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Effect of pre-emergence herbicides on weed control in soybean (*Glycine max*)

M.L. KEWAT[1], AND JITENDRA PANDEY

Division of Agronomy, Indian Agricultural Research Institute, New Delhi 110 012

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ABSTRACT

A field experiment was conducted at the Indian Agricultural Research Institute, New Delhi, during the rainy seasons of 1995 and 1996, to evaluate the effect of pre-emergence herbicides on weed control in soybean [*Glycine max* (L.) Merr.]. All weed-control treatments reduced the weed biomass and population of all the weeds except *Cyperus rotundus* L. and *Convolvulus arvensis* L. Pre-emergence application of Metribuzin at low dose (0.5 kg/ha) lowered the weed population and weed biomass than that of pendimethalin (1.0 and 1.5 kg/ha) and it was as good as 2 hand-weedings done 20 and 40 days after sowing. But application of Metribuzin at higher dose (0.75 kg/ha) had a little phytotoxic effect on soybean seedlings. The former registered the maximum seed yield (23.42 q/ha), net monetary return (Rs 9,590/ha) and benefit : cost ratio (2.22) among all the weed-control treatments. Weed-control treatments proved more remunerative than weedy check.

Key words : Pendimethalin, Metribuzin, Weed control, Soybean, Economics

Presently, soybean is grown in 5.23 million ha of land. However, its productivity is quite low (10 q/ha) as compared to leading soybean-growing country, i.e. China (18 q/ha). Among the several constrains, severe weed competition during rainy season is mainly responsible for its low productivity. Congenial soil-moisture conditions coupled with suitable temperature (30–35°C) as well as better nutrient availability during rainy season provide unique opportunity to weeds to appear simultaneously with crop plants and rob the crop for essential nutrients, light, moisture and space; and consequently causing substantial reduction in yield to the tune of 35-55% depending on the types of weeds and their densities (Kurmawanshi *et al.*, 1995; Pandey *et al.*, 1996). Kulshreshta and Yaduraju (1987) reported that the herbicides used for weed control have residual toxicity at least up to the end of critical period of weed competition. Therefore, the present study was aimed at to find out the most effective herbicidal

Present address: [1]Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur , Madhya Pradesh 482 004

treatment for curbing the weed notiriety during critical period of crop–weed competition in soybean.

MATERIALS AND METHODS

A field experiment was conducted on soybean variety 'Pusa 22' in sandy-loam soils at the Indian Agricultural Research Institute, New Delhi, during the rainy seasons of 1995 and 1996. The soil of the experimental field was slightly alkaline (pH 7.9), analysing low available nitrogen (198.5 kg/ha) and medium phosphorus (15.60 kg/ha) as well as potassium (231.6 kg/ha) contents. The rainfall of 716.6 mm and 828.8 mm was received in respective years during the crop season. Six treatments (Tables 1 and 2) were tested in randomized block design with 4 replications. Sowing of the crop was done on 10 and 17 July in the 2 consecutive years by drilling 100 kg seeds/ha in the rows 30 cm apart. Crop was fertilized with a uniform dose of 20 kg + 80 kg P_2O_5 + 40 kg K_2O/ha as basal application. Total weed population/m^2 was recorded 30 days after sowing (DAS) randomly under each treatment with the help of 0.25 m^2 quadrat. Species-wise weed population was also recorded in weedy check to work out the relative density of weeds. The weed dry matter and grain yield were recorded at harvest from each plot. The economic analysis of each treatment was done on the basis of prevailing market price of inputs used and output obtained under each treatment.

RESULTS AND DISCUSSION

Density and dry weight of weeds

The experimental field during both the years at 30 days was infected with broad-leaved weeds, viz, *Trainthema portulacastrum* (42.17%), *Digera arvensis* (13.08%), *Phyllanthus niruri* (5.22%), *Commelina benghalensis* (0.87%), *Convolvulus arvensis* (0.58%); and narrow-leaved weeds, viz. *Digitaria sanguinalis* (19.53%), *Echinochloa colonum* (12.64%), *Dactyloctenium aegyptium* (3.01%) and *Cyperus rotundus* (2.90%). The broad-leaved weeds constituted 61.92% relative density of the total weed population.

The species-wise weed population after pre-emergence herbicidal spray (Table 1) revealed that Metribuzin at both the rates (0.50 and 0.75 kg/ha) effectively controlled most of the dominant weeds, viz. *Trianthema portulocastrum*, *Echinochloa colonum*, *Digitaria sanguinalis* and *Digera arvensis*. The efficacy of Pendimethalin 1.0 kg/ha was also good but it improved further with increase in rate (1.5 kg/ha) of application. The herbicidal efficacy of Metribuzin and Pendimethalin against perennial weeds (*Cyperus rotundus* and *Convolvulus arvensis*) was almost zero because of regeneration from underground parts.

