WEEDS CHARACTERIZATION AND EFFECT OF WEEDING TECHNIQUE ON YIELD OF THREE MAIZE VARIETIES GROWN ON ACID SOIL

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|Received | 13 June 2017| |Accepted | 28 June 2017| |Published 04 July 2017 |

ABSTRACT

Background: Maize is one of the most important foods in the world, it is a seasonal plant; but faces a lot of competition with weed plant that reduces it productivity or slow down it yield of production. **Objectives:** This study was conducted to characterize weeds and to evaluate the influence of weeding technique on the yield of maize, in the locality of Akonolinga (Center Region of Cameroon). **Methods:** Three maize varieties (V1: local variety; V2: CMS 8501; V3: CMS 8704) and three weeding techniques (WT_0: no weeding, WT_1: hand weeding and WT_2: chemical weeding) were used in a factorial "Split-plot" design with 9 combinations. Weeds were collected by tracing a diagonal all with length of which of the quadrats of one m^2 will be placed. The species inventoried are preserved in newspaper for identification by the national herbarium of Cameroon. **Results:** In WT_0, weeds were present; in WT_2 and WT_1 they were eradicated at 97.5 and 50.0 % respectively. Grain yield of local maize were low: 51.65; 64.94, 68.11 g for WT_0, WT_1, WT_2 respectively; while it rose for improved varieties: 99.56, 139.11, 128.20 g for CMS 8501 and 110.31, 130.55, 130.60 g for CMS 8704, respectively for WT_0, WT_1, WT_2. **Conclusion:** The results of this experiment suggests that, for economic and environmental consideration, it is preferable to use hand weeding and improved maize varieties to enhance corn yield at small production scale. For intensive production, the use of improved varieties and chemical weeding seem to be better option.

Keywords: *maize varieties, weeds, hand weeding, chemical weeding, maize yield.*

1. INTRODUCTION

Maize is one of the most important cereals for human consumption directly or indirectly. Through its composition, it is a whole food that the human body needs. For 100 grams of corn flour there's 12.2 % water, 1.1 % calcium and iron, 3.1 % carbohydrates and 3.3 % lipids. Corn flour also contains vitamin B and an energetic value of 360 kcal [1]. Maize is derived from teosinte through mutation and natural selection [2]. It was first observed in Central America, then introduced in Africa through Egypt in the years 1540 and finally reached Cameroon through the Portuguese [3].In Cameroon, increasing production of corn doesn't satisfy food needs of the population. In 2012, the annual production was estimated at 1.6 million tons whereas forecasts were in the range of 1.8 to 2 [4]. Demands and expectations of production in developing countries showed that the production of corn which was about 27 Mt in 1995 will rise to 52 Mt in 2020 [5]. To cope with the increasingly demand, it is urgent to impair some major problems leading to low yields. Among them, there are inappropriate cultivation techniques and weeds that compete with crops for hydromineral nutrition. That is why strategies to alleviate these constraints are set up in order to enhance yields. The development of maize varieties tolerant to acidic soil: ATP, SR, Y and CMS; is one of these strategies [6]. The fight against weeds and the choice of crops varieties, resistance to invasive plants remain a great problem for farmers. Weeding techniques are complex and can be classified in three broad categories: mechanical weeding, chemical weeding through the use of herbicides and mixed technique (that involves the two previous techniques). In this perspective better, understanding of weeds types and weeding techniques is necessary. The overall objective of this study is to characterize weeds and assess impact of weeding techniques on the growth and yield of three varieties of maize.

2. MATERIALS AND METHODS

2.1 Study site: The study was conducted on a 5 years fallow plot whose previous crops were cassava and cocoyam. The plot is situated some 98 km from Yaoundé city, in the locality of Akonolinga: 3°46' 00"N and 12°15' 00" E in the Center region of Cameroon, the head quarter of Nyong and Mfoumou Division. Akonolinga belongs to agro-ecological zone V, called humid forest zone with bimodal rainfall. This area is characterized by a sub-equatorial climate of the

Congo-Guinean type, with two dry seasons alternating with two rainy seasons. Average rainfall varies between 1500 and 2000 mm for 10 months. The average annual temperature varies from 23 to 27 °C) and 80 % relative humidity [7].

