Biological Efficiency and selectivity of two (2) pre-emergence maize herbicide (Lagon 575 SC and Primagold 537.5 SE) on station and On-farm conditions

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ABSTRACT

In Sudano-Sahelian Africa, the mastery of the grass cover is the biggest challenge of the farmers'agricultural calendar and the labor required to perform weeding. Easily maintained by manual weeding, crops are increasingly invaded by weeds whose density increases over the years. Some species are very difficult to destroy and require localized treatment at the onset of the first seedlings. Known weed species are distributed among the grasses, broadleaf weeds and sedges. Chemical weed control is a solution in terms of crop rotation. This technique is developed in particular in the cotton growing areas, particularly in northern Cameroon, southern Mali and northern Côte d'Ivoire (Bassala, 2010). However, it requires favorable economic conditions and good training of extension staff and farmers on the recognition of flora, products management and the use of treatment devices. Maize is a particularly sensitive crop to weed competition during the first stage of its growth cycle, which goes from sowing to cover between the rows. It therefore requires a quality of weed control, especially vis-a-vis summer grasses. Root solutions through pre-emergence herbicides are most effective against grasses. They bring more sustainable efficiency and flexibility of action. Two (2) pre-emergence herbicides products (Lagon 575 SC and Primagold 537.5 SE) were experimented in Samanko research sub-station and tested on the farmers' fields in Bougouni agricultural sector (Sikasso region) and the Office of the high valley of the Niger River (OHVN) zones (Koulikoro region), to determine their biological efficacy and selectivity, respectively on weeds and for maize. From these experiments, the products showed good performance in both conditions. 0.5 liter/ha of Lagoon 575 SC showed an average efficiency on station of 80%, 70% and 70% respectively on grasses, broadleaf weeds and cyperaceae ; 80%, 60%, 60% in the same order for the On-farm tests. As for Primagold 537.5 SE, on station, an average efficiency of 70%, 70% and 50% were recorded for the rate of 2 liters/ha for grasses, broadleaf weeds and sedges, and 80%, 70% and 60% for the on-farm tests.

Key words: weed, cotton, maize, herbicide, Sudano-Sahelian Africa

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I. INTRODUCTION

According to a microeconomic analysis, in general, the benefits of using pesticides Such as herbicides, are primarily for farmers, manufacturers and distributors of pesticides (Barbier et al., 2005, Bassala et al., 203, 2012). Consumers benefit from low-cost food items, which translates into their purchasing power (Barbier et al., 2005). This is not the case for cotton, which is not a food product. On the other hand, for food products, this advantage over purchasing power could be important for the less affluent and low-income populations. In the cropping system, at the plot level, the use of herbicides for weeding allows the farmer to limit the infestation of plots by weeds, thus causing less competition between crops and weeds for water, light and nutrients, with positive effects in improving the overall yield of its crops (Déat, 1973, 1981; Marnotte, 1995). The cumulative effects of herbicides (repeated use on the same plot over 4 years) would result in a gradual reduction in weed pressure (duration limitation) but there is a saving in weeding time of 30-40% with a yield improvement of 3 to 15% (Koulibaly and Dakuo, 2001). On the farm, the use of total herbicides would eliminate the effect of plowing and do planting without tillage (direct seeding). From a socio-economic point of view, there would be better management of working time and lower costs of agricultural production, where there is an economy of wage labor. The time freed up by the use of herbicides would be in this case devoted to the maintenance of other plots. According to the Tropical Encyclopedia (1987), herbicides would also allow more or less cash management by regulating the need for labor for manual weeding, which explains their use by farmers. In a market economy, the use of pesticides could lead to lower prices for agricultural products if labor and/or land productivity increases. However, chemical control requires herbicides as agricultural inputs, and thus entails a higher cost. It also requires a good knowledge of the products and their mode of use. The management of the chemical products is not gained by all farmers, and direct seeded plots can be frequently invaded by weeds. Unfortunately, the use of herbicides can generate polluting gas emissions that cause greater or lesser discomfort to the users. The benefits of using herbicides would mask the risks these products may cause to both cultivated and uncultivated ecosystems. In order to satisfy a growing demand for agricultural products, environments, particular soils, have been intensively used (Kersanté, 2003). In addition to the practice of plowing with animal traction, this important use of pesticides in cultivated environments results in fields increase, a decrease in perennial cover crops, an export of biomass and additional inputs of pesticides and fertilizers (Kersanté, 2003). Changes in the use of environments can contribute to pollution of the environment, including soil, water and air, by the surplus of added inputs. In Uzbekistan, the world's second largest exporter of cotton, pesticides used 50 years ago still pollute land, air, food and water (EJF and PAN-UK, 2007). Polluting emissions are therefore a real problem when it is considered that the discomfort caused to the victims is too great, that is to say, when the situation is no longer acceptable to the society. The problem is when the pollution of herbicides exceeding the benefits? The analysis of pollution by pesticides starts from a postulate indicated that any reduction in pollution by pesticides tends to decrease agricultural income (Barbier et al., 2005)

