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Efficacy of Different Formulation of Glyphosate Herbicide on Sorghum Weeds

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ABSTRACT

Background: Sorghum is susceptible to weed at its early growth stage. The aim of this efficacy trial was to ensurethat efficacy of chemical Glyphosate-isopropylammonium 41% SL on sorghum weeds control non- selectively before sorghum sowing.

Methods: Thrice experiment was carried out in Humera area in Humera Agricultural Research Center, Semur farm and Desta Berhe farm during rainy growing season of 2019 using sorghum variety *i.e.* Brhan. Pre and post spray weed count were subjected to efficacy calculation.

Result: New product of herbicide, Glyphosate-isopropylammonium 41% SL (Glpho) at 3.00 lt a.i./ha was shown better performance than the standard check Glymax 48% SL (W/V). Therefore, the new Glpho product could be suggested as an alternative non-selective herbicide before sorghum sowing.

Key words: Efficacy, Herbicide, Sorghum, Spray, Weed.

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] is an important cereal crop belonging to family *Poaceae*. It is naturally self-pollinated monocotyledon crop with the degree of spontaneous cross-pollination, in some cases, reaching up to 30% depending on panicle type (Poehlman and Sleper, 1995). The annual domesticated sorghums are diploid (2n=2x=20) and tropical origin C_4 crop (Dicko *et al.* 2006). Sorghum is fifth most important cereal crop globally after rice, wheat, barley and maize (FAO, 2012). It has been domesticated since approximately 3000 years B.C. in the Ethiopia region (Ayana and Bekele, 1998). Ethiopia has a wide range of geographical adaptation and the country is a center of diversity for the crop (Tesso *et al.,* 2007). It is produced for its grain, which is used for food, feed and stalks for fodder and building materials in developing countries, while it is used primarily as animal feed and in sugar, syrup and molasses industry (Dahlberg *et al.,* 2011). It is a major food and nutritional security crop to more than 100 million people in Eastern horn of Africa (Gudu *et al.* 2013) including Ethiopia, providing a principal source of energy (70% starch), proteins, vitamins and minerals (Duodu *et al.,* 2003).

Ethiopia is the third largest producer of sorghum in Africa behind Nigeria and Sudan, which contributed about 12% of annual production (Wani *et al.,* 2011) and the second after Sudan in the Common Market for Eastern and Southern Africa (COMESA) member countries (USAID, 2010). It is the third most important crop both in sown area (ha) and becoming third primary staple food crop in Ethiopia after teff and maize (CSA, 2015) and second most important crop for *injera* (common leavened flat bread) making next to teff (Adugna, 2012). Currently, sorghum is produced by 5 million small holders and its production is estimated to be 4.6 million metric tons from nearly 2 million hectares of land giving the national average grain yield of around 2.3 tons per hectare (CSA, 2015). It covers 16% of the total area allocated to grains (cereals, pulses and oil crops) and 14.58% of the area covered by cereals (CSA, 2015). The crop is cultivated in all regions of Ethiopia between 400m and 2500m altitude, mostly at lower altitudes along the country's Western, South-Western, North Eastern, Northern and Eastern peripheries (EIAR, 2014) and staple food crop on which the lives of millions of poor Ethiopians depend (Adugna, 2007). 44% and 30% yield loss due to weeds in maize and sorghum, respectively (Stroud, 1989). An estimated yield loss about 10% in the less developed countries and 25% in the developing countries is caused by weeds (Akobundu, 1987). Meanwhile, weeds are also the hosts of various crop pests and pathogens (Tao and Hu 2009).

Sorghum is susceptible to weed competition at its early stage of growth because the seedlings start weak and frail. Sorghum has also lower water requirement than most weeds. This means that weeds with higher water requirements tend to take up more water per unit of dry mater produced. Weeds interfere with the growth of crop (SPL, 1988).

