Comparative efficacy of an onion weeding earthing - up machine (SBK2) and four herbicides (pendimethalin, oxadiazon, cycloxidim, haloxyfop-r-methyl) and their effects on a ferruginous soil agrochemical properties, in Burkina Faso.

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Abstract

A comparative study of a Weeding Earthing- Up Machine (SBK2) biological efficiency and pre emergency, post emergency herbicides (pendimethalin, oxadiazon, cycloxidim, haloxyfop-r-methyl) against Cyperus spp., *Spigelia anthelmia, Digitaria horizontalis etc…which cause big damages to onion and their effects on a ferruginous soil agrochemicals properties has been done at Kou valley, in Burkina Faso. The biological efficiencies of the different weeding methods have been evaluated according [1] method. The weeds reduction rates were evaluated with the help of [2] formula. Nitrogen nitrate content levels in the soil, were determined with a spectrophotometer [3]. Those of available phosphorus by [4]. Available potassium levels were evaluated using a flame photometer. The dry weeds reduction rate with the weeding earthing - up machine varied from 57. 46% to 91.40% while those of the herbicides from 11.61% to 57. 45%. At the onion- shaped dome stage, the absorption of nitrogen nitrate content, available phosphorus and potassium contents was disturbed by herbicides application. This dry weeds reduction and all of these factors led to a yield increase of 54.11% at the weeding earthing-up machine SBK2 against 47.31% at Pendimethalin associated with Haloxyfop-r-methyl, in comparison with the untreated control. The use of SBK 2 augurs a new integrated pest management method against onion weeds, preserving consumers' health and the environment.*

Keywords*: weeding earthing- up machine, herbicides, weeds, onion, Burkina Faso.*

I. INTRODUCTION

Horticulture in Burkina Faso is an important source of income and employment for the farmers during the dry season. With an irrigable land potential estimated for more than 225.000 hectares; this activity is done, in all regions of the country, on more than 27 661 ha [5]. Nearly 22 vegetables are produced each year. Between these vegetables, onion bulb is the most important in terms of quantities produced and areas planted. According to the [5], nearly 11.449 ha or 41.4% of the areas exploited are intended for the production of onion bulb. For the 2014-2015 season the total production of onion bulb was estimated at 445 568 tons [6]. In terms of income, more than 82 billion FCFA are generated each year. Onion production, however, is subject to several insect and disease constraints as well as weed pressure. According to [7], (2004) [8], [9], [10], [11]; onions are less resistant to weeds competition. In addition, the cylindrical shape of the onion leaves does not provide a soil cover that can affect the growth and development of weeds. In Burkina Faso, weeds as an agronomic constraint to onion production are composed of rhizome grasses (*Imperata cylindrica*), tuber grasses (*Cyperus* spp.) and creeping grass (*Cynodon dactylon, Digitaria horizontalis*). According to some authors, [12], [13] losses caused by weeds would be equal to or even higher than those caused by other pest. But it is easy to overlook their importance because, at the opposite of most insects and diseases, they produce large decreases in yield without obvious signs of damage to crops. Weeds cause yield losses of up to one tone / ha [14], 10 to 56% of the production [15]. In order, to overcome this situation, several weed control methods are used (manual weeding, false seeding, mechanical weeding, biological control, etc.). Manual weeding is the most common method of weeds management but it requires a lot of time and labor that is not always available especially with the mining boom that Burkina Faso knows now. A method of biological control against *C. rotundus* and *C. tuberosus*, little practiced, involves the pigs who dig up the tubers and bulbous tubercles and eat them [16] quoted by [17]. Other biological control against Cyperaceae have been developed by [18], [19], [20], [21], [22]. The most commonly used agents are Lepidoptera (*Bactra* sp.) And microscopic fungi (*Cercospora* sp., *Puccinia* sp.). However, biological control against Cyperaceae is not sufficiently popularized and adopted in intertropical Africa because of the difficulties to drive it. The short-term alternative requiring less labor time and manpower remains chemical control [23]. However, the use of herbicides is not without consequences on humans (cancers, dermatoses etc.) health and on environment (pollution of water, soil air, etc.) [24]. It is therefore necessary to find other accessible, efficient and less polluting methods to improve onion production, in Burkina Faso. This study is mainly to evaluate the efficiency of weeding earthing – up machine (SKB 2) to control weeds in onion production in comparison with those of four herbicides (Pendimethalin, Oxadiazon, Cycloxydim and Haloxyfop-r-Methyl) used in vegetable production and their effects on a ferruginous soil agrochemical properties in Burkina Faso.

