A REVIEW ON WEEDS AND WEED CONTROL IN OIL CROPS WITH SPECIAL REFERENCE TO SOYBEANS (*Glycine max L.*) IN KENYA

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Abstract

A general overview of weeds and their effects on oil crops is discussed. Common weeds of soybeans, their effects and control measures have been discussed in detail. Knowledge gaps have been identified and what needs to be addressed is suggested.

Key words: weed control, oil crops, soybeans, Kenya.

INTRODUCTION

Oil crops are grown all over the world and in many economies; they play a crucial role in the agricultural sector. There are three groups of oil crops: Annuals which include soybean (*Glycine max*), sunflower (*Helianthus annus*), rapeseed (*Brassica napus*), groundnuts (*Arachis hypogea*), sesame (*Sesamum indicum*) and safflower (*Carthamus tinctorius*); Perennials: include oil palms (*Elaesis quanensis*), coconut (*Cocos nucifera*) and olives (*Olea europaea*) and by product crops like cotton and corn (Americanos, 1994).

Among seed oils, soybeans has had an extra-ordinary growth due to rising consumption of livestock products and concurrent rapid growth in meal demand; as well as the fact that it is a cheap source of proteins especially in developing nations. Soybeans account for more than 50% of the world oilseed output (Joshi, 2001).

Generally, oil crops are tropical crops. Annual oil crops like sunflower, soybeans and groundnuts appear to do well in almost the same altitudes, 0-2740 m.a.s.l. According to Joshi (2001) many of the world's worst weeds in the zone 30 degrees North and South of the equator infest oil crops.

Kenya relies heavily on imported vegetables oils and fats, making them the largest item on the country's import bill. In 1991, continuous oil and fat required was estimated at 270,000 metric tons and only 15,000 metric tones were produced locally. As such soybean as an up coming crop is hoped to contribute to reduced imports. The major soybean producing areas in Kenya are the western districts. However, they are grown country wide; and areas include Nyanza, Kisii, Kitale, Nakuru, Tran-zoia, Uasin-ngishu and Baringo (Wasike, 1997).

Effect of weeds on oil-crops

Significant yield loss in oilcrops is mainly due to competition, allelopathic effects of weeds, and contamination of harvested products. Competition is defined as that condition that exists when requirements of one or more organisms living in a community cannot be obtained from the available resources. According to Cheema and Khaliq (2000) allelopathy is the direct or indirect harmful effect by one plant on another, through production of compounds that escape into the environment. This concept is of significant importance especially with respect to losses in crop yield due to presence of weeds.

Competition between oil crops and weeds vary with species involved. Daugovish *et. al.* (2003) found that full competition from weeds reduced the yield of sunflower (*Helianthus annuus*) by 58%. According to Americanos (1994) and Musambasi *et. al.* (2002) groundnut crop (*Arachis - hypogea*) is highly sensitive to competition and yield reduction due to weeds can be severe, reaching up to 70%; where as weed competition with rape-seed (*Brassica napus*), can reduce yield up to 50%.

Annual oil-crops and young trees are more sensitive to competition from weeds. Weed competition is greatest early in the crops life, because weeds have a tendency of out growing the crop if they are not controlled early in the growth period. For example in trials carried out in Senegal and Mali, weed competition reduced yield of groundnuts pods by 20% and fodder by 30% when weeding was delayed for 21 days. When weeding was delayed for 35 days, output fodder was reduced by 43%. Apart from reduction in crop yield, weeds reduce both the quantity and quality of harvested products, increase incidence of diseases and insects; and frequently hamper efficient use of equipment (Americanos, 1994).

Effects of weeds on soybean Production

Soybean (*Glycine max*) is an important food crop for human consumption whose yield is up to 80% is lost due to weed competition in many parts of the world (Daugovish *et. al.*, 2003). Jannink *et. al.* (2000) reported that root and shoot interference is the main factors that cause soybean yield reduction. Weeds that germinated at the same time as soybeans grow faster and maintain a canopy above and below the top of the soybean canopy. Therefore they intercept photosynthetically active radiation (PAR) at the expense of soybeans. This results to elongation of soybean stems with a decrease in diameter, causing lodging.