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Botanical names of common weeds associated in Sorghum cultivation of the study area are *Pennisetum villosum* Fresen., *Sorghum arundinaceum* (Desv.) Stapf, *Sida rhombifolia* L., *Corchorus trilocularis* L., *Cyanotis* sp., *Eragrostis pilosa* (L.) P. Beauv, *Pennisetum pedicellatum* Trin, *Dinebra retroflexa* (Vahl) Panzer, *Abutilon figarianum* Webb, *Rottboellia cochinchinensis* (Lour.) Clayton, *Aristida adscensionis* L., *Rhynchosia malacophylla* (Spreng.) Eoj., *Ipomoea eriocarpa* R. Br. and *Ipomoea* sp. (Unpublished data). These weed have great impact on the sorghum growth and yield. Weeds compete with crops for water, nutrients and light. Being hardy and vigorous in growth habit, they grow faster than crops and consume large amount of water and nutrients, thus causing heavy losses in yields.

Chemical weed control plays a major role in increasing the efficiency of modern cropping systems (Combellack *et al.,* 1992). The herbicide glyphosate, N-(phosphonomethyl) glycine, is a biocide with a broad spectrum activity that was introduced for weed control in agricultural production fields in 1974 (Benbrook, 2016). Glyphosate is taken up by the foliage of plants and transported throughout the plant resulting in plant death after several days. Glyphosate is formulated with various adjuvants (Li *et al.,* 2005), in particular surfactants such as polyoxyethylene amine (POEA), to enhance the uptake and translocation of the active ingredient in plants. The best known product formulated with POEA is Roundup (Benbrook, 2016). Glyphosate products are used primarily before planting of traditional agricultural crops and after planting of genetically modified glyphosate-resistant crops (Duke and Powles, 2009). Increasingly, they have been used for desiccation as a 'harvest aid' on traditional grain crops (Goffnett, *et al., 2016*; Nelson *et al.,* 2001; Zhang *et al.,* 2017).

Commercial glyphosate formulations usually contain a monovalent salt of glyphosate, due to their high water solubility (Baird *et al.,* 1971; Franz, 1985). Glyphosate salts perform a variety of important functions. In particular, the salt portion of the formulated product may allow for greater absorption of glyphosate through its more effective penetration into the leaf (Nordby *et al.,* 2011). However, the salts do not have an impact on the herbicidal activity, since only the parent acid acts at the target site within the plant. When comparing different salt formulations with the same active ingredient, the acid equivalent of the formulation should be taken into consideration (Nordby *et al.,* 2011). Consequently, differences in the theoretical yield of the parent acid of formulated products applied could be observed under these circumstances. In addition, various types and amounts of adjuvant additives, either included in the formulated products or added in the tank mixture, have been found to improve glyphosate performance in different ways. For instance, surfactants, the most commonly used adjuvants, can activate herbicide diffusion across the cuticle by penetrating into the plant cuticle and improving herbicide uptake (Hess and Foy, 2000). It is also worth mentioning that formulations may differ with respect to the quantity of glyphosate that can ultimately be concentrated, due to the different molecular weights of different salts and the various adjuvants that have been used by different manufacturers (Miller *et al.,* 2013). Outcome of research confirms that interaction among glyphosate formulations and leaf surfaces should be taken into consideration, as they may be crucial to the efficacy of the formulations (Travlos and Chachalis, 2010; Travlos and Chachalis, 2013). Concerning formulation of glyphosate products, the responses of various weed species vary among the different formulations. The objectives of this study were to (i) ensure efficacy of candidate chemical Glpho (Glyphosate-isopropylammonium 41% SL) on sorghum weeds non-selectively before sorghum sowing (ii) To verify the product efficacy of non-selective herbicide Glpho (Glyphosate-isopropylammonium 41% SL) in comparison with a standard check Glymax 48% SL (Glyphosate 48% EC).

MATERIALS AND METHODS

Herbicide used

Glyphosate-isopropylammonium 41% SL (Glpho) applied before Sorghum sowing as foliar spray treatment 3 lt/ha active ingredient using 300 liters of water per hectare and formulation of the chemical Soluble liquid (SL). The agro-chemical manufactured by: Yixing Yizhou Chemical Products Co.