II. MATERIALS AND METHODS

A. Materials

The experiment has been set at the Kou Valley, located at 25km from Bobo-Dioulasso town.

The soils of Kou Valley are alluvial and ferruginous type with a light texture, sandy-clay-silt and acid [25]. The pH is between 5.5 and 6.5 with a high concentration of exchangeable bases. The plant material was onion (*Allium Cepa* L.) variety violet of Galmi. Its yield is on order of 25 to 35 tons / ha in traditional production, while in modern production, the yield can reach to 60t / ha. Violet of Galmi has a good aptitude for conservation, and a plant cycle of about 140 days but more sensitive to weeds.

B. Methods

The experimental design was a factorial assay of two pre-emergence herbicides (pendimethalin, oxadiazon) and two post emergence herbicides (Cycloxidim, haloxyfop-r-methyl) with two controls (untreated control and weeding-earthing up machine) in four replications. A total of 24 elementary plots were established. Each elementary plot had an area of 10 m^2 (2m x 5m) with 11 rows of onion. The useful plot an area of 8.82m² (1.80 m x 4.90 m) consisted of 9 onion rows. The onion plants were planted 45 days after sowing in the nursery, at the rate of one plant per pouch. 20 cm and 10 cm spacing were respectively observed between the lines and between the plants on the same line.

The implementation of the test consisted in a tillage in a deep of 0.25 cm by a tractor followed by harrowing. At the end of this operation, a spray of organic manure (20 tons per hectare) composed mainly of oxen dung has been done. The plots also received NPK fertilizer (15-15-15) (200kg / ha) at 15th and 45th day after onion plants transplanting. They were irrigated every 48 hours until leaves falling. Weeding operations with weeding earthing up machine (SKB2) have been done at the 10th and 40th days after application (DAA), depending on the weeds density. All products were applied using a pressure-controlled sprayer at a rate of 200 l / ha with water.

C. Biological efficiencies of the different weeding methods.

Weeds density has been evaluated per square meter (m^2) on each elementary plot, by counting the number of weeds and pulling them off after herbicide application, using a sampling square. of 25m^2 placed around 4 pockets at regular intervals, diagonally in each plot useful at the 7th DAA, 14th DAA, 30th DAA 45th DAA 60th DAA, 90th DAA and 120th DAA [1].

The weeds dry biomass evaluations have been done after drying weeds under a greenhouse. The weeds were cleared of clods of land and their roots were cut. The mass of their biomasses has been then determined using a precision balance according to the method of [1]

The biological efficiency coefficients were determined by the formula of [2]

$$C = \frac{100\ (Bk - B0)}{Bk}$$

C = Weed reduction versus untreated control (%),

B_0 = Number of weeds per m^2 or weeds dry biomass weight (g / m²) on herbicide treatment at the 1st (2nd or 3rd) counting.

B_K = Number of weeds per m² or weight of weeds dry biomass (g / m²) on the untreated control at the 1st (2nd or 3rd) counting.

D. Effects of the different weeding methods on soil agrochemical properties

The agrochemical properties were analyzed in the laboratory using different methods. Soil samples were taken at a depth of 0 to 25 cm and at the different onion phenological stages. The determination of the nitrogen nitrate by colorimetry, with disulfophenic acid in alkaline medium at 410 nm according to the methodology of [3]. The method of [4] was used to determine assimilable phosphorus. The Potassium content has been determined with the help of flame photometer.

E. Effects of the different weeding methods on onion yield.

The yields of the different treatments were evaluated for each useful plot.. After counting the number of onion bulbs, they were weighed in kg / ha.

F. Statistical analysis of data

An analysis of variance of the obtained data was computed and means separations carried out using Newman-Keuls test at 5% level, with the help of GENSTAT Discovery Edition 4 software. The correlation between some studied factors has been done using the same software.

III. RESULTS

A. Effects of the weeding earthing up machine SBK2 and herbicides on weeds dry biomass.

Following the application of different control methods, the number of onion weeds does not correspond to their dry biomass. The weeds dry biomass of the different control methods is significantly lower than that of the untreated control (table I).