Concerning the presence of herbicides in the environment, some studies have shown that the distribution of atrazine in the various compartments of the environment was as follows: water 73%; soil 26%; Sediment, 1% and air, 0% (Tissier et al., 2005). The half-life of the atrazine in the soil (time during which 50% of the product degrades or disappears) is 40 days according to ATSDR (2003). In the field, this time is between 16 and 77 days. These values correspond to cold and dry climatic conditions. Barriuso and Houot (1996) observed that 75% of atrazine is mineralized in soils in 64 days by maize monoculture; 50% in 64 days by wheat-maize rotation and less than 4% in a soil never grown in maize. This accelerated degradation corresponds to the adaptation of the soil to the mineralization of the herbicide. But there is also a process of transferring herbicides through runoff in agricultural watersheds, which contributes to the contamination of river waters by herbicides. Depending on the conditions of use and the characteristics of the environment, these active molecules are likely to be found in the various compartments of the environment (air, water, sediments). On the other hand, studies on the dynamics of herbicides in the soil show that organic matter plays a predominant role in the adsorption of hydrophobic molecules. Thus, a supply of exogenous organic matter in the form of compost on a clay loam soil favors the adsorption by the clay-humic complex the atrazine and sulcotrione herbicides (Khan, 1998; Kersanté, 2003). However, the biotic and abiotic degradations of pesticides lead to the natural attenuation of molecules in the soil, through micro and macrofauna capable of partially degrading these molecules (Kersanté, 2003). Minimum soil tillage techniques, such as direct seeding with herbicides, favor the accumulation of herbicides at certain soil depths (Villeneuve and Bernier, 2004). For these authors, soil conditions have an impact on the persistence of herbicides. Dry soil degrades herbicides, which can hinder the emergence or growth of certain plants such as green manure from cereals. Microorganisms are very involved in the decomposition of herbicides. They are at their maximum activity when the soil is moist and when temperatures vary from 21 ° to 32 ° C (Bradley et al., 2000). Lagon 575 SC is an herbicide composed of active ingredients (Tembotriones + isoxadifen). It is used as a pre-emergence herbicide, selective for maize to control annual weeds and must be used under good growing conditions (regular rainfall, non-sandy soil, or stony soil). As for Primagold 537,5 SE, it is a herbicide composed of active ingredients (S-metolachlore + Mesotrione + Terbuthylazine) and should be used under good growing conditions (regular rainfall, non-sandy or stony soil). It is used as a pre-emergence herbicide, selective for maize to control annual weeds.

II. MATERIAL AND METHODS

As part of the registration of pesticide products, experiments were conducted to determine the biological efficacy and selectivity of the herbicides Lagon 575 SC and Primagold 537.5 SE on both research station and On-Farm. The products were tested on the station in two years and the results obtained were confirmed in the third year through On-farm Tests.

Experimental sites

The Samanko agronomic research sub-station is at latitude of 12 °. 31.552 'N, a longitude of 8 ° .04.906' W and an altitude of 316.8 m. The soil is of the tropical ferruginous type slightly leached of sandy silty texture with 76% sand, 15% silt and 9% clay (IER, 2008); PH 4.8, 0.19% organic matter and 3.44 kg/ha of available P and an average annual rainfall of 800 to 900 mm. The On-farm Tests were Bougouni sector in the CMDT zones located in the South and the Bancoumana sector in the OHVN zone in the west, all located in the isohyet 800-1000 mm.

Plant material

The maize varieties used were the intermediate cycle Dembanyuman from 100 to 110 days, adapted from 800 to 1000 mm for the Lagon 575 SC and the intermediate cycle Sotubaka from 100 to 110 days, from sowing to harvest.

Chemical products

Tableau 1 : Products composition (Lagon 575 SC and the control, Stomp 455 CS)

Products	Active ingrédients	Content	Formulation	Firm
Stomp 455 CS	Pendimethaline	455 g/l	Liquid CS	Cigogne
LAGON 575 SC	ITF Aclonifène	75 g/l 500 g/l	Liquid SC Liquid SC	Bayer

Tableau 2 : Products composition (Primagold 537,5 SE and the control, Stomp 455 CS)

Products	Active ingrédients	Content	Formulation	Firm
Stomp 455 CS	Pendimethaline	455 g/l	Liquid CS	LDC
Primagold 537,5SE	S-metolachlor Mesotrione Terbuthylasine	375 g/l 37,5 g/l 125 g/l	Liquid-SE	MPC

Fertilizer :

The complex cereal (NPK 15-15-15) was used as the base fertilizer and urea (46% N) as the top dress/cover fertilizer.