Soybean are not strong competitors in the early part of the season, therefore weeds out grow them. If the crop is not kept weed free, light competition takes place after 4 weeks when the weed grow taller than soy beans and intercept photosynthetically active radiation PAR (Jannink *et. al.,* 2000). Where weed density of common cocklebur (*Xanthium pensylvanicum*), velvet leaf (*Abutilon theophrasti*) or jimson weed (*Datura stramonium*) exceeded 1-2 plants/m^2, a full canopy over soybean formed which intercepted 44-56% of the photosynthetic active radiation, and yield reductions varied from 18-80%. Sink strength (rate of change in weight of substance for a plant part) is profoundly affected by the shading effect of weeds in soybean (Bradley, *et al.* 2002). Shading flower and pods promotes abscission and reduces strength and intensity of young reproductive sinks. However, the precise relationship between sink strength and abscission remains unresolved. Failure of fertilization play a negligent role in soybean floral abscission (abscised flowers were fertilized) and cessation of development at this stage could be attributed to reduced level of cell division mediating factors or increased level of inhibiting hormones or both.

Heavy infestation of weeds in soybean greatly interferes with timeliness and efficiency of harvest. Weeds in the field at harvest also result in reduced grades (quality). Chivinge (1995), found that common cocklebeur (*Xanthium pensylvanicum*) can result into foreign matter content of up to 5.1% in harvested soybeans. 70% control of common cocklebur is required to keep seeds moisture levels from exceeding 13%. In the absence of control, a grade of 3.9 results as compared to grade 1.3 for adequate control. Weeds also have effect on the use of fertilizer because they compete with the crop for nutrients. Fertilizers encourage weeds growth therefore they should not be applied until the first weeding has been done. This means delaying application of the fertilizer to the crop for a month or so, hence reducing its effectiveness. However, the addition of fertilizer to the soybean crop increases yield as compared to unfertilized crops.

There is a possibility of allelopathic interference of some weeds like velvet leaf (*Abutilon theophrasti*) on soybean by means of reproductive organ abortion, water relation's interference or both. This was observed where soybean plants were stressed when in close proximity of velvet leaf. Yellow nutsedge (*Cyperus esculentus*) has also been found to have allephathic effects on soybeans. Concentrations of 0.125% (W/W) yellow nutsedge tuber residues reduced the dry weight of soybean roots by 61% (Drost and Doll, 1980).

The role of weeds as alternate hosts for soybean crop pests and disease and their interference with cultivation operations resulting into higher costs of production must not be over looked. Bare soil which result when chemical control is successful may lead to soil erosion and potential for re-infestation. However, the extent of damage is determined by the time of weed removal from the crop and the extent of removal. All season presence of weeds cause yield losses regardless of weed type; but when weed presence is compounded by other stresses, the extent of yield loss varies. When moisture is limiting weeds presence for a short time as 2 weeks results in yield loss but when moisture is not limiting competing for up to 4 weeks can take place without any yield reductions.

Weeds of soybean

Many weed species infest soybean but the extent of damage on the soybean crop varies with the weed species involved. According to Joshi (2001), common cocklebur (*Xanthium pensylvanicum*) ranks as the most detrimental weed in soybeans. He reports that one *Xanthium pensylvanicum* per 30.5cm of row reduced soybean dry matter production by 59% and seed yield by 87%. Total loss occurred with 2 weeds per 30.5cm of row.

Grasses and sedges

Generally, perennial grasses are the most problematic weeds of soybeans. They cause significant damage and are difficult to control. Such weeds include common cocklebur (*Xanthium pensylvanicum*), giant foxtail (*Setaria faberii*), sword grass (*Imperator cylindrica*), Johnson's grass (*Sorghum halepense*) and Couch grass (*Cynodon dactylon*) (Daugovish *et. al*., 2003). They form extensive underground vegetative system which make them hard to control. Sedges (*Cyperus rotundus*) and (*C. esculentus*) are also difficult to control, yet cause a lot of damage to soybeans. Apart from competition of moisture, carbondioxide, light and nutrient; they have allelopathic effects on soybeans (Drost and Doll, 1980; Jannink *et. al*., 2000). Perennial weeds usually have the ability for vegetative reproduction from underground parts. These are also organs for growth after cutting and they are storage organs for food reserves. They therefore require deep cultivation which brings the underground propagules to the surface and expose them to desiccation by the sun and wind ((Drost and Doll, 1980).

