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Effect of chemical weed control of soybean (*Glycine max* L.) field in Mongolia

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Abstract

Chemical control is currently the most widely used weed control for soybean crops, due to its ease of control and to the small areas planted in Mongolia. Forward (Quizalofop-ethyl 60g/l) herbicide in dose 1.0-1.2 l/ha and Gallantsuper (Haloxyfop-P-methyl 10.8%) in dose 0.45-0.65 l/ha applied in postemergence control of annual grasses and quackgrass became at 10 to 15 cm plant height. Cobra (lactofen 24%) herbicide in dose 0.45-0.55 l/ha applied in postemergence control of many broadleaf weeds, including Perennial Sowthisle (*Sonchus arvensis* L). The soybean fields 15 species of weeds belonging to 9 families, 12 genus including 62.5 % annual, 37.5% perennial weeds were identified. The major grassy weeds; Common millet (*Panicum miliaceum* L), Couch grass-(*Agropyron repens* L), Bristlegrass (*Seteria viridis* L) sp and broadleaved weeds Redroot Pigweed-(*Amaranthtus retroflexus* L), lambsguarters-(*Chenopodium album* L), Aristate Goosfoot-(*Chenopodium aristatum* L), Black bindweed-(*Polygonum convolvulus* L), Mallow weed (*Malva mochileviensis Down*), Field bindweed -(*Convolvulus arvensis* L), Bristhly thistle-(*Cirsium setosum* L), Dwarf bifurcate cinquefoil-(*Potentilla bifurca* L), Perennial Sowthisle-(*Sonchus arvensis* L) weeds were predominant in the field experimen . Forward herbicides were applied in doses of 1.0-1.2 l/ha have reduced the number of weeds by 86.8-91.6%, weight by 38.7-66.1% and Gallantsuper herbicides applied in doses of 0.45-0.65 l/ha have reduced the number of weeds by 91.0-95.0%, weight by 39.5-59.8% while Cobra herbicides applied in doses of 0.45-0.55l/ha used for broadleaf weed control, the number of weeds by 42.7-50.7% reduced.

Keywords: Forward, Gallantsuper, Cobra, weed density, weed control, yield.

Introduction

Soybeans are adaptable to many recipes, produce excellent oil and can be ground to make soy milk. Considering the growth in global population in recent years and human societies increasing need for oilseed product, correct agricultural management for increasing the yield is of significance Emam et al., [1]. It is an excellent health food containing 40 to 44% good quality protein, 20% cholesterol free oil, 20% carbohydrates and 0.69% phosphorus. It also fixes atmospheric nitrogen (45 to 60 kg ha^{-1}) through root nodules and adds about 0.5 to 1.5 ton organic matter per hectare through leaf fall Kanase et al., [2] In common with beans, soybean does not tolerate weed competition at early growth stages. Uncontrolled weeds not only reduce soybean yields through their competition for light, nutrients, and moisture, but they can also severely reduce harvest efficiency. Before implementing a weed management plan for soybeans, several factors need to be considered including weed species, rotational crops, and cost. Some weed seeds are also difficult to remove from harvested broadleaf weed seeds, reducing the quality of harvested seed. considering that Weeds are considered the number one problem in all major soybean producing countries. This crop is a large herbicide consumer, and almost 90% of the planted area in India is herbicide-treated. Thus, chemical weed control is necessary to decrease cost and to increase soybean productivity. Even with advanced technologies, producers note high losses due to interference by weeds. According to estimates, weeds, alone, considering that an average reduction of 37% on soybean yield, while other fungal diseases and

agricultural pests account for 22% of losses [3]. In the United States, it is considered that weeds cause losses of several millions of US dollars annually. In Brazil, with an average production of 75 million tons, it is estimated that expenses on weed control represent between 3% and 5% of total production cost, which means more than US$ 1.2 billion used in that country, only for weed chemical control in soybeans. Disregarding the high cost, weed might be controlled in soybean crop using good management practices of all available methods, combining them in an integrated weed management.