Experimental design

The experiment was carried out in Humera area on three different farms (Semur Farm, Desta Farm and Humera Agricultural Research Center) during 2019 growing season, each experiment replicated thrice. A Sorghum variety, *Brhan*, was sown in rows on plots with spacing of 75 cm and 20 cm between rows and plants, respectively. The experiment was contained of in a single block plot size of 75 m^2 in each plot were demonstrated. Foliar spray was applied using manually operated knapsack sprayer with one hollow-cone nozzle for three treatments *i.e.* new product-Glyphosate-isopropylammonium 41% SL at 3.00 lt/ha active ingredient, as standard check herbicide-Glymax 48% SL (W/V) at 3.50 lt/ha active ingredient and untreated check. The application time was before the main crop was planted. The per treatment data were counted by randomly throwing the quadrant on dated 29/10/2011 E.C means one days before the treatment [Glpho and Glymax 48% SL (W/V)] herbicides spray. The post treatment data on weeds were collected 15 days after the treatment's application by throwing quadrant randomly to the plots. Finally, pre and post spray weed count data were subjected to efficacy calculation using formula of (Fleming and Retnakaran 1985) as below:

$$\% \text{ Efficacy} = [1- (Ta*Cb)/(Tb*Ca)] *100$$

Where,

Ta= Post-treatment population in treatmen.

Cb= Pre-treatment population in check.

Tb= Pre-treatment population in treatment.

Ca= Post-treatment population in check.

Data subject to excel analysis.

Table 1: Mean Efficacy of glyphosate 41% SL on weed before sorghum sowing 2019.

Treatment no	Products trade name	Common name	Pre-spray mean	Post spray	% efficacy	Yield (Q/ha)
1	Glpho	Glyphosate-isopropylammonium 41% SL	138	9	93.64	18.6
2	Glymax 48% SL (W/V)	Glyphosate 48% EC	122	22	82.00	17
3	Untreated Check	-	118	121	-	-

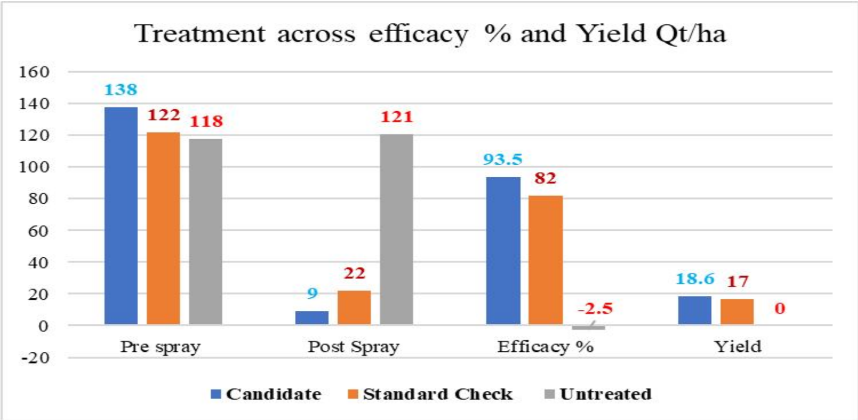

Fig 1: The candidate glyphosate non-selective herbicide glpho efficacy verification % on weed control in sorghum crop across the standard check and untreated Bar chart.

RESULTS AND DISCUSSION

The treatments received only one spray before sorghum crop sowing. Efficacy of the candidate herbicide Glpho (Glyphosate-isopropylammonium 41% SL) was showed an excellent performance in controlling weeds before sowing a Sorghum crop as a non-selective weed control. The candidate Glpho efficacy showed a higher percentage than the check Glymax 48% SL (W/V) efficacy were recorded 93.50% and 82.0% respectively (Table 1 and Fig 1).

In general, Glyphosate-isopropylammonium 41% SL showed excellent performance in controlling weed as Table 1. The differences in absorption and translocation of the herbicide are responsible for the fluctuation in glyphosate efficacy and the variations in glyphosate tolerance among weed species (D'Anieri *et al.,* 1990). Concerning formulation of glyphosate products, the responses of various weed species vary among the different formulations (Ilias *et al.,* 2017). The increased efficacy of Glyphosate-isopropylammonium 41% SL versus Glyphosate 48% EC on Sorghum weeds may be due to the greater rate of absorption and subsequent translocation of Glyphosate-isopropylammonium 41% SL.

CONCLUSION

The new product of herbicide, Glpho, shown better performance than the standard check Glymax 48% SL (W/V). Therefore, the new Glpho herbicide product could be suggested as an alternative non-selective herbicide to destroy the weeds in sorghum before sowing. However, further research needs to be done to determine the actual mechanism of Glpho for increasing efficacy.

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