At the 7th Day after application, there is a strong similarity between herbicide treatments. The weeds biomass at weeding earthing - up machine treatment was lowest 1.50 times compared to the untreated control. The average effect of herbicide treatments (3.67 g / m^2) was a decrease in weeds dry biomass of 15.44% compared to the untreated control.

Two weeks after treatment, at the 14th Day after application, an increase in weeds dry biomass was observed for all treatments compared to the 7th Day after application, except for the weeding earthing - up machine treatment. The average effect of herbicides (4.99 g / m^2) is a decrease in dry biomass of 16.83% compared to untreated control. There is a similarity between the Pendimethalin + Cycloxidim, Oxadiazon + Cycloxidim and Oxadiazon + Haloxyfop-r-methyl treatments.

At the 30th Day after herbicides application, there was an increase in weeds dry biomass in all the treatments compared to the 14th Day after application. However all the weeds control methods have led to a reduction of their dry biomasses compared to the untreated control. Pendimethalin + Haloxyfop–r-methyl treatment resulted in the best reduction of weeds dry biomass between herbicide treatments. This reduction was 1.37 times compared to the untreated control. Pendimethalin + Haloxyfop – r - methyl and Oxadiazon + Cycloxidim treatments show similarity.

At the 45th Day after application the same trend of dry biomass compared to previous periods was maintained in all treatments, except on the weeding earthing - up machine treatment. In the weeding earthing- up machine treatment there was a decrease in weeds dry biomass by 3.18 times compared to the untreated control. The best reduction between herbicide treatments was at Pendimethalin + Haloxyfop – r- methyl. Between Pendimethalin + Cycloxidim, Pendimethalin + Haloxyfop – r - methyl and Oxadiazon + Haloxyfop – r - methyl treatments there is no significant diferences.

At the 60th Day after application, we observe an increase in dry biomass compared to the previous observation in all treatments. The average effect of chemical treatments (7.40 g/ m^2) is a dry biomass reduction of 27.66% compared to the untreated control. Weeding earthing- up machine treatment reduced weeds dry biomass by 3.28 times compared to the untreated control. The best chemical treatment is Pendimethalin + Haloxyfop – r – methyl.

At the 90th Day after herbicide application, the average effect of herbicides (9.7 g / m^2) is a reduction in dry biomass of 1.38 times compared to the untreated control. The best herbicide treatment is Pendimethalin + Haloxyfop–r–methyl which has reduces dry biomass by 1.48 times compared to the untreated control.

At the 120th days after herbicide application, there is an increase in dry biomass compared to the previous observations. Weeding earthing – up resulted in the best reduction of weeds dry biomass (7.99 g/m²). Between chemical herbicides, the best reduction has been got on Pendimethalin associated with Haloxyfop – r – methyl treatment which is not different with Pendimethalin associated to Cycloxidim.

Table I: Effects of the weeding earthing- up machine SBK2 and herbicides on weeds dry biomass (g / m²). 2013-2015

Treatments		**Observation Periods (Days After Application = DAA)**						
Pre-emergent herbicide	**Post-emergent Herbicide**	**7**	**14**	**30**	**45**	**60**	**90**	**120**
	Untreated control	4.34 a	6.00 a	8.04 a	8.43 a	10.23 a	13.43 a	13.98 a
	Weeding Earthing up Machine	2.89 c	1.96d	3.90 e	2.65 d	3.12 f	5.51 e	7.99d
Pendimethalin	Cycloxidim	3.64 b	5.04 b	6.64 c	6.86 c	7.18 d	9.76 c	10.06 c
	Haloxyfop-r-methyl	3.46 b	4.58c	5.87 d	6.33 c	6.69 e	9.06 d	9.92 c
Oxadiazon	Cycloxidim	3.78 b	5.10b	6.20 d	7.81 b	7.73 c	10.28 b	11.77 b
	Haloxyfop- r-methyl	3.80 b	5.22b	7.40 b	6.93 c	7.98 b	9.70 c	11.99 b
Mean		3.64	4.48	6.25	6.26	7.03	9.58	10.96
CV (%)		6.3	4.48	3.9	5.5	1.9	3.2	6.6
ETR (ddl=15)		0.23	0.16	0.24	0.35	0.13	0.31	0.72
L s d		0.34	0.24	0.36	0.51	0.20	0.45	1.06
Pre- emergent herbicide		***	***	***	***	***	***	***
Post- emergent herbicide		NS	NS	NS	**	NS	**	NS
Interaction		NS	**	***	*	***	*	NS

NB: The averages affected by the same letter do not differ significantly at 5% level Newman-Keuls test.