2.2 Plant material and experimental design: Three varieties of maize were used: V1 (local variety), V2 (CMS 8501) and V3 (CMS 8704). V2 and V3 are improved varieties obtained from the Institute of Agricultural Research for Development (IRAD) suitable for the climate of the region. V1 is a variety obtained in the locality of Akonolinga from farmers. The vegetative cycle for V1 and improved varieties is 120; 115 days respectively source [8]. Color and form of maize grains depend on the species. Mature cob measure 5-45 cm in length and 3-8 cm diameter. The experiment was conducted in a factorial "split-plot" with 9 treatment combinations per block, three varieties and three weeding techniques. Each combination used 168 plants per plot for a total of 504 plants per block. Thirty six experimental units, each measuring 2.3 m x 3 m separated by a distance of 1 m were used. The distance between blocks was 1.5 m. In each sub-plot, sowing density was 50 cm x 80 cm, corresponding to two seeds per seed hole, with seven plants per line.

2.3 Cropping methods: After clearing the experimental site, work soil surface with a hoe, the experimental design made of 4 blocks, 12 plots and 36 sub-plots were set up. Two seeds were planted in one seed hole with a spacing of 50 cm between plants and 80 cm between lines [9].

2.4 Weeding methods: Hand and chemical weeding were carried out the same day, two weeks after sowing, when maize plantlets bear 8 leaves and young weeds 4-5 leaves as recommended by MINADER. In hand control, weeds were pulled off and all owed to dry and decay on the same plot in order to mimic chemical techniques which dry weeds on the spot. A chemical pesticide named "Herbimaïs", a mixture of Atrazine 750 g/kg and Nicosulfuron 40 g/kg was used for weeding in maize plots after plantlet emergence. A weed-killer solution of 15 liters obtained from 46 g of "Herbimaïs" and water was used to spray a surface area of 86.4 m², representing 12 experimental units [10].

2.5 Data collection: In each experimental unit, five maize plants were randomly selected for the measurement of growth parameters: rate of seedling emergence, plant height, root diameter at collar and leaf number. The types of weeds were recorded in different plots.

2.6 Species collection, preservation and identification: The weed diversity of maize crop fields in the area was studied as per the methods described by Rahman et al. (2007) [11]. Which consists has to trace a diagonal and has to place the quadrates of one m^2 along this line has regular intervals. The species collected has interior quadrats are stored each one in a newsprint in continuation to be carried for identification at the herbarium nation of Cameroon.

2.7 Yield: The harvest of maize was made 3 months 16 days after sowing. Dry grain yield of 6 plants randomly collected in each experimental unit of a block, express in kg per hectare was calculated with the formula below according to N'Goran and Kanga (2000), Svecnjak et al. (2006) [12, 13]:

$$Y\ (kg/ha) = \frac{DGWp \times 28}{7.2\ m^2} \times 10\,000\ m^2 \qquad (1)$$

With: Y = yield; DGWp = dry grains weight per plant, 28 = number of plants per treated elementary plot**,** 7.2 m² = surface of each treated elementary plot.

2.8 Data analysis: Data were subjected to analysis of variance (ANOVA) to determine significant differences among treatments, followed by Duncan's test at 5 % probability level to detect differences between: weeding techniques, varieties and grain yield.

3. RESULTS

3.1 Effect of weeding techniques on fresh biomass

Fresh biomass is higher for TD_1 (425.39 g) than in the two other treatments TD_0 (393.11 g) and TD_2 (412.16 g) for the local variety (Figure 1). For CMS 8501, the highest fresh biomass was obtained in the treatment TD_0 (293.16 g) followed by TD_2 (289.53 g) and finally TD_1 (263.03 g).For CMS 8704, chemical technique (TD2) presented the highest biomass (335.96 g) followed by manual control (288.01 g) then TD0 (228.0 g).These results showed local maize presents the highest fresh biomass in all types of weeding compared to other varieties. The analysis of variance for the fresh biomass did not reveal significant differences *($p > 0.05$)* between treatments and varieties 50 DAS.