Reduction in soybean yield due to weed infestation varies from 27 to 77% Gogoi et al., [4], depending on type of weed, soil, seasons and weed infestation intensities. The grain yield reduction due to the weed infestation in soybean may be up to 31- 84 percent. Some have reported the yield decline as high as 84% Kachroo et al., [5]. Weed infestation removed 21.4 kg N and 3.1 kg P ha^{-1} in soybean Pandya et al., [6]. Hence, the following research was conducted to measure the appropriate amount of Gallantsuper, Cobra and Forward herbicides usage in soybean plants in Mongolian.

Soybean has an average protein content of 24- 28% and is more protein-rich than any of the common vegetable or animal food sources found in Mongolia. The soybean can take a good preceding crop in the agriculture rotation of our country and to enrich the soil. The crop can be successfully grown in Mongolia using low agricultural inputs. In common with beans, soybean does not tolerate weed competition at early growth stages. Uncontrolled weeds not only reduce soybean yields through their competition for light, nutrients, and moisture, but they can also severely reduce harvest efficiency. Before implementing a weed management plan for soybeans, several factors need to be considered including weed species, rotational crops, and cost. The advantages of herbicide use are high efficiency in weed control, the presence of selective products soybean at the lowest cost, compared to other available weed control methods.

Materials and Methods

A field experiment was conducted at the research farm (49°48‟ N latitude longitude and located at 665m above mean sea level) of Plant Protection Research Institute, Mongolian University of Life Sciences.

The field experiment was conducted on May 10, 2010 and September 30, 2012. The randomized block design with nine treatments and replications was three. The climate condition of the study area is warm-moderate dry. The mean temperature were 15.60C and 16.00C and rainfall 283.2 mm during of the growing season (May to September). In the study years, the mean temperature for the growing season was 16.70C, 15.6 0C and 16.0 0C and rainfall 202.1 mm, 283.2 mm and 195.7mm, respectively. The soil had a sandy-loam texture with a pH from 6.5 to 7.0. Herbicde applications were made to 2-3 trifoliate leaf soybeans with a CO2 –pressurized backpack sprayer calibrated to deliver 200 L ha-1 of spray solution at a pressure of 200/240 kPa using low drift nozzles.

We determined the weed species composition and density in soybean field (N.N. Libershtein and A.M. Tulikov, 1980). Counting of weeds conducted at two locations within each plot, using a 0.5 yard2 quadrant [7].

- Sampling was done randomly, by systematic method according to pattern by 0.5X0.5 quadratic square meter and density, percentage of abundance and weeds uniformity were determined by separating genus and species.
- The weeds in every frame were conducted weed density count and classified into biological groups. Before and after spaying the herbicides (7, 14 and 21 days) the $1m^2$ area selected from each experimental plot in four replications to establish weed density and mass during tillering stage of soybean.
- Data on weeds was recorded 14, 21 and 30 DAS in each plot in quadrates, each measuring 50x50cm. Weeds were counted species-genus and were removed for recording their total dry weight.
- Weed density counting per square meter carried out by randomly placing two $1m^2$ quadrants in the middle five rows of each plot. Soybean yields were taken at maturity.
- Crop yields and relative yields were subjected to an overall ANOVA using PROC MIXED in SAS [16,18]. Relative yield of each experimental plot was calculated as a percent of the corresponding weed-free yield for each level of main factor.

Herbicide definition used for experiment

Cobra herbicide

Lactofen is a member of the diphenyl ether chemical family. It is available in the technical solid form or as an emulsifiable concentrate. It is applied as a foliar spray on target weeds. It is commonly used to control broadleaf weeds in soybeans, cereal crops, potatoes and peanuts.