*Significant. ** High significant. *** Very high significant. **NS:** not significant

B. Weeds reduction rates by the weeding earthing up machine and by herbicide

After weeds dry biomass evaluation, the biological efficiency rates of the weeding methods were determined using the formula of [2].

From the 7th day to the 120th day after herbicides application the weeding earthing – up machine treatment is the one that led to the best reduction of the weeds dry biomass This rate of reduction has varied from 57.46% to 91.40%. For Pendimethalin + Haloxyfop – r - methyl chemical treatment, the reduction rates were the best from the 7th to the 60th day after application. They ranged from 34.65% to 57.45% (Figure 1).

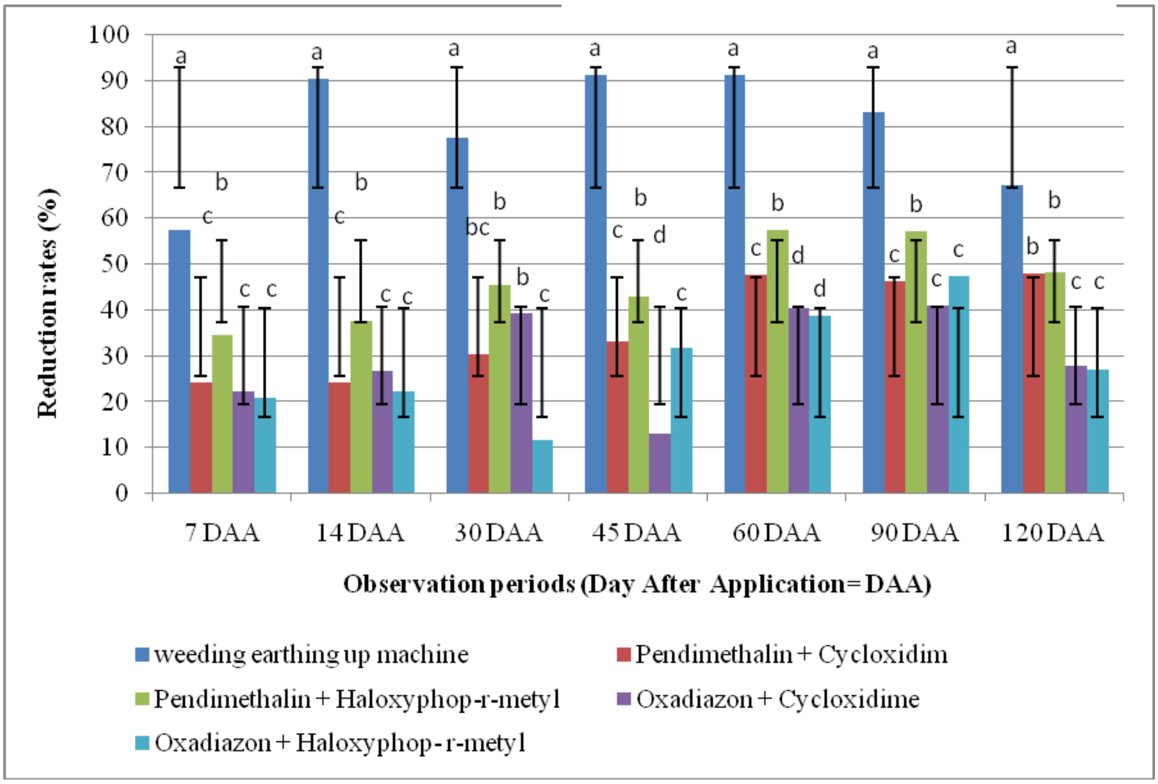

Figure 1: Biological efficiency of the weeding earthing -up machine SBK2 and herbicides according to the weeds dry biomass (%), 2013-2015.

