

Weed management

in conservation agriculture based soybean-wheat cropping system

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Conservation agriculture (CA) is an eco-friendly approach of farming that emphasizes minimal soil disturbance, diversified crop rotations, and surface crop residue retention. CA systems are frequently associated with weed infestations and shifts in weed communities, sometimes with the problem of more difficult to control species. Hence, weed control is the most difficult management issue in CA, since some control options such as bush burning and 'unrestricted' tillage are not possible options. Therefore, successful weed control in conservation agriculture is utmost important factor for enhanced soybean and wheat productivity in soybean-wheat cropping system. Weeds compete with crop for light, moisture and nutrients, with early-season competition being the most critical. Weeds account for about one third of total losses caused by all pests. For realizing full genetic yield potential of the crops, the proper weed control is one of the essential ingredients. Therefore, effort has to be made to develop important weed control strategies in soybean-wheat cropping system under conservation agriculture ecosystem.

Keywords: Conservation agriculture, Oilseed, Weed control, Wheat

SOYBEAN (*Glycine max* (L.) Merrill) is the leading oilseed crop of India and the world. It is a protein-rich food (42%) which may help in alleviating malnutrition of Indian population and occupies the premier position in the country. Soybean is mostly grown on vertisols and its associated soils in the country. Being a rainy season crop, it faces severe weed competition during early stages of crop growth (20-45 days after sowing, DAS) due to slow initial growth rate of soybean provides congenial atmosphere for profuse growth of weeds. Scarcity of labourers and the heavy rains during critical period restrict to carry out the manual or mechanical weed control in time, further, the continuous drizzling allows weeds to come in several flushes resulting in a loss of about 35 to 75% of the potential yield. Wheat is one of the

predominant staple foods and a main cereal crop of the country after rice and accounts for 36% food grain production in India. Growing of high yielding, short stature, input responsive cultivars with less weed competitive nature have provided the conducive environment for increased weed infestation in wheat. Wheat crop requires a weed-free period of initial 45 days. The average yield losses due to weeds in different wheat growing zones range from 20-30%. The yield losses due to weeds depends on weed species and density, management practices and environmental factors. Both the crops constitute the most dominant cropping system of the central India.

Weed problems in conservation agriculture based soybean-wheat system

Among all 30 major cropping systems of the country, soybean-

wheat has emerged as an important cropping system only after 1980 with the introduction of soybean as a *kharif* crop in wheat growing areas of central India, and is being currently practiced in 4.5 mha. In recent years, serious concerns have been raised on yield decline in soybean-wheat cropping systems in central India due to several biotic and abiotic stresses among them biotic stress like weeds, insect pests and diseases are the major concern. However, in conservation agriculture ecosystem, weed control is a challenging task as indicated by several scientific studies the minimum and no-tillage induce shifts in weed population particularly towards perennial weeds, thus creating a long-lasting weed problem. No-till increased the number of annual weeds as a result of the accumulation of weed seeds on the soil surface at initial years. Whereas,



Commonly observed weeds in soybean under CA-based soybean-wheat cropping system

reduced tillage alters weed species distribution, densities and composition. In general, small-seeded weeds that require light to break dormancy will likely become the dominant weed species in minimum and no-tillage systems, including in the first years of adoption of CA. Thus, effective weed management is considered a critical issue and determines success in minimum and no-tillage based CA systems.

Major weeds associated with soybean-wheat system under CA ecosystem

The major weeds which are associated with soybean and wheat in

a cropping system under CA practices varied with location. However, some of the common weeds which are found in soybean and wheat throughout India are published by Directorate of Weed Research (DWR), Jabalpur, in Weed Atlas and a Handbook on weed identification. Some other weeds observed in both crops are listed in Table 1.