Methods: Field experiments

Experimental plots were installed at the Samanko research Sub-station, located 15 km southwest of the Bamako District. The experimental design was the Fisher Block with 4 replicates and 5 completely randomized treatments per replicate for the products efficacy; 4 replicates and 4 completely randomized treatments per replicate for the products selectivity as indicated in Table 3 and 4 below.

Table 3 : Efficacy

Treatments	Products	Rates	Identification	applying period
1	No products	-	Control	-
2	Stomp 455 CS	2,6 l/ha	reference product	sowing
3	Lagon 575 SC	0,375 l/ha	¾ firm rate	sowing
4	Lagon 575 SC	0,50 l/ha	firm rate	sowing
5	Lagon 575 SC	0,75 l/ha	3/2 firm rate	sowing
1	No products	-	Control	-
2	Stomp 455 CS	2,6 l/ha	reference product	sowing
3	Primagold 537.5 SE	1,5 l/ha	¾ firm rate	sowing
4	Primagold 537.5 SE	2 l/ha	Firm rate	sowing
5	Primagold 537.5 SE	3 l/ha	3/2 Firm rate	sowing

Table 4 : Selectivity

Treatments	Products	Rates	Identification	applying period
1	Lagon 575 SC	0,50 l/ha	firm rate	sowing
2	Lagon 575 SC	1 l/ha	double rate	sowing
3	Lagon 575 SC	1,5l/ha	triple rate	sowing
4	Sarclage manuel	-	control	15, 30, 45 (DAS)*
1	Primagold 537.5 SE	2 l/ha	firm rate	sowing
2	Primagold 537.5 SE	4 l/ha	double rate	sowing
3	Lagon 575 SC	6 l/ha	triple rate	sowing
4	manuel weeding	-	control	15, 30 45, (DAS)

***** = day after sowing

The selected or recommended dose per product during the experimentation phase is then tested on On-farm environment with ten (10) producers in a dispersed block system with 3 treatments without replication and each producer constitutes a replication indicated in Table 5.

Tableau 5 : On-Farm Testing

Treatments	Products	Rates	Identification	Applying Periods
1	Lagon 575 SC	0,5 l /ha	Recommended rate	sowing
2	Stomp 455 CS	2,6 l /ha	Reference Product	sowing
3	Weeding	-	Control	15, 30 ,45 (DAS)
1	Primagold 537,5 SE	2 l /ha	Recommended rate	sowing
2	Stomp 455 CS	2,6 l /ha	Reference Product	sowing
3	Weeding	-	Control	15, 30, 45 (DAS)

DAS= day after sowing

Conditions for carrying out the tests

The seeding was done in line at 3-seeds/hill on wet soil using a graduated rope with 0.80 m spacing between rows and 0.50 m between hills. The thinning was done 15 days after sowing at the rate of 2 plants per hill, ie. 50,000 Plants per hectare.

The herbicidal treatment was carried out using a handy sprayer equipped with the orange nozzle which makes a flow rate of 20 liters of slurry/ha.

The mineral fertilizer applied was 100 kg/ha of complex cereal plus 50 kg/ha of Urea at sowing and 100 kg/ha of Urea at the maize elongation phase (30 days after first application) followed by a hilling).

Data collection

The study examined the following parameters: the number of weeds (monocotyledonous, dicotyledonous and sedate) and visual rating of herbicide efficacy at 15, 30 and 45 days after the product application according to the Biological Testing Commission (CEB) ranging from 0 (total grass cover) to 10 (zero grass cover). The phytotoxicity of the products found on maize at the 15^{th}, 22^{nd}, 29^{th} and 36^{th} days after application.

Statistical analysis

The analysis of variance was done using the MSTATC software to distinguish the difference between treatments.

III. RESULTS

A. PRODUCTS EFFICIENCY, PHASE 1

Statistical analysis of counted weed data showed significant differences between the reference product, the absolute control and the tested doses of Lagoon 575 SC for Monocotyledons and dicotyledons at 15 and 30 days after product application. The absolute control showed more grass than the others for broadleaf and sedate (Table 6). The same phenomenon was observed with Primagold 537.5 SE on the same weeds with a prolonged effect at the 45th day after product application (Table 7). These differences are in favor of the absolute control where the greatest numbers of weeds were counted compared to the tested doses of Lagoon 575 SC, Primagold 537.5 SE and the reference product Stomp 455 CS. However, no significant differences were observed between the tested doses of Lagoon 575 SC and Primagold 537.5 (Table 6, 7).

