well to the local environment as indigen fungi selected from the ecosystem in these plants. It seems that the MAA-001 mycorrhizal isolate is an indigenous mycorrhizal fungus that has a good inoculation response to increase plant growth in marginal soil conditions. This is in line with the results of field research, which show that the success of AM inoculation depends on the indigenous species and the potential of the inoculant itself. It is further argued that indigenous AM populations' effectiveness is related to the factors of soil nutrient status, host plants, propagule density, and competition between AM and other soil microorganisms [17].

The AM species used in this study were *Glomus* sp. A type of AM can produce a lot of spores on maize plants in a relatively fast time. The above facts are supported by evidence of data on the number of spores and the percentage of root colonization of host plants by AM on the Sukmaraga variety, which is higher and significantly different from the P8IS variety treatment. A high percentage of root colonization is the preferred prerequisite for AM in the safe plant. However, the large percentage of colonization in the field depends on the host plant species, soil conditions, and indigenous AM species. The percentage of colonization also depends on the density of the plant roots. Furthermore, it is said that the degree of colonization gives an idea of how significant the external influence is on the root relationship and MA [18].

Each plant has different functional compatibility to AM inoculants because they prefer certain types of MA. Functional compatibility can be seen from plant response indications to AM inoculation, such as root colonization, relative AM dependence, and upper P levels or uptake of plants. Root hair diameter, length, and root abundance are the morphological characteristics of the roots related to P. uptake. The plant's low root system and short root hairs indicate high dependence on AM [19].

Also, the number of spores and colonization of AM in the rhizosphere of plant roots varied greatly depending on the type of vegetation, the type of host plant, the environment, and the land from which the collection came from. Besides the overall specific differences [20], the biodiversity of AM is also affected by soil conditions [21].

➢ *Crop Yield*

The analysis of variance results showed that the use of the Sukmaraga variety had a significant effect on the increase in crop yields compared to the use of the P8DPP variety (Table 3). The results of the HSD test at the 5% level showed that the use of the Sukmaraga variety compared to the P8DPP variety could increase the yield of harvest dry ear weight, oven-dry ear weight, ear length, ear diameter, dry seed weight per plant successively from 178.5 g, 18.5 g, 10.0 g, 4.90 g and 145 g increase to 271.5 g, 25.5 g, 16.5 g 5.30 g and 180 g.

Varieties	**DCW (g)**	**ODCW (g)**	**EL (cm)**	**ED (cm)**	**DSW (g))**
V1 (P8IS)	216.0[bc]	25.0[a]	11.0[cd]	4.20[c]	155[bc]
V2 (P8DPP)	178.5[c]	18.5[b]	10.0[d]	4.90[b]	145[c]
V3 (Gumarang)	244.5[ab]	21.5[ab]	14.5[ab]	4.85[b]	165[ab]
V4 (Lamuru)	215.5[bc]	19.0[b]	13.0[bc]	5.15[ab]	120[d]
V5 (Sukmaraga)	271.5[a]	25.5[a]	16.5[a]	5.30[a]	180[a]
HSD 5%	40.20	0.046	2,7446	0.316	0.019

Table 3: - Results of Harvested Dry Cob Weight, Oven Dry Cob Weight, Ear Length, Ear Diameter, Dry Seed Weight per Maize Plant in Various Varieties (numbers followed by the same letters in the same column show the results are not significantly different according to the HSD test 5%)

Likewise, the HSD test results at the 5% level of the yield components showed that the Sukmaraga variety significantly increased the yield components compared to the P8DPP variety (Table 4). This increase can be seen in the weight of harvested dry cobs, dry cob weight in the sun, the value of dry seeds per plot, and weight of 1000 seeds of seeds respectively from 106 kg, 8.43 kg, 6.20 kg, and 278 g increased to 157 kg, 11.73 kg, 8.53 kg, and 288 g.

Variety	**WFDC (kg)**	**WDC (kg)**	**WDCS (kg)**	**1000 seeds (g)**
V1 (P8IS)	111[ab]	7.86[c]	5.73[c]	279[a]
V2 (P8DPP)	106[b]	8.43[bc]	6.20[bc]	278[ab]
V3 (Gumarang)	111[ab]	8,03[c]	6.53[bc]	285[a]
V4 (Lamuru)	138[a]	9.73[b]	6.96[b]	264[b]
V5 (Sukmaraga)	157[a]	11.73[a]	8.53[a]	288[a]
HSD 5%	4.652	1.642	1.072	14.244

Table 4: - Yields Harvested Dry Cob Weight, Dry Cobs Weight in the Dry, Dry Seed Weight and 1000 Grains of Seed Per Plot in Various Maize Varieties (WFDC = Weight of Harvested Dry Cob, WDC = Weight of Dry Cobs in the Dry in the Sun, WDCS = Weight of Dry Cobs of Seeds, Weight of 1000 Grains of Seeds and numbers followed by the same letters in the same column show the results are not significantly different according to the HSD test 5%)

In the treatment of the Sukmaraga maize variety, it is suspected that it can better absorb solar energy for use in the photosynthesis process and can use it more efficiently so that the resulting yield is also greater. Dry weight represents the net yield of carbon dioxide throughout growth. The assimilation of carbon dioxide is the result of the absorption of solar energy and due to solar radiation, which is distributed evenly over the surface of the absorbed leaf and the efficiency of the utilization of this energy for carbon dioxide fixation [22].

There are indications that the Sukmaraga variety is more responsive to MA inoculation accompanied by the addition of manure so that it can improve roots, increase water uptake and uptake of nutrients, especially phosphorus nitrogen [23, 24]. This causes an increase in yields in the form of harvested dry ear weight, dry seed weight per plant, harvest yield of harvest dry ear weight, dry ear weight, dry seed weight per plot, and 1000 seed weight.

Also, inoculation of AM in maize varieties Sukmaraga has good symbiotic suitability. It can dissolve phosphates bound in soil and fertilizers, increase the absorption of nutrients N, P, K, increase plants against drought, produce growth-stimulating compounds, stimulate activity. Beneficial microbes improve soil structure and aggregation and aid in mineral cycling [25]. Decomposition and mineralization of organic matter in AM's presence are also better, which positively affects soil physical, chemical, and biological factors. The unity of all these factors supports the increase in crop yields [26].

IV. CONCLUSION

Varieties Sukmaraga (V5) with the application package fertilizing cattle manure (15 tons/ha) and a biological fertilizer mycorrhizal (1 ton/ha) and inorganic fertilizers (Urea 300 kg/ha and NPK Phonska 200 kg/ha) respond best results in suboptimal land of North Lombok. The use of the Sukmaraga variety can increase the wet and dry weight of the plant shoots and roots, the number of spores, the percentage of mycorrhizal colonization, the yield of harvested dry cob weight, oven-dry weight, ear length, ear diameter, peanut shell weight per plant, cob weight yield. Harvest dry, the weight of dry cobs in the sun, weight of dry seeds shelled per plot, and weight of 1000 seeds.

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