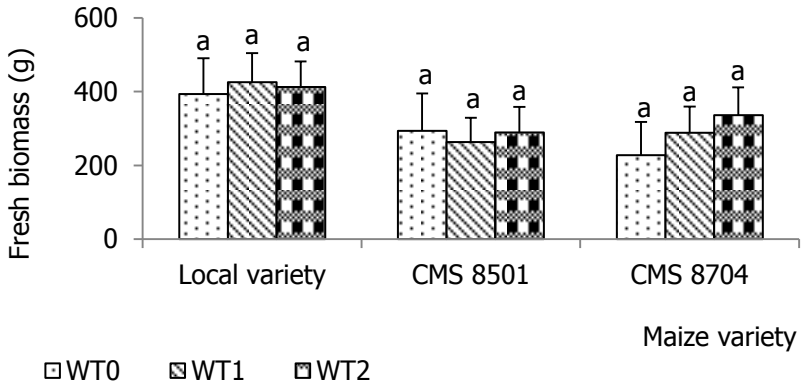

Figure: 1 Figure presents the fresh biomass yield (g) according to three varieties of maize and technique of weeding after 50 days of sowing; the treatments carrying the same letter are not significantly different according to the test from Duncan to the threshold of 5 %.

3.2 Typology of the species of weed identified on the experimental piece (Ekam/Akonolinga)

In TD_1, two weeks after weeding, *Pueraria phaseoloides* appeared first, then *Starschitarpheta cayennensis.* For TD2, weeds started to appear 80 day after weeding. We counted for this experiment, 16 different families of weeds, among them, the most abundant were: Asteraceae (22.00 %), Malvaceae and Cyperaceae (9.09 %) and 4.54 % for others (Table I). Among them, they are dicotyledons (82.61 %) and monocotyledons (17.39 %).

Table 1: The table presents the typology of the weed species identified on the experimental piece (Ekam/Akonolinga)

Family	Genus	Species	Class
Malvaceae	*Synedrella*	*Synedrella nodiflora*	Dicotyledon
	Abutilon	*Abutilon theophasti*	
Asteraceae	*Vernonia*	*Vernonia cinera*	
	Acanthospermum	*Acanthospermum hispidum*	
	Chromolaema	*Chromolaena odorata*	
	Ageratum	*Ageratum conozoides*	
Fabaceae	*Sida*	*Sida corymbosa*	
	Pueraria	*Pueraria phaseoloides*	
	Desmodium	*Desmodium abdescendens*	
Rubiaceae	*Mitracarpus*	*Mitracarpus villosus*	
Tiliaceae	*Corchorus*	*Corchorus olitorius*	
Capparidaceae	*Cleome*	*Cleome viscosa*	
Portulacaceae	*Talinum*	*Talinum triangulare*	
Apocinaceae	*Voacanga*	*Voacanga africana*	
Verbenaceae	*Starchytarpheta*	*Starchytarpheta cayennensis*	
Oxalidaceae	*Oxalis*	*Oxalis corniculata*	
Urticaceae	*Urtica*	*Urtica dioica*	
Euphorbiaceae	*Manihot*	*Manihot esculentum*	
Discoreaceae	*Discorea*	*Discorea bulbufera*	
Cyperaceae	*Kyllinga*	*Kyllinga purpurmula*	Monocotyledon
	Cyperus	*Cyperus esculentus*	
Poaceae	*Paspalum*	*Paspalum scorbiculatum*	
Commelinaceae	*Commelina*	*Commelina benghalensis*	

%Monocotyledon: 17.39
% Dicotyledon: 82.61

3.3 Percentage of the three species most represented

Throughout the experimental plot, we counted a total of 23 species among which three were highly represented: *Pueraria phaseoloides* represented (844 times), followed by *Abutilon theophasti* (817 times) and *Sida corymbosa* (484 times) (Figure 2)