Tableau 6: Weed counting (average number/m²), Lagoon 575 SC

Treatments	15 DAA			30 DAA			45 DAA		
	Mono	Dico	Cyp	Mono	Dico	Cyp	Mono	Dico	Cyp
Absolute control	5 a	107 a	157 a	2	84a	108 a	20	53	71
Stomp 2,6 l/ha	5 a	73 a	124 a	6	32b	49 b	7	37	61
Lagon 0,375 l/ha	1 b	11	25 b	3	28b	37 b	5	36	45
Lagon 0,5 l/ha	0,25 b	15 b	40 b	1	27b	35 b	8	35	42
Lagon 0,75 l/ha	0	5 b	6 b	2	16b	15 b	0	21	28
Signification	S	S	S	NS	S	S	NS	NS	NS
CV %	101,19	79,24	48,26	160,66	51,56	47,51	105,96	39,76	63,39
LSD	3,35	53,60	52,12	-	39,64	35,43	-	-	-

DAA = day after application; Mono = monocotyledon; Dict = dicotyledons; Cyp = cyperaceae S = significant ; NS = not significant; Figures with the same letters are not statistically different at 5% threshold; LSD=least signicant difference; CV= variation coefficient

Tableau 7 : Weed counting (average number/m²), Primagold 537,5 SE

Traitements	15 DA			30 JAT			45 JAT		
	Mono	Dico	Cyp	Mono	Dico	Cyp	Mono	Dico	Cyp
Témoin absolu	24 a	40 a	14	220 a	406 a	153	233 a	458 a	194
Stomp 455 CS 2.6l/ha	0 b	22 a	11	5 b	89 b	106	41 b	99 b	121
Primagold 537.5 SE 1.5l/ha	0 b	0 b	0	0 b	172 b	51	37 b	185 b	76
Primagold 537.5 SE 2l/ha	0 b	0 b	0	0 b	163 b	20	24 b	18 c	34
Primagold 537.5 SE 3l/ha	0 b	0 b	0	0 b	47b	0	16 b	60 b	14
Signification	S	S	NS	S	S	NS	S	S	NS
CV %	185.4	99.95	256.42	174.88	54.94	137.69	115.47	52.15	105.93
LSD	13.43	19.03	-	121.246	148.257	-	124.71	156.346	-

DAA = day after application; Mono = monocotyledon; Dict = dicotyledons; Cyp = cyperaceae S = significant ; NS = not significant; Figures with the same letters are not statistically different at 5% threshold; LSD= least significant difference; CV= variation coefficient.

The main weeds encountered are for the **Monocotyledons**: *Digitaria horizontalis, Setaria pollidefisca, Digitaria velutina, Echinochloa colona, Dactyloctenium aegyptium, Digitaria debelis, Eleusine indica, Brachiaria distychophylla;* **Dicotyledons**: *Cassia mimiriosoides, Alysicarpus rugosus, Vignara cemuosa, Cassia obtusifolia, Ipomoea triloba, Hibiscus asper, Commelina benghalensis; Cyperaceae: Cyperusrotondus*, Cyperusiria, *Juncellus pustilatus, Fimbristylis exilis.*

Regarding the efficacy of Lagoon 575 SC compared to the reference product, Stomp 455 CS, the tested dose of 0.5 liter/ha showed a higher efficacy than the reference product at 45 days after the product application (9 to 6 or 90% to 60% against 8 to 5 or 80% to 50% (Table 8) and for Primagold 537.5 SE, the tested dose of 2 liters/ha was more effective than the reference product during 45 days after the product application (9 to 3 or 90% to 30%) against (8 to 2 or 80% to 20%), (Table 9).

Table 8: Rating of Lagon 575 SC herbicide effect on Weeds

Traitements	15 DAA			30 DAA			45 DAA		
	Mono	Dicot	Cyp	Mono	Dicot	Cyp	Mono	Dicot	Cyp
Stomp2,6 l/ha	8	7	6	8	7	6	7	6	5
Lagon0,375 l/ha	9	8	8	8	8	8	8	7	7
Lagon0,5l/ha	9	8	8	9	7	7	9	6	6
Lagon0,75 l/ha	10	10	9	10	9	8	9	6	6

DAA = day after application; Mono = monocotyledon; Dict = dicotyledons; Cyp = cyperaceae
(Scale from 0 to 10): 0 = zero efficiency and 10 = maximum efficiency.

Table 9: Rating of Primagold 537,5 SE herbicide effect on Weeds

Traitements	15 DAA			30 DAA			45 DAA		
	Mono	Dico	Cyp	Mono	Dico	Cyp	Mono	Dico	Cyp
Stomp 455 CS 2.6 l/ha	8	7	5	6	5	3	4	4	2
Primagold 537.5 SE 1,5l/ha	7	7	4	6	5	2	3	2	2
Primagold 537.5 SE 2l/ha	9	8	6	8,5	7	4	5	5	3
Primagold 537.5SE 3l/ha	10	8	7	8	6	6	6	5	4

DAA = day after application; Mono = monocotyledon; Dict = dicotyledons; Cyp = cyperaceae
(Scale from 0 to 10): 0 = zero efficiency and 10 = maximum efficiency.