Broad leafed weeds

Broad-leafed weeds are not as detrimental as the grasses and sedge in soybean production. However, they cause some damage and should not be over looked. Some produce many seeds making then difficult to control e.g. lamb squatters (*Chenopodium album*). Other serious broad-leafed weeds common in soybean fields include spiny Amaranth (*Amaranthus spinosus*) and morning glory (*Convolvulus arvensis*). Annual weeds can be dealt with by repeated shallow cultivation. Common weeds worldwide have been given by Joshi (2001). Table one shows some of the common weeds in soybean production system.

WEED CONTROL

In order to increase production in oil crops and specifically soybean, effective weed control measures must be taken. Soybean usually develop a full canopy cover at 8 weeks after emergence and can then compete with weeds up to maturity. Little or no reduction in yield occurs if soybean are kept weed free for the first 4 weeks this is the critical period for weed competition in soy beans (Jannink *et. al*., 2000). However, up to 50% yield loss could occur in comparison to control.

Cultural weed control

Vigorous seed is a good contributor to weed control especially if planted in a well prepared seed bed; and at a uniform depth. A vigorous uniform stand of seedling will most likely emerge which help shade out the early and late season weeds. Some herbicides may depress soybean growth early in the season but vigorous seedlings are most likely to outgrow this effects, (Daugovish *et. al.*, 2003). Since soybean are weak competitors during the early growth stages; early season control is very important. Soybeans maintained weed free for 4 weeks after planting allowed them to compete effectively with *Sorghum bicolor*. Delaying weeding in groundnut up to 35 days after panting (DAP) reduces crop output by 33% and fodder by 43% (Coste, 1991). Placement of fertilizer in the crop row gives the crop a competitive advantage over weeds in the inter-crops gain more from the fertilizer then the weeds between the rows.

Soybean should be grown as apart of rotation in which crops and cultivation are selected to minimize the weed problems progressively. Rotation of crops with different production requirements keeps down weed growth by preventing a build up of weeds ecologically adapted to one crop. Rotating crops means rotating herbicides. This enables growers to match herbicides to a specific weed problem. For example, one way to reduce cocklebur and morning glory problem is to plant the field to corn using post emergence 2,4-D spray. Soybean can be planted the next year with less cocklebur or morning glory problems (Drost and Doll, 1980).

Plant densities have an effect on weeds. Studies by Zimdahl, (1980) on variable plant population influence on competitive relation show that soybean stand with fewer plants e.g. 9-11 plants/feet of row yield less and permit increase weed growth. When soybean are reduced to 3 plants/feet of row, weeds caused yield production increase to more than 10 fold. This implies that soybean should be planted in as narrow a row as possible. Weed control by mulching appear to have considerable potential, provided that residues from previous crops are used in the same field; transportation from another area can add considerably to the cost of growing the crop.

Mechanical weed control.

Proper tillage system are the first operational pre-requisite in reducing weed problem. Primary tillage operations which bury as great a proportion of weeds at lower depths in the soil as possible can reduce the total weed population which will germinate. Ahmad-Zamri (2002) noted that the rotary hoe and cultivator can be valuable implements for weed control in soybean production if operated properly. He points out that 70% weed control can be achieved by rotary hoeing until weeds are 1-3 leaf stage. Harrowing before planting can also help reduce weed effect in soybean. Disking kills the crop weeds that are growing, but it also brings weed seed to the surface. It is recommended that perennial should be allowed to grow one or two weeks before disking.

Hand weeding in soybean has been recommended where herbicides cannot be used especially in small scale production (Wasike, 1997). Soybean can be hand weeded 2-3 times to achieve adequate control. For coconut and oil palms, weeding a circular area around the base of each tree as well as inter-row maintenance have been recommended. The first operation is intended to keep the young trees clear of plants, which would compete with it. This is mainly because the space it needs during the first two years is relatively restricted. The second operation (inter-row) is intended to assist in he establishment of the cover crop and creation of a sward which will prevent any weed growth (Coste, 1991: Chivinge, 1995). Slashing has also been recommended for perennial oil crops.