C. Effects of the weeding earthing -up machine SBK2 and herbicides on the soil dynamic nitrogen nitrate content.

The dynamic evolution of the nitrogen nitrate content during the onion development is an increase from the first observation to 120th day after application (table 2).

Before the application of the different treatments, and Two weeks after application, there are no significant differences between the treatments at the 90th days after herbicide application, the average Effects of the different kind of weeding (7.30 mg/kg) content 15.87% in comparison of the untreated control. Between the different methods of weeding, SBK2 showed the low content. It is a reduction of 19.68% in comparison with the untreated control. It is followed by Pendimethalin associated with Cycloxidim and Haloxyfop-r- methyl which are not different between them. The others associated herbicides are characterized by an increase in comparison with the untreated control.

At the 120th day after application of the herbicides, the average effect of the different methods of weeding (19.48 mg/kg) is an increase of 258.09% in comparison with the untreated control. The highest contents of nitrogen nitrate are situated on mechanical weeding SBK2 and Pendimethalin associated with Cycloxidim with an increase of 61.58% and of 55.88% respectively in comparison with the untreated control. In all treatments the nitrogen nitrate contents are higher in comparison with the period before herbicides application.

D. Effects of the weeding- earthing up machine SBK2 and herbicides on the dynamics of assimilable phosphorus content.

Before herbicides application, the average content of assimilable phosphorus (5.80 mg/kg) in the different weeding methods plots is an increase of 21.85% in comparison with the untreated control. There is no significant difference between them (table 2).

At the 14th day after application, the average effect of assimilable phosphorus content (8.06 mg/kg) is an increase of 21.57% in comparison of the untreated control. Between the different weeding methods, there is no significant difference between SBK 2, the untreated control and Oxadiazon associated with Cycloxidim. Between Pendimethalin associated with Cycloxidim, with haloxyfop-r-methyl and Oxadiazion associated with Holoxyfop-v-methyl there is no significant difference and led to a reduction of 19.90% in comparison with the untreated control.

At the 90th day after application, the average effect of the different weeding methods (8.06 mg/kg) is a reduction of 45.28 % in comparison with the untreated control. The lowest contents are situated at Pendimethalin associated with Cycloxidim, Haloxyfop-r-methyl are not different and led to a reduction of 59.95% to 62.53%. At SBK2 which is not different with oxadiazon associated with Cycloxidim. the reduction of phosphorus content is about 30, 41%. Oxadiazon associated with Haloxyfop-r-methyl led to a reduction of 45.42% in comparison with the untreated control.

At the 120 th day after application (3.80 mg/kg) is an increase of 8.88% in comparison with the untreated control. Between SKB2 and Pendimenthalin associated with cycloxidim there is no significant difference and they led to an increase of assimilable phosphorus content from 26.93% to 28.37%. Between the others treatments and the untreated control there is no statistical difference.

E. Effects of weeding eathing-up machine SBK2 and herbicides on the dynamic of soil available potassium content

The dynamic of available potassium content is characterized by a reduction during the raising-flowering stage and an increase at onion maturity (table 2).

Before insecticides application, the average of potassium content (150.64 mg/kg) is an increase of 19.56% in comparison with the untreated control. Between the different weeding methods there is no significant difference. The highest content is situated at oxadiazon associated haloxyfop-r-methyl.

At the 14th day after herbicides application, the average effect of the different weeding methods (145.22 mg/kg) is an increase of 13.10 in comparison with the untreated control. Between the different methods of weeding, Oxadiazon associated with Cycloxidim and Haloxyfop-r-methyl led to an increase of 27.25% and of 130.07 % respectively. The lowest content is at pendimcthalin associated with Cycloxidim which is not different with the untreated control.

At the 90th day after herbicides application, the average effect of the different weeding methods (144.20 mg/kg) is a decrease of 1.37 in comparison with the untreated control. The highest content is situated at SBK2 and Pendimethalin associated with Cycloxidim which are not different between them (126.7 mg/kg and 128.00 mg/kg).

At the 120th after herbicides application, the average potassium content in the different weeding methods (167.92 mg/kg) is an increase of 27.41 % in comparison with the untreated control. Between the different weeding methods Pendimethalin associated with Haloxyfolp-r-methyl led to an increase of 74.13 % in comparison with the untreated control. They have been followed by SBK2, Oxadiazon associated with Cycloxidim which are not different mathematically. They increase the available potassium content of 25.56% and 25.03% respectively. The lowest avalaible content of potassium is at Oxadiazon associated with Haloxyfop-r-methyl (133.10 mg/kg).