Weed management options under CA based soybean-wheat system

In conventional agriculture, practice farmers usually go for primary or secondary tillage

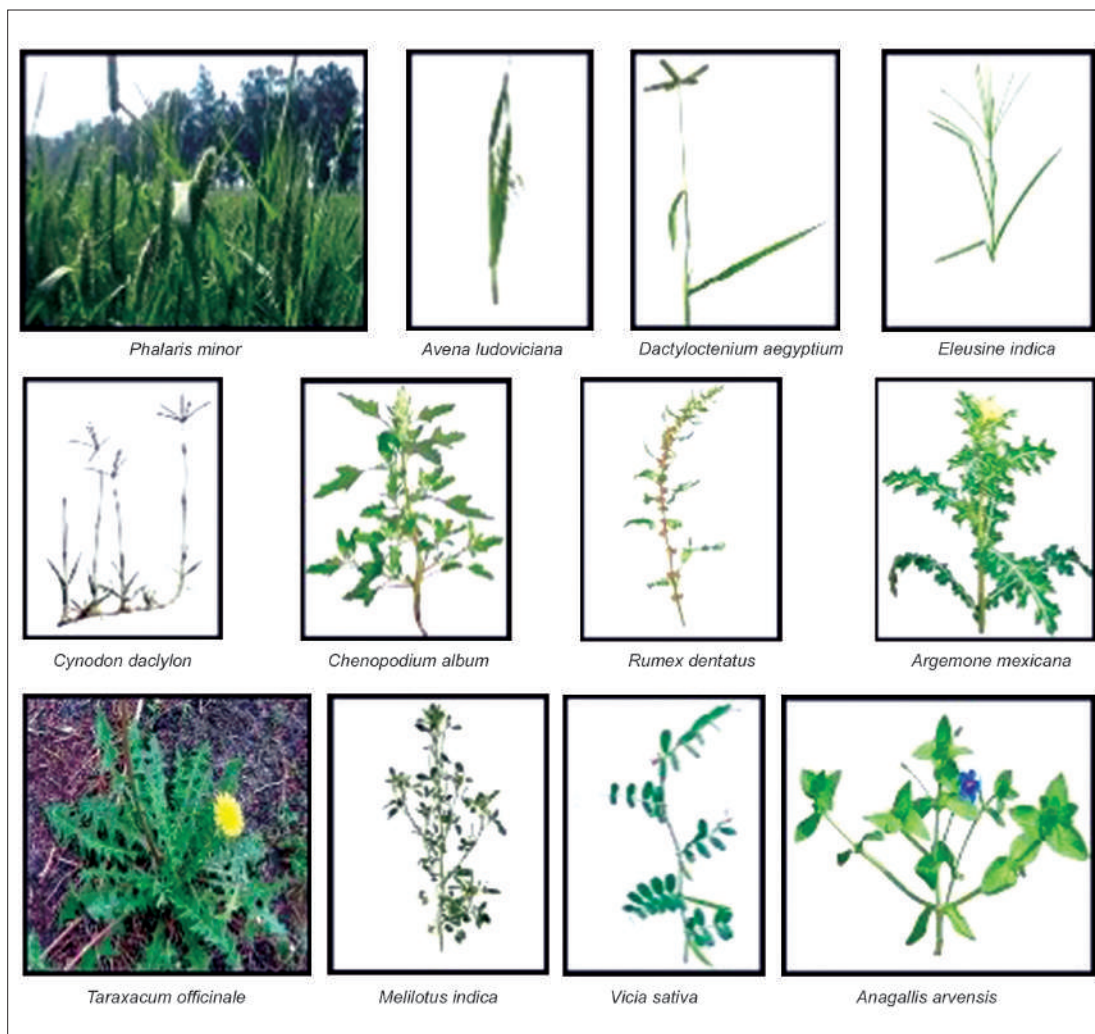
practices, manual/mechanical weeding to control the weeds and prepare clean seed bed to sow crops. The farmers believed and accepted that these are the synonyms for weed management to control weeds since age old times. But in CA practices, there will be no disturbance of soil with tillage implements nor the heavy machineries used to clean the field for control weeds and prepare seed bed to sow crops. Furthermore, by adopting no-till or zero till, producers lose the benefit of weed control offered by tillage from seed burial as well as the option to incorporate soil applied pre-plant and pre-emergent herbicides. Moreover, soil applied herbicides that do not require