Conclusion 1

Compared with the reference product Stomp 455 CS, Lagon 575 SC and Primagold 537.5 SE herbicides have shown to be effective against the different classes of maize weeds during 45 days after products application for this first phase of experimentation on station. Doses of 0.5 liters/ha and 2 liters/ha for Lagoon 575 SC and Primagold 537.5 SE respectively were more efficient than the reference product. Thus, these doses were recommended for phase two (2) which was the determination of the biological selectivity of the two products for maize crop.

SELECTIVITY, PHASE 2

15 days after the Lagoon 575 SC product application, the presence of dicots and *cyperaceae* by their percentage was greater than that of monocotyledons at all doses tested including weeding. The same applies to other periods (30 and 45 days after product application). The same applies to Primagold 537.5 SE, 45 days after product application. This indicated a weed cover area dominated by dicotyledons and *cyperaceae*, on one hand, and the well-known

control of grasses by the tested doses of Lagoon 575 SC and Primagold 537.5 SE (Tables 10 and 11).

Table 10: Percent (%) infestation of weed types

Traitements	15 DAA			30 DAA			45 DAA		
	Mono	Dico	Cyp	Mono	Dico	Cyp	Mono	Dico	Cyp
Lagon 0,5 l/ha	0	27,35	72,6	43,12	42,18	54,68	9,74	35,71	54,54
Lagon1l/ha	0	53,33	46,66	0	43,93	56,06	2,59	37,66	59,74
Lagon1,5 l/ha	0	62,5	37,50	0	55,26	44,73	1,33	26,66	72,00
Weeding: 15-30, 45 DAS	3,42	35,33	61,24	6,38	34,14	59,47	40,50	31,64	27,84

DAA = day after application; Mono = monocotyledon; Dict = dicotyledons; Cyp = cyperaceae
DAS = day after sowing

Tableau 11. Percent (%) infestation of weed types

Traitements	45 JAT		
	Mono	Dico	Cyp
Primagold 2l/ha	3,41	73,30	23,30
Primagold 4l/ha	8,08	78,79	13,13
Primagold 6l/a	0	86,49	13,51
Weeding: 15, 30, 45 DAS	11,03	58,09	30,88

DAA = day after application; Mono = monocotyledon; Dict = dicotyledons; Cyp = cyperaceae; DAS = day after sowing.

Phytotoxicity

Lagoon 575 SC showed no signs of visual phytotoxicity (burning, necrosis, etc.) on the leaves of maize plants. However, low germination was observed with high doses (78.90% and 69.30%), respectively for the double dose 1 liter/ha and the triple dose 1.5 liter/ha). The same is true for the density of the plants (64.47% and 51.82% respectively), (Table 12). Thus, Lagon 575 SC was not selective for maize at the doses of 1 liter/ha and 1.5 liter/ha. This phytoxicity was evaluated and is shown in Table 13 for the 15 and 30 days period after the product application. No phytotoxicity was observed on the maize crop even with high doses of Primagold 537.5 SE (Table 14).

Tableau 12 : Evaluation of the phytotoxicity on plant density (in%)

Treatments	Theoretical hills/ha	Germinated hills/ha	% hills Germinated	Theoretical plants /ha	Counted plants/ha	% Counted plants/ha
Lagon 0,5 l/ha	25326	24063	95	50652	40313	79
Lagon1l/ha	25326	20000	78,9	50652	32656	64,47
Lagon1,5 l/ha	25326	15938	69,30	50652	26250	51,82
Weeding: 15-30, 45 DAS	25326	23125	91,30	50652	37750	74,5

-DAS = day after sowing

Tableau 13: Rating of Lagon 575 SC herbicide phytotoxity on maize plant stand

Traitements	phytotoxicity 15 DAA	phytotoxicity 30 DAA
Lagon 0,5 l/ha	1	2
Lagon1l/ha	2	4
Lagon1,5 l/ha	3	5

DAA =day after application; (Scale from 0 to 10): 0 = zero phytotoxicity and 10 = maximum phytotoxicity.

Tableau 14 : Rating of Primagold 537,5 SE herbicide phytotoxity on maize plant stand

Traitements	Phytotoxicity 15 JAT	Phytotoxicity 30 JAT	Phytotoxicity 45 JAT
Primagold 537.5 SE 2l/ha	0	0	0
Primagold 537.5 SE 4 l/ha	0	0	0
Primagold 537.5 SE 6 l/ha	0	0	0

DAA =day after application; (Scale from 0 to 10): 0 = zero phytotoxicity and 10 = maximum phytotoxicity.