F. Effects of weeding eathing-up machine SBK2 and herbicides on onion yield.

The average effects of the different weeding methods (27, 19 T/ha) is an increase of 36, 70 % in comparison with the untreated control. Between them, the higher yield is at SBK2 with an increase of 57.11% in comparison with the untreated control. It is followed by Pendimethalin associated with Haloxyfop-r-methyl with an increase of 47. 31%. The others herbicides allowed to get an increase of 20. 11% to 32. 53% in comparison with the untreated control.

Table II: Effects of the different methods of weeding on nitrogen nitrate, assimilable phosphorus and available potassium contents, 2013-2015

Treatments	Observation periods (Days After Application = DAA)											
Pre post-emergent herbicides	Nitrate nitrogen (mg/kg)				assimilable phosphorus (mg/kg)				available potassium (mg/kg)			
	0	14	90	120	0	14	90	120	0	14	90	120
Untreated control	4.91 a	6.45a	6.30 c	5.44 d	4.76 b	6.63 a	14.73 a	3.49 b	126.0 b	128.4cd	146.2 c	131.8 d
SKB2	4.86 a	5.52a	5.06 e	8.79 a	5.97 a	6.42 a	10.25 b	4.43 a	140.9 ab	146.3 b	126.7 d	165.5 b
Pendimetalin Cycloxidim	4.74 a	4.51a	5.91 d	8.48 a	5.36 ab	5.31 b	5.90 d	4.48 a	146.7 ab	122.1 d	128.0 d	146.7 c
Haloxyfop	4.67 a	4.08a	6.07cd	6.61 c	5.75 ab	4.51 b	5.52 d	3.17 b	140.6 ab	135.5 c	141.1 c	229.5 a
Oxadiazon Cycloxidim	4.74 a	3.81a	9.57 b	7.00 b	6.19 a	6.47 a	10.60 b	3.29 b	151.6 ab	158.3 a	171.2 a	164.8 b
Haloxyfop.	5.07 a	4.47a	9.88 a	6.54 c	5.73 ab	4.65 b	8.04 c	3.65 b	173.4 a	163.9 a	154.0 b	133.1 d
Mean	4.84	5.10	6.77	7.14	5.56	5.88	10.00	3.80	143.26	141.17	142.50	158.58
CV (%)	4.40	17.00	1.80	2.30	5.20	5.80	4.70	4.50	7.10	2.30	2.30	3.20
ETR (ddl= 15)	0.22	0.87	0.12	0.16	0.29	0.34	0.47	0.17	10.24	3.29	3.30	5.15
L s d	0.51	2.05	0.29	0.38	0.69	0.81	1.12	0.41	24.21	7.79	7.80	12.19
Pre- emergent herbicide	NS	**	***	***	**	***	***	***	**	***	***	***
Post- emergent herbicide	NS	NS	NS	***	NS	**	**	**	NS	**	NS	**
interaction	NS	NS	NS	***	NS	**	**	**	NS	**	**	***

Table III: Effects of herbicides and SKB2 on onion yield, 2013-2015.

Treatments			
Pre- emergent herbicide	**Post- emergent herbicide**	**Yield (T/ha)**	**% to untreated control**
	Untreated control	19.89 f	---
	SBK2	31.25 a	157.11
Pendimethalin	Cycloxidim	26.36 c	132.53
	Haloxyfop-r-methyl	29.30 b	147.31
Oxadiazon	Cycloxidim	23.89 e	120.11
	Haloxyfop- r-methyl	25.14 d	126.40
Means		25.87	
CV(%)		3.0	
ETR (ddl=15)		0.77	
L s d		1.14	
Pre- emergent herbicide		***	
Post- emergent herbicide		***	
Interaction		**	

G. Correlations between some studied factors and the yield.

The correlation between weeds dry biomass and onion yield during the raising period has shown a regression equation y = - 1.73x + 37.19 with correlation coefficient r = - 0.87 (p = 0.02).