incorporation can have reduced persistence and efficacy in the presence of plant residue that may intercept and bind the chemical before it reaches the soil surface. This reduced efficacy of pre-plant and pre-emergent herbicides has forced producers wishing to adopt conservation practices to become primarily dependent upon post-emergent herbicides, which reduces their weed control options. Apart from this, at present increased labour shortage and their wages has triggered the herbicide usage to control weeds in conservation agriculture based crop production

systems. To further complicate the situation, adoption of CA can also lead to major changes in weed population dynamics due to altered distribution of weed seed within the soil perennial weed species also thrive in reduced-tillage systems and can be difficult to control with available post-emergent herbicides. Therefore, new herbicides are often used in tank-mixes to achieve effective weed control. The success of CA practices in any cropping system in general and in particular to soybean-wheat cropping system entirely depends on how best we can control weeds by recommending suitable herbicides during cropping season are the key to attain good yield under CA system. Therefore, some of the promising herbicides for weed control in soybean and wheat

under conservation agriculture based soybean-wheat system are given in Table 2. However, non-selective herbicides like paraquat and glyphosate should be applied prior to sowing to kill existing weeds.

SUMMARY
Soybean-wheat is one of the dominant cropping systems of India. In recent years, productivity of soybean-wheat system is decreasing due to biotic and abiotic stresses.



Commonly observed weeds in wheat under CA-based soybean-wheat cropping system



Glyphosate spraying in conservation agriculture field after harvest of soybean

Table 1. Important weeds commonly seen in soybean and wheat under conservation agriculture based soybean-wheat cropping system

Soybean	Wheat
Grasses (G)	
<i>Echinochloa colona</i>	<i>Phalaris minor</i>
<i>Cynodon dactylon</i>	<i>Avena ludoviciana</i>
<i>Brachiaria reptans</i>	<i>Avena fatua</i>
<i>Digitaria sanguinalis</i>	<i>Cynodon dactylon</i>
<i>Eleusine indica</i>	<i>Dactyloctenium aegyptium</i>
<i>Dactyloctenium aegyptium</i>	<i>Echinochloa colona</i>
<i>Dinebra retroflexa</i>	<i>Eleusine indica</i>
	<i>Dinebra retroflexa</i>
Sedges (S)	
<i>Cyperus rotundas</i>	<i>Cyperus rotundus</i>
Broad leaved weeds (BLW)	
<i>Euphorbia geniculata</i>	<i>Chenopodium album</i>
<i>Commelina communis</i>	<i>Medicago denticulata</i>
<i>Physalis minima</i>	<i>Parthenium hysterophorus</i>
<i>Trianthema spp.</i>	<i>Vicia sativa</i>
<i>Altemanthera sessilis</i>	<i>Convolvulus arvensis</i>
<i>Chenopodium album</i>	<i>Lagascea mollis</i>
<i>Convolvulus arvensis</i>	<i>Melilotus indica</i>
<i>Digera arvensis</i>	<i>Rumex dentatus</i>
<i>Cynotis axillaris</i>	<i>Cichorium intybus</i>
<i>Amaranthus spinosus</i>	<i>Euphorbia hirta</i>
<i>Cleome viscosa</i>	<i>Euphorbia geniculata</i>
<i>Phyllanthus niruri</i>	<i>Tephrosia pururea</i>
<i>Acalypha indica</i>	<i>Physalis minima</i>
<i>Parthenium hysterophorus</i>	<i>Argemone mexicana</i>
<i>Corchorus spp</i>	<i>Anagallis arvensis</i>
<i>Physalis minima</i>	<i>Cirsium arvense</i>
<i>Conyza canadensis</i>	<i>Taraxacum officinale</i>
<i>Ipomea spp</i>	<i>Boerhaavia spp</i>
<i>Amaranthus viridis</i>	<i>Sonchus asper</i>