Yield components

Statistical analysis of yield and maize yield components showed significant differences between treatments in terms of the number of germinated hills, plants after thinning and at harvest for Lagoon 575 SC. The dose 0.5 liter/ha was higher than the triple dose 1.5 liter/ha for the three parameters mentioned. On the other hand, no significant difference was observed between the tested dose and the weeded control for the same parameters with the coefficients of variation ranging from 12.62% to 19.07% (Table 15). The best yield was obtained with the regular weeding, 4113 kg/ha followed by the tested dose, 3841 kg/ha. However, for Primagold 537.5 SE, no significant difference was observed between treatments. The best yield 4348 kg/ha was obtained by the tested dose of 2 liters/ha. As for the weedings 15, 30 and 45 days after sowing, the yield was 4031 kg/ha, with coefficients of variation from 10.05% to 31.43% (Table 16).

Table 15: Analysis of variance for yield and yield components of maize.

Treatments	Germinated hills/ha	Phinned plants/ha	harvested plants/ha	Ears weight/ha	Harvested plants/ha	Grain yield kg/ha
Lagon1l/ha	20 000 ab	32656 ab	29531 bc	30781	5907	3625
Lagon1,5 l/ha	15 938 b	26250 b	23936 c	23750	4507	2766
weedings 15-30-45 DAS	23125 a	38750 a	35625 ab	35625	6719	4113
Signification	S	S	S	NS	NS	NS
CV%	12,62	17,78	16,01	19,07	17,28	17,02
LSD	41,95	98,10	81,16	-	-	-

S = significant ; NS = not significant; Figures with the same letters are not statistically different at 5% threshold
CV= variation coefficient; DAA= day after application; LSD=Least significant difference

Table 16 : Analysis of variance for yield and yield components of maize

Treatments	Germinated hills/ha	Phinned plants/ha	Plant vigor	Plant. height	Harvested plants/ha	Ears number/ha	Ears weight	Grain yield kg/ha
Primagold 2 l/ha	23125	41563	1,75	187	36563	35781	5735	4348
Primagold 4 l/ha	24063	42344	1,50	191	39375	36875	5963	4325
Primagold 6l/ha	20781	36875	1,0	192	35156	31719	5219	3618
weeding 15, 30, 45 DAS	21563	38125	1,75	182	36563	34219	5344	4031
Signification	NS	NS	NS	NS	NS	NS	NS	NS
CV%	10,05	13,53	31,43	12,71	13,07	12,76	15,81	15,25

NS = not significant; Figures with the same letters are not statistically different at 5% threshold
Cv= CV= variation coefficient; DAA= day after application; DAS=day after sowing.

Conclusion 2

Compared to the reference product, high doses of the pre-emergence herbicide, Lagoon 575 SC (1 liter/ha and 1.5 liter/ha) showed a negative effect on maize germination. The dose of 0.5 liter/ha of Lagon 575 SC was recommended for Phase 3 (the On-farm Testing). As the pre-emergence herbicide, Primagold 537.5 SE, is concerned, there was no adverse effect on maize. The dose of 2-liters/ha of Primagold 537,5 SE was recommended for Phase 3 (the On-Farm testing).

ON-FARM TESTING, PHASE 3

In weed control, the doses of 0.5 liters/ha of Lagoon 575 SC575 SC and 2 liters/ha of Primagold 537.5 SE have shown to be superior to Stomp 455 CS at 2.6 liters/ha against the different types of weeds listed in Tables 17, 18, 19 and 20 during the three phases of observation. The efficacy of Lagon 575 SC and Primagold 537.5 SE was more pronounced on monocotyledons and dicotyledonous in the two locations of Bancoumana and Bougouni (Tables 17, 18, 19 and 20). As for the reference product, the same effect was observed in Bougouni and Bancoumana during the same period. No phytotoxic effects of the tested products were observed on maize in the two location throughout the remanence period (phytotoxicity = 0).

Table 17 : Rating of Lagon 575 SC herbicide effect on Weeds, Bougouni

Treatments	15 DAT			30 DAA			45 DAA		
	Mono	Dico	Cyp	Mono	Dico	Cyp	Mono	Dico	Cyp
Lagon 575 SC 0,5 l/ha	1	0	9	7	8	8	7	5	23
T2= Stomp 455 CS 2,6 l/ha	8	8	7	7	7	6	3	2	3

DAA = day after application; Mono = monocotyledon; Dict = dicotyledons; Cyp = cyperaceae
(Scale from 0 to 10): 0 = zero efficiency and 10 = maximum efficiency.

Table 18: Rating of Lagon 575 SC herbicide effect on Weeds, Bancoumana

Treatments	15 DAA			30 DAA			45 DAA		
	Mono	Dico	Cyp	Mono	Dico	Cyp	Mono	Dico	Cyp
Lagon 575 SC 0,5 l/ha	1	0	9	7	8	6	5	6	45
T2= Stomp 455 CS 2,6 l/ha	8	7	7	7	6	6	5	3	4

DAA = day after application; Mono = monocotyledon; Dict = dicotyledons; Cyp = cyperaceae
(Scale from 0 to 10): 0 = zero efficiency and 10 = maximum efficiency.