Chemical Name: ethyl O{5-(2-chloro-a,a,a-trifluoro-p-toluoxy)-2-nitrobenzoyl}-DL-lactate **CAS:** 77501-63-4
Molecular Weight: 461.78
Molecular Formula: $C_{19}H_{15}ClF_3NO_7$
Water solubility: 0.1 mg/L @ 20 degrees C
Melting Point: 43.9 - 45.5 degrees C
Vapor Pressure: 1.1 x 10 to the minus 3 mPa@25 degrees C

Gallant super herbicide

Haloxyfop-P methyl (10.8 % EC) herbicide formulations are sold primarily under the tradename Gallantsuper herbicides. Haloxyfop-P methyl is a white crystalline solid, but is normally formulated as a water-dispersible, emusifiable concentrate. The formulated products are yellow-to-brown liquids that contain 10 to 48% active ingredient, with the balance petroleum solvents and stabilizers. Haloxyfop -P methyl is an herbicide used for selective control of grass weeds in crop and non-crop situations.

Chemical Name: methyl (R)-(+)-2-[4-[[3-chloro-5-(trifluoromethyl)-2 pyridinyl]oxy]phenoxy]propanoate
CAS: [72619-32-0]
Molecular Weight: 375.7
Molecular Formula: $C_{16}H_{13}ClF_3NO_4$
Water solubility: 9.08 mg/l (25 ºC)
Melting Point: 56-58 degrees C
Vapor Pressure: 1.1 ×10-3 Pa m3 mol-1 (20 °C, calc.)

Forward herbicide

Common name is Quizalofop-p-ethyl. Biochemistry Acetyl CoA carboxylase inhibitor; inhibition of fatty acid biosynthesis. Mode of action Systemic herbicide, absorbed from the leaf surface, with translocation throughout the plant, moving in both the xylem and phloem, and accumulating in the meristematic tissue. Uses Selective post-emergence control of annual and perennial grass weeds in potatoes, soyabeans, sugar beet, peanuts, oilseed rape, sunflowers, vegetables, cotton, and flax.

Chemical Name: ethyl (R)-2-[4-(6-chloroquinoxalin-2-yloxy)phenoxy]propionate **CAS:** 100646-51-3

Molecular Weight: 372.8
Molecular formula: $C_{19}H_{17}CIN_2O_4$

Water solubility: 0,4 мг,61/дмг/л (при 20°C)
Melting Point: 76-77 degrees C
Vapor Pressure: 0,011 мПа

Results and Discussion

The study years in 2009 to 2012, of the 15 species of weeds belonging to 9 families, 12 genus including 63.6 % annual, 9.1% biennial, 27.3% perennial weeds have been occurred during the soybean growing period.

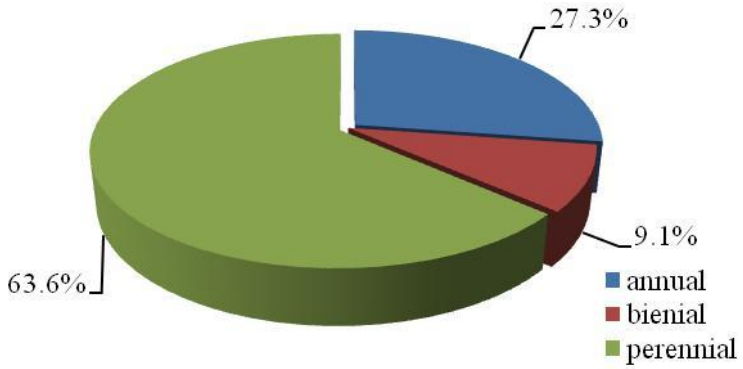

Figure 1. The ratio of weed group spread in the experimental fields (%).

The total combined density of weed species, ranged from 163-389 weeds per square meter, in the experimental–production field at Orkhon sum, Darhan-Uul province. The major grassy weeds; Common millet- (*Panicum miliaceum* L*)*, Couch grass- (*Agropyron repens* L*)*, Bristlegrass-(*Seteria viridis* L) sp and broadleaf weeds Redroot Pigweed-(*Amaranthtus retroflexus* L), lambsguarters-(*Chenopodium album* L), Aristate Goosfoot-(*Chenopodium aristatum* L), Black bindweed-(*Polygonum convolvulus* L), Mallow weed- (*Malva mochileviensis* Down), Field bindweed - (*Convolvulus arvensis* L), Bristhly thistle-(*Cirsium setosum* L), Dwarf bifurcate cinquefoil-(*Potentilla bifurca* L), Perennial Sowthisle-(*Sonchus arvensis* L) weeds have been distributed in the soybean field.