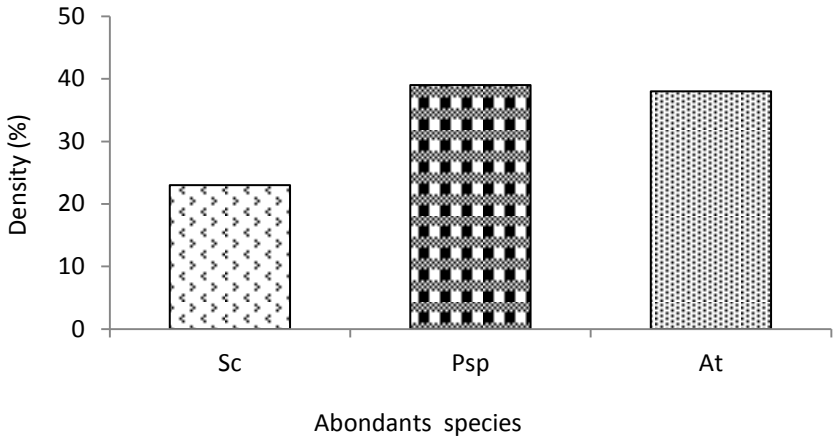

Figure 2: The figure presents the percentage of the three most represented species; *Sc: Sida corymbosa, Psp: Pueraria phaseoloides, At: Abutilon theophasti.*

Results of figure 2 shows clearly that the site was mostly composed of dicotyledons within sight of the percentages (densities) of these three species the most represented in the experimental site, here an abundance 39 % was observed for *Pueraria phaseoloides* followed by the flowering *Abutilon theophasti* with 38 % and finally *Sida corymbosa* with 23 %.

3.4 Effect of weeds density on grain yield: Grain yield decreased when weeds were present on the plot (Table 2). In TD0 (100% weeds cover), TD1 (2.5% weeds cover) and TD2 (2.5% weeds cover) were recorded; 0.235 t / ha, 2.142 t / ha and 2.24 t / ha yield respectively.

Table 2: The table presents the comparison of losses due to the degree of weeds.

Treatments	Parameters		
	Loss	Means (t/ha)	Degree of weed cover
WT0	88.25	0.235	100.0
WT1	28.60	2.142	50.0
WT2	25.33	2.240	2.5

WT_0: no weeding; **WT_1**: hand weeding; **WT_2**: chemical weeding

3.5 Effect of weeding technique on maize yield: The local variety yielded 51.65g, 64.94g and 68.11g for TD_0, TD_1 and TD_2 respectively. The CMS 8501variety yielded 99.56g, 139.11g and 128.2g for TD_0, TD_1 and TD_2 respectively. For CMS 8704 variety, 110.31 g, 130.55g and 130.6g yields were obtained for TD_0, TD_1 and TD_2 respectively.

The lowest yields were obtained for the local variety irrespective of the treatment used on one hand and the yields of the improved varieties CMS 8501 and CMS 8704 were not statistically different from those of the local variety. For the same variety no significant difference between weeding techniques were noticed, but significant differences between different varieties were recorded. The analysis of variance showed significant differences to varieties and treatments *($p < 0.05$).* No significant differences to interaction between varieties and techniques of weeding *($p > 0.05$)* were observed for yields.

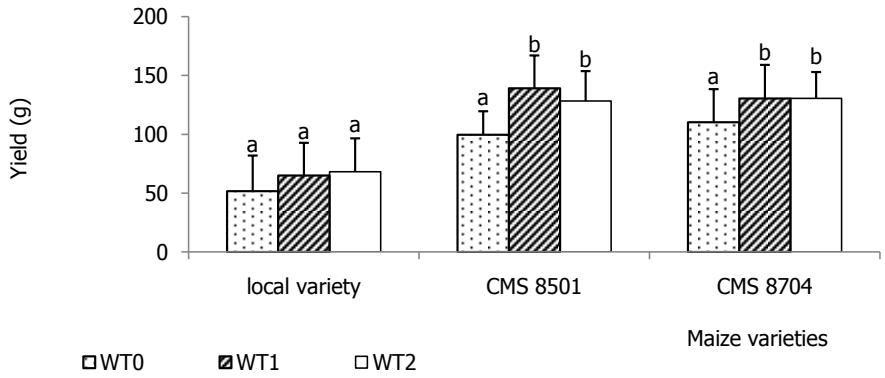

Figure 3: The figure presents the maize yield (g) dry weight depending on variety and weeding techniques; the treatments carrying the same letter are not significantly different according to the test from Duncan to the threshold of 5 %.