Chemical weed control

Herbicides offer an additional tool to a farmer in controlling weeds. Selective herbicides can control all weeds. Therefore a farmer must know predominant weed species in his field so as to make choice of the herbicides he will use. Special sprays as indicated by Bastiani *et. al*. (2000) may be necessary to control the most serious weed problems i.e. cocklebur, morning glory, sickle pod. Herbicides must be applied within narrow range of rates - if too low, therefore will be inadequate control, and too high will kill the seedlings. Disking too deep when inter cropping pre-plant in cooperated herbicides can increase plant damage, and too high will kill the seedling at too great a depth. Residues from application of herbicides to previous crops can cause soybean production problems e.g. atrazine applied to a previous corn crop can reduce soybean stand and yield. Some herbicides such as metribuzin and bentazon have proved effective in the temperate regions but in the tropics either give poor weed control at rates recommended or cause phytotoxicity. Herbicides must be tested under tropical conditions before being recommended to farmers in this area.

Herbicides that can be used in soybean growing, include preplant incorporated herbicides e.g. trifluralin and metribuzin; pre-emergence herbicides e.g. alachlor and linuron; post - emergence herbicides e.g. paraquat, 2,4-D and dinoseb while directed post-emergence herbicides e.g. 2,4-D and dinoseb. They can be translocated, contact, soil acting or foliage acting herbicides. Translocated herbicides are readily absorbed by leaves and transported in the symplast; hence effectiveness in controlling perennial weeds and killing underground buds as well as apical meristems. Contact herbicides, are not translocated, hence weeds readily regenerate and can only achieve better control for broad-leaved annual weeds unlike perennial weeds.

Some herbicides recommended for weed control in soybean in Kenya by Wasike (1997) are; Sencor: a post emergence herbicides for control of grassy weeds and broad leafed weeds; Basagran: a post emergence against broad-leaved weeds; Flex and Fusilade a combination of a grass and broad leafed herbicides for control of grassy and broad leafed weeds. Herbicides that have been recommended for soybean and other oil crop in East Africa as given by Joshi (2001) are given in Tab. 2.

Biological weed control

Involve suppressing of weed by insects, plants and micro organism. Use of plant pathogens to control weeds in soybean has been highly successful in temperate agriculture (Bulher, 1992). The fungus *Colletotricum gloesproides* f. Sp. *Aeschnomene* {CGA} controls the northern joint vetch {*Aeschinomene virginica*} in rice and soybean. It can be tank mixed with acifluofen to control *Sesbania exaltata*. *Altanaria cassicae* has been reported to control sickle pod in soybean. Some soybean cultivators have allelopathic effects that allow them to compete well with weeds e.g. sickle pod and velvetleaf.

Living and dead mulch is a promising means of biological control in developing countries. In comparison to system land management, living mulch reduce weed problems. While dead mulch e.g. *Mucuna pruriens* var *Utilis* minimizes herbicide in put in soybean production. A combination made by bacteria *Rhizobium japonicum* kills several weed species in soybeans.

Integrated weed management/control

This involves combing two or more weed control measures to increase effectiveness and efficiency. However intensively a soil is ploughed or worked weeds emerge and compete with crops. Therefore, combining weed control method can help keep weed damage before economic threshold levels. Research done by Buhler, (1992) show that rotary hoeing followed by cultivation resulted in higher soybean yield than cultivation alone. He found that combining herbicides often give better results for better weed control as compared to non combined herbicides. In the study pre emergence treated plots were 98% weed free early in the season, but weeds emerged later and reduced yield, hence the need to combine. The care taken that weeds do not need to go to seed, that harvesting equipment is not transporting weed seeds, and that clean seed is used for all crops in the rotation; is an integral part of a weed program.