Herbicide rates and timing for foliar treatments selected very much dependent on weed size. Early application, when weeds are young, may allow the use of lower herbicide rates. Hot, humid weather, active growth at application, and the addition of surfactants or oil concentrates increase both herbicidal effectiveness and the possibility of soybean injury.

Soybean beyond the third trifoliate leaf stage may interfere with the spray pattern and reduce the weed coverage. Apply to annual broadleaf weeds in the 2 to 4 inch stage. Very susceptible weeds such as common lambsquarters and pigweeds will turn yellow in 3 to 5 days, growth stops and they die within 7 to 21 days. Other grasses weeds will remain green but stunted.

In soybean field the Forward herbicides were applied at 1.0-1.2 l/ha have reduced the number of weeds by 86.8-91.6%, weight by 38.7-66.1% and Gallantsuper herbicides applied at 0.45-0.65 l/ha have reduced the number of weeds by 91.0-95.0%, weight by 39.5-59.8%. These effects of quizalofop for controlling weeds in soybean are in evaluation with the earlier results reported by Pandey *et al.*, [8]. Treatment Imazethapyr 0.100 kg a.i./ha + Quizalofop ethyl @ 0.075 kg a.i/ha as PoE was found to be superior for controlling monocot and dicot weeds in soybean which recorded lowest weed count of these weeds but the lowest weed dry matter, weed index and highest weed control efficiency was found in Imazethapyr @ 0.100 kg a.i./ha + Quizalofop ethyl @ 0.075 kg a.i/ha as PoE [9]. The Cobra herbicides applied at 0.45-0.55 l/ha used in for broadleaf weed control, have reduced the number of weeds by 90.2-94.6% and weight by 42.7-50.7%. Our research results have agreeable with other researchers. Chemical weed control with reduced doses were highly effective on weed population

density and soybean yield, depending on herbicide type. All herbicide treatments were; however, equally effective on grassy weeds and recorded significantly lower dry weight compared to control (weed check) Similar to other studies (Malik *et al*.., [10] and Pandey et al.,), in our trials, the best efficacy of total weed biomass control was obtained by Forward compared to other herbicides. In soybean grain yield vary in each experimental field depending of the herbicide type and rate where herbicide Gallantsuper with doses of 0.45-0.65 l/ha have average yield of 0.81-1.32 t/ha and Forward herbicide with doses of 1.0-1.2 l/ha have yield of 1.1-1.34 t/ha, while 0.45-0.55 l/ha dose of Cobra herbicide were giving 0.69-1.07t/ha yield /table 2/. All the herbicides gave significantly higher grain yield compared to control.

Table I. Effect of the herbicides applied against weeds in soybean (2010-2012)

No.	Variant of herbicides	Herbicide rates, (l/ha)	Herbicide to spray		Weed density, (weeds/m^2)	Weed control efficiency, (%)	Compared to control	
			before in weeds/m^2	after in weeds/m^2			weed dry weigh, (g/m^2)	percent, (%)
1.	Control	0	192.5	389.0	-	-	299.5	-
2.	Gallant super, 10.8%	0.45	177.3	16.0	161.3	91.0	120.1	59.8
		0.55	193.3	11.0	182.3	94.3	172.6	42.3
		0.65	204.0	10.3.0	193.7	95.0	181.0	39.5
3.	Forward 60g/l	0.9	167.0	22.0	145.0	86.8	183.0	38.7
		1.0	197.6	15.0	164.6	91.6	121.2	59.5
		1.2	163.0	16.0	147.0	90.1	101.4	66.1
4.	Cobra 24%	0.45	164.0	16.0	148.0	90.2	171.5	42.7
		0.50	185.0	12.6.0	172.4	93.1	165.3	44.8
		0.55	159.0	8.0	142.0	94.6	147.5	50.7

Table II. Effect of herbicides to soybean yield.