4. DISCUSSION

In this study, among weeds, we noticed a high percentage of Asteraceae, Fabaceae and Malvaceae. This presence of Asteraceae could be due to their high ability to withstand harsh conditions and especially ploughing period because ploughing is better when done at the beginning of the dry season when most of the plant biomass is in the rhizomes and drying is most effective [14]. For Fabaceae, their significant presence comprises on the one hand a strong competition for water with respect to the culture because of their major root system, and on the other hand, they allow a great provision of nitrogen in the ground [15]. Moreover, these Fabaceae such as *Pueraria phaseoloides* can stabilize the culture of corn durably because it is a leguminous cover plant, which protects, enriches the ground, quickly increases the vegetable biomass and eliminates the adventitious flora completely [16]. Lastly, for Malvaceae, their presence is illustrated by the use of the normal amounts for the treatments, in this bad grass the amounts been owed is higher and a supplementary product such as the pulp of butylate is added [17].

The lowest yield was obtained for the local variety of maize compared to improved varieties whatever the weeding technique used, for example in 2002, one-third the production of corn-grain in Quebec (34,13%) came from these tolerant hybrides to the weedkillers and from 2003 to 2005, the sown surfaces with genetically modified corn-grain increased by 30,3% [18]. This result shows that improved varieties yielded more on weed plots than on unweed ones. Thus, when they are not in competition with weeds they yielded better in acid soils of the Center Region of Cameroon compared to the local variety that doesn't have this ability as confirmed by the results of Zaidi et al. (2003) on maize [19]. In the same way, Khando et al. (2015) work on varieties of local and improved maize in Ivory Coast shows that the improved varieties have a potential for higher output, most of this output in grain of the varieties of maize is influenced by the technics of weeding [20]. Indeed, the chemical treatment knows the highest output; in the chemical treatment the yield raised could be explained by the fact that the chemical product used reacted on one side with the interior of leaves by photosynthesis inhibiting and on the other side, its roots [21], in same continuity, Boerboom (2002) estimated that the use of atrazine as a weed killer at post-emergence, effectively decreased the workload of the producer by fighting against the graminaceous and bad grass with broad leaves: thus leading to a high yield in corn grains, followed by manual treatment [22]. For the manual treatment, the results obtained were similar to that obtained when the weed killer was used could be explained by the fact that the weeding allowed for the elimination of competition with bad grass, thus resulting to a sufficient supply of water and nutritive elements to the corn seedlings for their growth, their development and a good fructification [23]. In same the way, Bouhache et al. 2002 having worked on corn proved that the best outputs were obtained in the weeded pieces, with a difference from 12 to 14 kg/ha compared to the not weeded pieces, that is to say a profit from 22 to 54 % [24].

5. CONCLUSION

The aim of this study was to characterize weeds and assess the impact of weeding technics on yield of different varieties of maize. The main results showed high percentage of Asteraceae, Cyperaceae and dicotyledons weeds in plots. The most abundant weeds were *Pueraria phaseoloides*, *Abutilon theophasti* and *Sida corymbosa*. Local variety yields were lower compared to improved varieties whatever the weeding technique used. Thus for economic consideration, intensive production using improved varieties and chemical weeding seem to be the better option. But, hand weeding and improved varieties can be advised, as on eco-friendly way to improve maize production on acid soil of the South Region of Cameroon, at the scale of a small producer.

Acknowledgment: The authors are thankful to Mrs. Bigueme B.E., Head of Service of Pesticides Regulation for all technical material.

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Cite this article: Mamadou Mounpoubeyi Njipit, Ndongo Bekolo, Esaïe Tsoata, Patrice Zemko Ngatsi, Daouda Kuitnjem, Abdou Nourou Nsangou Kone and Zachée Ambang. Weeds characterization and effect of weeding technique on yield of three maize varieties grown on acid soil. *Am. J. innov. res. appl. sci.* 2017; 5(1): 34-39.