Hence, adaptation of conservation agriculture practices in soybean-wheat system will enhance the productivity of cropping system. Weed management is one of the crucial components of conservation agriculture due to non availability of labour, frequent rains for *kharif* crop, residue retention interference narrow down use of pre-plant and pre-emergent herbicides in both crops under CA system. Therefore, availability of prominent broad

Table 2. Herbicides for weed control in soybean and wheat under CA based soybean-wheat system

Herbicide	Dose (ai)	Time of application	Remarks
Soybean			
Chlorimuron ethyl	6-9 g/ha	10-12DAS	Broadleaved weeds and sedges
Bentazone	900 g/ha	10-12 DAS	Broad-leaved weeds and sedges
Fenoxaprop-p-ethyl	80-100 g/ha	20-25 DAS	Annual grasses
Imazethapyr	100 g/ha	20-25 DAS	Annual grasses and broad-leaved weeds
Quizalofop ethyl	50g/ha	15-20 DAS	Annual and perennial grasses
Propaquizafop	50-75 g/ha	10-12 DAS	Annual and perennial grasses
Fluazifop-p-butyl	125-250 g/ha	20-25 DAS	Annual and perennial grasses
Fluthiacet methyl	12.87 g/ha	20-25 DAS	Broad-leaved weeds
Fluazifop-p-butyl + Fomesafen	250 g/ha	20-25 DAS	Grasses and broad-leaved weeds
Imazethapyr + Imazamox	70 g/ha	20-25 DAS	Grasses and broad-leaved weeds
Propaquizafop + Imazethapyr	50+75 g/ha	10-12 DAS	Grasses and broad-leaved weeds
Sodium Aceflourofen + Clodinafop Propargyl	80-165 g/ha	20-25 DAS	Grasses and broad-leaved weeds
Fenoxaprop + Chlorimuron	80+6 g/ha	20-25 DAS	Annual grasses and broad-leaved weeds
Wheat			
Pendimethalin	1000-1250 g/ha	0-30 DAS	Annual grasses and some broad-leaved weeds
Clodinafop propargyl	60 g/ha	25-30 DAS	Annual grasses especially wild oat
Fenoxaprop-ethyl	100-120 g/ha	25-30 DAS	Annual grasses
Pinoxaden	35-40 g/ha	25-30 DAS	Annual grasses
Pyroxasulfon	125-150 g/ha	25-30 DAS	Annual grasses and broad-leaved weeds
Flufenacet	300 g/ha	25-30 DAS	Annual grasses
Methabenzthiazuron	750-1500 g/ha	25-30 DAS	Annual grasses and broad-leaved weeds
2,4-D	500-750 g/ha	20-25 DAS	Annual broad-leaved weeds and sedges
Triasulfuron	20 g/ha	30-35 DAS	Grasses and broad-leaved weeds
Metribuzin	175-200 g/ha	30-35 DAS	Annual grasses and broad-leaved weeds
Sulfosulfuron	25 g/ha	25-30 DAS	Annual grasses and broad-leaved weeds
Sulfosulfuron metsulfuron	25 + 2 g/ha	25-30 DAS	Annual grasses, broad-leaved + weeds and sedges
Mesosulfuron + idosulfuron	12 + 24 g/ha	20-25 DAS	Annual grasses, broad-leaved weeds and sedges
Isoproturon + metsulfuron	1000 + 4 g/ha	20-25 DAS	Annual grasses and broad-leaved weeds

spectrum post emergent herbicides either alone or tank mixture with other herbicide or factory mixture for successful control of grassy, sedges and broad leave weeds along with herbicide resistant weeds in soybean-wheat cropping system will further encourages to adopt CA practice to

enhance yield and obtain higher profit to farmers under conservation agriculture based soybean-wheat cropping system.

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