Table 19 : Rating of Primagold 537.5 SE herbicide effect on Weeds, Bougouni

Treatments	Efficacité 15 DAA			Efficacité 30 DAA			Efficacité 45 DAA		
	Mono	Dico	Cyp	Mono	Dico	Cyp	Mono	Dico	Cyp
Primagold 537.5 2 2/ha	8.5	7	7	8	7	7	6	5	3
Stomp 455 CS 2,6 l/ha	8	8	7	7	7	6	5	2	3

DAA = day after application; Mono = monocotyledon; Dict = dicotyledons; Cyp = cyperaceae
(Scale from 0 to 10): 0 = zero efficiency and 10 = maximum efficiency.

Table 20 : Rating of Primagold 537.5 SE herbicide effect on Weeds, Bancoumana

Treatments	15 DAA			30 DAA			45 DAA		
	Mono	Dico	Cyp	Mono	Dico	Cyp	Mono	Dico	Cyp
Primagold 537.5 2l/ha	9	8.5	8	8.5	8	5	6	4	5
Stomp 455 CS 2,6 l/ha	8	7	7	7	6	6	5	3	4

DAA = day after application; Mono = monocotyledon; Dict = dicotyledons; Cyp = cyperaceae
(Scale from 0 to 10): 0 = zero efficiency and 10 = maximum efficiency.

Yield components

Lagoon 575 SC: The statistical analysis did not show any significant differences between the treatments for the yield components in the 2 locations excepted for ears weight at Bougouni (Tables 21). The yields obtained at Bougouni were 2556 kg/ha for the dose of 0.5 liter/ha of Lagoon 575 SC, 2218 kg/ha for the reference product Stomp 455 CS at the rate of 2.6 liters/ha and 2062 Kg/ ha for the weeded control with variation coefficients from 12.90% to 15.61%. As for Bancoumana, they were of the order of 2739 kg/ha, 3151 kg/ha and 3541 kg/ha with the variation coefficients from 3.41% to 15.56% (Table 22). The results were comparatively better in Bancoumana than in Bougouni (Tables 21 and 22).

Primagold 537.5 SE: The statistical analysis showed significant differences between treatments for ears weight and yield at Bougouni (Tables 23). Yields at Bougouni were 3903 kg/ha for the weeded control, 3786 kg for Primagold 537.5 SE and 3370 kg/ha for the reference product with variation coefficients from 6.03% to 7.72%. For Bancoumana, they were of 3194 kg/ha for the dose of 2 liters/ha of Primagold 537.5 SE, 2896 kg/ha for the weeded control and 2763 kg/ha for the dose of 2.6 Liters/ha of Stomp 455 CS with variation coefficients from 10.81% to 18.61% (Table 24). The results were comparatively better at Bougouni than at Bancoumana, (Tables23,24).

Tableau 21: Analysis of variance for yield and yield components of maize. Bougouni

Treatments	Germinated hills/ha	Phinned plants/ha	Harvested plants/ha	Harvested plants/ha	Ears weight/ha	Grain yield (kg/ha)
Lagon 575 SC 0,5 l/ha	20250	33375	34000	25425	659 a	2556
Stomp 455 CS 2,6 l/ha	19500	35500	32187	25631	3219 ab	2218
Weeding : 15-30-45 JAS	20250	33437	28625	28125	2831 b	2062
Signification	NS	NS	NS	NS	S	SN
CV%	15,462	1,99	15,61	44,80	12,90	14,28
LSD	-	-	-	-	608,8	-

S = significant ; NS = not significant; Figures with the same letters are not statistically different at 5% threshold; LSD= least significant difference; CV= variation coefficient.

Tableau 22 : Analysis of variance for yield and yield components of maize, Bancoumana

Treatments	Germinated hills/ha	Phinned plants/ha	Harvested plants/ha	Harvested plants/ha	Ears weight	Grain yield (kg/ha)
Lagon 575 SC 0,5 l/ha	21000	41770	32291	28124	3437	2739
Stomp 455 CS 2,6 l/ha	21666	42916	33958	26875	3771	3151
Weeding : 15-30-45 DAS	22333	45208	33228	29479	4177	3541
Signification	NS	NS	NS	NS	NS	NS
CV%	3,77	4,68	8,85	4,85	13,35	15,56

NS = not significant; CV= variation coefficient; DAS=day after sowing

Tableau 23 : Analysis of variance for yield and yield components of maize., Bougouni

Treatments		Germinated Hills/ha	Phinned plants/ha	Harvested plants/ha	Ears harvested/ha	Ears weight/ha	Grain yield (kg/ha)
Primagold 537.5 SE	2 l/ha	22600	42795	41620	40172	4840 a	3786a
Stomp 455 CS	2,6 l/ha	22827	43088	40040	36930	4270 b	3370b
Weeding : 15-30-45 DAS		23675	45542	42190	40820	4974 a	3903a
Signification		NS	NS	NS	NS	S	S
CV%		6.94	6,55	6,91	6,03	7,72	6,70
LSD	-	-	-	-		526.49	360.234