No	Variation	Herbicide rates, l/ha	1000 seed weight, (g)	Soybean yield, t/ha		
				2010	2011	2012
1.	Control	Not herbicide	121.0	0.32	0.33	0.34
2.	Forward	1.0	145.6	1.26	1.10	1.34
		1.2	150.0	1.16	1.18	1.21
3.	Cobra	0.45	132.0	0.70	0.53	0.84
		0.50	140.1	1.01	0.67	0.92
		0.55	139.4	0.68	0.58	1.07
4.	Gallantsuper	0.45	136.0	0.81	1.17	0.86
		0.55	144.1	1.23	0.81	1.03
		0.65	155.6	1.32	1.05	1.26
				Sx=sqrt(S2/n)		1.05
				Sd=sqrt(2*s2/n)		1.48
				HCP0.5=T0.5 * Sd		3.15

Gallantsuper at 0.45 to 0.65 l/ha and Forward at 1.0 to 1.2 l/ha produced similar but significantly higher grain yield compared to spray of Cobra at 0.45 to 0.55 l/ha. In all studied experiment trials there was obtained a significant yield increase. The results corroborate the findings of Vyas et al. (2000) and Pandya et al. (2005) and manly others researcher for report enhanced soybean yield due to various weed control treatments. Weedy check produced lowest yield of soybean which was significantly inferior to different weed control treatments. Increased number of branches as a result of chemical and hand weeding methods has also been reported by Kushwah and Vyas [11]. Various yield components were markedly influenced by different weed control measures. Of the yield soybean following factors are direct dependent in present year total seasonal time of applied herbicide, soil fertile, distribute on of precipitation, active heat amounts. The improvement in yield and economical parameters which resulted from better weed control with different weed management practices in soybean was also earlier reported by Sharma [12] and Raskar and Bhoi [13].

Table III. Chemical component of the soybean grain /percentage in dry mass/

Indicator / Variant of herbicides	Humidity, (%)	Protein, (%)	Crude fat, (%)	Crude fiber, (%)	Ash, (%)	Sw/oN, (%)
Control	9.25	30.0	16.9	18.93	5.31	29.6
Gallantsuper	9.1	29.9	18.3	15.69	6.03	30.98
Cobra	10.6	34.0	12.9	11.65	6.32	34.6
Forward	12.1	31.5	15.4	13.26	5.83	32.0

Biochemistry analysis for soybean seed showed that fat content in seed were 12.9-18.3%, protein content were 29.9-31.5% and in green mass fat content were 12.1-12.6%, protein content 11.9-15.9% when tested in laboratory. Increased oil content in soybean under weed control treatments has also been reported by Mohamed 2004 and EL-Metwally and Shalby 2007. In conclusion, the seed rate and weed density significantly influenced the plant growth and yield parameter.

Conclusion

Soybean yields were increased by herbicides applications made prior to the second trifoliate stage of plants. Gallantsuper at 0.65 l/ha integrated the most appropriate method for effective weed management and profitable cultivation of soybean. Other methods are either less profit earners or are labour expensive. All land managers, communities, research institutions, and all levels of government have a role in the early detection and eradication of weeds. In this case, soybean producers must use all available technologies, considering both socioeconomic and environmental efficiency. Furthermore, the authors propose that the costs of control and the amount received by the commercialization of grains should be used as criteria for defining the interference periods of the weed.

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Author's introduction

Ariunaa Ochir was born in Binder sum of Khentii province in 1975. She graduated the University of Agriculture in 1999 as "Plant Scientist" and The Intitute of Finance and Economics in 2008 as in Accounting bachelor of Business Administration. In 2001 she took master's degree in of Science to thesis "Study of biology-ecology and damages caused by some weeds on potato plants" and doctor degree in Agricultural thesis "Effect of major weed controlled in soybean (*Glycine hispida* Max L.) field in 2014". Since 1999 she has been working of the ''Weed Research Laboratory'' in Plant Protection Research Institute as a research worker.

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