CONCLUSIONS

Weed interference in oil crops and specifically soybeans causes significant yield reductions. The mechanism of competition vary, but some significant aspects include allelophathy and shading. Duration of weeds in the field also affect yield as do damage thresholds; which vary from one weed to another. To avert economic losses therefore, weed control should be affected early in the growth period, especially the first four weeks; which is the critical period of competition in soybeans. However, its evident that competition *per se* is not the prime factor that causes yield loss; but compounds variations which might have been there during seedling emergence and establishment, like moisture stress. In such cases land use methods that minimize erosion and loss of organic matter are essential, and for success rely heavily on improved weed control.

Soybeans, not being a priority crop in Kenya is planted late, inadequately weeded hence low yields. At present most farmers use hand hoes and land preparation and weeding are expensive, tedious and time consuming. The rising cost of fuel and agricultural implements make mechanical cultivation unpopular. Improved weed control therefore through reduced tillage would enable farmers to cultivate additional crops like soybeans at low costs while increasing yields.

Some herbicides are phytotoxic to soybean, and the fact that they are expensive; results to limited use by small scale farmers. Research should focus more on developing resistant soybean varieties to herbicides. Currently, nothing has been done in Kenya on this area; and what has been done else where especially in the US may not yield the same results due to he diversity in geographical positions. Consequently, soybean production should be promoted extensively throughout the country as this would go a long way in reducing the country's expenditure on importing consumed oil products; especially so, through the agriculture extension system and the media.

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Tab. 1.: Common weeds of soybean

Broad leafed-weeds	Grass weeds and sedges	Grass weeds and sedges
Chenopodium album	**Perennial**	**Annuals** (continued)
Convolvulus avensis	*Cyperus rotundus*	*Echinochloa colona*
Abutilon theoprasti	*Cyperus esculentus*	*Eleusine indica*
Amaranthus spinosus	*Imperata cylindrica*	*Rottboela exaltata*
Amaranthus hybridus	*Xanthium pensylvanicum*	*Rottboella cochnichinesis*
A. tuberculatus	*Cynodon dactylon*	*Eleusine africana*
Protolactus oleracea	*Pennisetum clandestinum*	*Digitaria spp*
Solanum nigrum	**Annuals**	
Bidens pilosa	*Setaria virids*	
Baltimora recta	*Setaria faberii*	
Parthenium hysterophonus	*Setaria veticillata*	
Melampodium diranicatum	*Centhrus spp*	
Tridax procumbuens	*Sida spinosa*	

Tab. 2.: Common herbicides for control of weeds in soybean and other oil crops

Crop	Herbicide	Dose Kg a.i/ha	Treatment	Type of weed
SOYBEAN	Trifluralin	1.0-1.5	PPL	Annual Weeds
	Pendimethalin	1.01-32	Pre	Annual grasses
	Metachlor	2.0-2.5	PPL	Annual Weeds & Sedges
	Vernolate	.2.9-3.6	PPL	Annuals & Sadges
	EPTC	3.6-4.8	PPL	Broadleaved
	Linuron	0.5-1.0	Pre	Annual grasses
	Metropromuron	0.75-1.0	Post	Annual grasses
	imazaquin	0.07-0.20	Pre/Post	Annual grasses
	imazethpyr	0.70-0.10	Pre/Post	Broadleaved
COCONUT+	Diuron	2-3	Pre	broadleaved/ Annual grasses
OILPALMS	Glyphosate	1.5-3.0	Post	broadspectrum
	Imazapyr	0.38-0.56	Post	Grasses, broadleaved
OLIVES	Diuron	1.0-1.24	Pre	Annual grasses,
	Simazine	+0.48-0.6	Pre	Broadleaved
	Diquat	0.2+0.2	Post	Broadspectrum
GROUNDNUT & SESAME	Alachlor	2.0-3.0	Pre	Annual grass, broadleaved
	Pendimethalin	1.0-3.0	Pre	Annual grasses
RAPE. SEED	Alachlor	1.0-1.5	Pre	Annual grasses, broadleaved
	Metachlor	1.25-1.75	Pre Post	Annual & sedges
SUNFLOWER	Alachlor	1.75-2.5	Pre	Annual grasses broadleaved
	Chloramben	2.0-3.0	Pre	Annual grasses broadleaved
	Butachlor	1.0-1.5	PPL	Annual grasses

Source Joshi (2001)