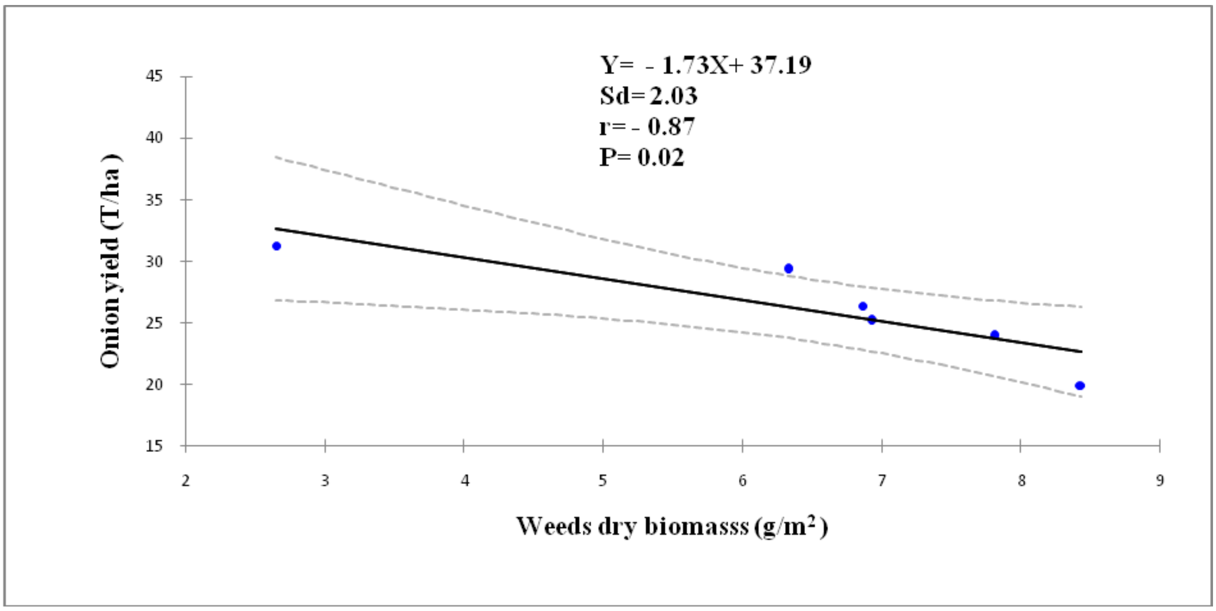

Fig 2: Correlation between weeds dry biomass at 45th day after herbicides application and onion yield

IV. DISCUSSION

The variations in onion weeds population have been determined not only by the active ingredients of the herbicides but also by their rates, their persistence and spectrum of action. The efficiency of the herbicides is also determined by the cellular structure of weeds and their capacity to destroy herbicides molecules or their metabolites. Thus, Pendimethalin inhibits division and cell elongation in shoot and root of weeds meristems. Its activity field extends to a large number of dicotyledons and grasses. It acts by inhibition of seed germination and on very young seedlings in wet conditions. Its efficiency would be much worse on crucifers and some compounds will have a fairly long persistence of action [26]; [27].

Oxadiazon acts by contact on the young tissues without being absorbed by the roots or conveyed inside the plants. Oxadiazon is active in preemergence and postemergence on a large number of dicotyledonous and annual grasses [26].

In post-emergence herbicides, Cycloxydim from Cyclohexadione family is absorbed by the green parts of the plant and somewhat by the roots. With systemic properties, it migrates to the meristematic tissue and acts by inhibiting the biosynthesis of fatty acids [28]. Its action is on grasses.

Haloxyfop-r-methyl is absorbed mainly by the leaves but also by the roots. It inhibits lipid synthesis and the growth of grasses (weeds) is immediately blocked. It is effective only on annual and perennial grasses [26].

In our experimentation, the characteristics of these herbicides were confirmed. These pre-emergence and post-emergence herbicides effectively reduced grasses and Solanaceae such as *Setaria pallide fusca, Paspalum scrobiculatum, Paspalum orbiculare, Physalis angulata* etc.