S = significant ; NS = not significant; Figures with the same letters are not statistically different at 5% threshold; LSD= least significant difference; .CV= variation coefficient; DAS=day after sowing

Tableau 24: Analysis of variance for yield and yield components of maize, Bancoumana

Treatments		Germinated hills/ha	Phinned plants/ha	Harvested plants/ha	Harvested ears/ha	Ears weight/ha	Grain yield (kg/ha)
Primagold 537.5 SE	2 l/ha	19660	38560	37840	37278	4581	3194
Stomp 455 CS	2,6 l/ha	18130	35716	34658	34061	4000	2763
Weeding : 15-30-45 DAS		17800	30200	34020	44540	4287	2896
Signification		NS	NS	NS	NS	NS	NS
CV%		8.98	18.61	10.81	37	14.08	12.64

NS=non significatif au seuil de 5 % ; CV = coefficient de variation ; DAS=day after sowing

IV. DISCUSSION

Weed control techniques are often specific; they can only be implemented if the species constituting the grass are clearly identified. Investigations revealed the presence in the field of three classes of weeds namely: grasses, dicotyledons and cyperaceae. This has been demonstrated by the works of N'Diaye et al, (2010) which indicated that the introduction of the herbicides into the agricultural practices has resulted in considerable time savings: with regard to weed control, giving up of the manual intervention in favor of the sprayer reduced labor by 20 to 25%. But the use of herbicides requires a certain level of knowledge because it is necessary to be able to differentiate the pre-emergence and post-emergence herbicides, to correctly measure the doses, to know the time of application, whether the pesticide is systemic or total and know its range of action. They also added that in traditional agriculture, manual weeding routinely absorbs 20-50% of total labor, from field preparation to harvesting. It is in view of all these constraints that herbicides are known by the majority of the producers.

Efficiency of the products.

The trials allowed a study of weed behavior after application of Lagon 575 SC and Primagold 537.5 SE herbicides and, depending on the agro-ecological conditions of the environment, to compare their effectiveness in controlling weed (80% to 90%), determine their efficacy spectrum and resistant species (monocotyledons, dicotyledons and cyperaceae), determine the duration of remanence (45 days) and evaluate the visible symptoms of phytotoxicity. This is in agreement with CIRAD (2000), which indicated that herbicides are sometimes called weed killer, particularly in horticulture, whether they are active ingredients or formulated products that are capable of killing plants.

Product selectivity

The phytotoxicity of Lagon 575 SC and Primagold 537,5SE herbicides has been assessed on maize crop after the efficacy tests in the previous efficacy trials. In general, the selectivity test was conducted until harvest and all plots have been thoroughly weeded with no weed effect on maize crop. The study allowed an assessment of the phytotoxicity of herbicidal products at the crop emergence phase by counting the number of plant showing signs of phytotoxicity, an estimate of growth factors and visual rating of the phytotoxicity in the different treatments compared to the reference control during the growth period and the measurement of of yield and yield components. This is perfectly in line with the work of Thomson (1985) on the biochemical interactions between plants; Lance et al. (1996) on weed biology and CIRAD (2000), who indicated that the study of selectivity of herbicides should consider three (3) doses (single, double and triple doses): D, 2xD and 3xD. D being the dose determined to be effective from the series of previous efficacy tests.

On-Farm Tests

The field tests of Lagon 575 SC and Primagold 537.5 SE herbicides made it possible to be assessed and accepted by the users. They constituted an indispensable phase before the use of the products; they made it possible to judge at large scale the advantages and constraints of the new formulation. The tests were implemented with the equipment normally used by the farmer with regular monitoring of grass cover and maize crop. They made it possible to confirm the effectiveness and selectivity of the herbicidal products tested on the research stations using untreated control bands without herbicide to verify the potential weed cover of the plots (importance and principal weeds species) and treated bands with a reference product to estimate the difference in behavior between the two techniques. This phenomenon has been illustrated by Deat (1973) and Marnotte (1995), in which the use of herbicides for weed control in cropping systems allows the farmer to limit the infestation of plots by weeds, less competition between crops and weeds for water, light and nutrients, with positive effects on improving the overall yield of the crops.

V. CONCLUSION

Compared to the reference product, Stomp 455 CS at 2.6 liters/ha, Lagon 575 SC and Primagold 537.5 SE herbicides were effective against the different classes of maize weeds on the research station and on the farmers' fields, respectively at Samanko, and the locations of Bougouni and Bancoumana (South and West zones) of Mali throughout the period of the products remanance or retention. The tested doses of 0.5 liters/ha of Lagoon 575 SC and 2 liters/ha of Primagold 537,5 SE demonstrated superior efficacy to that of the reference product and showed no remarkable phytotoxicity effect on the crop. These doses for both products were recommended for registration in the country.

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