These results are similar to those obtained by [29]; [30] about the efficacy of Pendimethalin against grasses. However, as [31] showed, this efficiency of pendimethalin can varied with the retention by humic acid from the soil, according to different cropping systems. Because of the fact that, Kou valley soils are poor in organic matter, the phenomenon retention cannot take place other than the surface or the deep leaching phenomena, which may explain inefficiency. On the other hand, these herbicides proved to be not efficient against *Euphorbia heterophila, Echinochloa colona*. Mechanical weeding by SBK2 has reduced grasses and broadleaf weeds such as *Euphorbia heterophila, Spigelia anthelmia* and Cyperaceae. This is due to the combined effects of its spoon-shaped spoon drum, the mouldboard and the blade cross, which allow the bulbs to be dug up and exposed to sun-drying. This is in ad equation with the work of some authors [16], [32], [33] and showed by [17]. They said that the most effective fight against cyperaceae consisted systematically to cultivate the soil at a depth of about 50 cm, for the purpose of digging up the tubers and then, exposing them to the soil surface because they are sensitive to desiccation. The impact of weeding earthing up machine and herbicides effiiencies was clearly reflected in the mathematical relationships at the 45th day after application between the weeds dry biomass and the yield expressed by the equation of regression. (Fig: 2). Moreover, [34] recognized that Pendimethalin and Oxadiazon, in combination with weeding earthing up machine at 60 days after application, resulted in increased bulbs yield.

Plants need from the soil, some of chemical elements necessary for their development. These assimilable elements in the form of ions in the soil solution are mainly the nitrogen in its nitrate form, phosphorus in the assimilable form and potassium in its available form. The results of soil samples analyzes have shown the effects of herbicides and SKB2 on the dynamics absorption of these elements by onion. These elements are the products of soil microorganism activities as cellulolytic bacteria, microscopic fungi, ammonifying and nitrifying bacteria. These products can be stimulated or inhibited by pesticides including herbicides or could have no impact on microorganisms [35]. However, the availability of these nutrients could be also influenced by many others factors as soil moisture, clay minerals or humic compounds, micaceous crystals, poorly soluble minerals when they are linked to these, or stored in the biomass, and also by the soil acidity.

The dynamics of the major mineral elements were an increase in general in all treatments at the 14th day after application. This could be explained by the mineral manures given to onion during this period. At the 90th day after herbicides application, there was a decrease in nitrogen content at untreated control and weeding earthing up machine treatments but a slight increase in herbicide treatments compared to the previous period. The decline in the content can be explained by a strong absorption of plants at SBK2 but also by weeds in the untreated control. Indeed, during the vegetative stage development, developing leaves and roots absorb nitrogen nitrate and ammonium, incorporate nitrogen into carbon molecules to produce amino acids, protein precursors, and nucleic acids, genetic information [36]; [37]. From the 90th day after herbicides application to the maturity of the onion, it has happen a gradual increase of nitrogen nitrate content but also available potassium content at weeding earthing –up machine treatment. In the others herbicides treatments we have sometimes a decrease of these contents This can be explained by a strong absorption of nitrogen nitrate and potassium by onion at the weeding earthing – up machine which has small quantity or lack of weeds and a toxicity of herbicides on soil microorganisms. Phosphorus is an essential element for sugars synthesis and for the firmness of bulbs [38] The dynamics of the assimilable phosphorus is not characteristic because phosphorus is in form bound

by ferrous and aluminas ions proper to ferruginous tropical soils. This is why there are sometimes in increase or a decrease of these contents at the onion maturity.
The efficiency of the Weeding earthing-up Machine is due to the spoon-shaped spurs removing a number of sedge bulbs from the soil. The cover of weeds between onion pockets, with soil discarded by iron moldings, contributes to the mineralization and transformation of these weeds into green manure, an enrichment of soil fertility leading to an increase of yield.

V. CONCLUSION

Weeding Earthing - Up Machine and herbicides have affected the density but also the dry biomass of onion weeds consisting mainly of grasses, dicotyledons but especially sedges. The SBK2 with spurs has reduced especially Cyperaceae. The SBK 2 provides in two weeding – up, an average biological efficiency of 79.82% on weeds dry biomass at the 3-5 leaf stage and a yield increase of 57.11% in comparison with the untreated control. The best herbicide treatment (Pendimethalin + Haloxyfop – r - methyl) achieved an average biological efficiency of 46.32% and a yield increase of 47.31%. SBK 2 augurs a new method of integrated control, without the use of herbicides against onion weeds, preserving farmers, consumers' health and the environment.

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