The total weed density and weed biomass were reduced identically in all the treated plots compared to weedy check which had the highest weed density (593/m^2) and weed biomass (13.05 g/m^2). Pre-emergence application of Metribuzin at 0.50 and 0.75 kg/ha had caused higher reduction in the total weed density (32–35/m^2) and weed biomass (3.53–3.45 g/m^2), followed by Pendimethalin which curbed the weeds to the extent of 69–53/m^2 and 6.25–7.15 g/m^2 weed biomass after pre-emergence application at 1.0 and 1.5 kg/ha

Table 1. Weed density, weed biomass and weed-control efficiency under different weed-control treatments (mean data of 2 years)

Treatment	Rate (kg/ha)	Time of application	Weed density at 30 DAS (m²)						Total weed density (m²)	Weed biomass at harvest* (g/m²)	WCE
			Trianthema portulacastrum	*Digera arvensis*	*Convolvulus arvensis*	*Cyperus rotundus*	*Digitaria sanguinalis*	*Echinochloa colonum*			
Pendimethalin	1.00	Pre. em.	5	18	4	21	12	9	69	7.15	45
Pendemethalin	1.50	Pre. em.	0	12	4	20	9	8	53	6.25	52
Metribuzin	0.50	Pre. em.	0	5	4	19	2	2	32	3.55	72
Metribuzin	0.75	Pre. em.	0	3	3	18	1	0	25	3.45	73
Hand-weeding	2.00	20, 40 DAS	20	10	4	20	9	12	75	5.10	59
Weedy check			271	86	5	19	129	83	593	13.05	
CD (P = 0.05)										0.75	

Pre. em., Pre-emergence; WCE, weed-control efficiency; DAS, days after sowing; * square root transformed values

respectively. Hand-weeding twice (20 and 40 days) also eliminated the weeds to the tune of 87% but it could not supersede Metribuzin and Pendimethalin at both the rates. Some of the weeds growing within the rows and late-emerging weeds escaped removal by hand-weeding. This might have resulted in little more weed infestation under hand-weeding treatment.

The application of Metribuzin at both the rates attained the higher weed-control efficiency (WCE) of 72–73% as against 59% under hand-weeding, while Pendimethalin 1.0 kg/ha had the lowest (45%) WCE but it improved further (52%) with increase in the rate of application of Pendimethalin (1.5 kg/ha). The poor activity of Pendimethalin against late-emerging weeds might be the reason for lower weed-control efficiency. Kulshrestha and Yaduraju (1987) also endorsed the similar views from their studies.

Growth and yield of crop

The visual rating after pre-emergence application of herbicides indicated that Pendimethalin at both the rates did not show any phototoxic effects on soybean crop, whereas application of Metribuzin at higher rate 0.75kg/ha caused slight phototoxicity on the soybean seedlings which were recovered 20 days after application.

Season-long crop–weed competition caused the maximum reduction (50.5%) weed index) in the grain yield of soybean but reduction was substantially checked when weed-control measures were adopted (Table 2). Least reduction in grain yield (4.7% weed index) was recorded under Metribuzin 0.50 kg/ha. Better efficacy of

Table 2. Seed yield and economics of weed-control treatments in soybean (mean data of 2 years)

Treatment	Rate (kg/ha)	Time of application (q/ha)	Seed yield index	Weed cultivation (%)	Cost of return (Rs/ha)	Net cost ratio (Rs/ha)	Benefit: cost ratio
Pendimethalin	1.00	Pre. em	19.15	22.0	8,032	6,222	1.77
Pendimethalin	1.50	Pre. em	20.85	15.1	8,787	6,711	1.76
Metribuzin	0.50	Pre. em	23.42	4.7	7,809	9,590	2.22
Metribuzin	0.75	Pre. em	21.60	12.1	8,457	7,587	1.90
Hand-weeding	2	20, 40 DAS	24.57		9,261	8,768	1.96
Weedy check			12.17	50.5	6,356	2,736	1.43
CD (P=0.05)			2.76				

Pre. em., Pre-emergence; DAS, days after sowing

Metribuzin might be due to its prolonged persistence in soil and broad-spectrum activity on dominant weeds (Kewat, 1998). All the weed-control treatments showed significantly higher grain yield of soybean than weedy check (12.17 q/ha). Application of Metribuzin 0.50 kg/ha to soybean as pre-emergence led to record significantly higher yield (23.42 q/ha) over other treatments except to hand-weeding twice which was comparable. The higher dose of Metribuzin (0.75 kg/ha) caused slight phytotoxicity on the seedlings which were recovered later. However, it reduced the grain yield to the tune of 1.82 q/ha over its lower dose (0.50 kg/ha). The pre-emergence application of Pendimethalin at both the rates (1.0 and 1.5 kg/ha) also yielded 57–71% higher grain yield over weedy check, though the difference in grain yield between 2 rates of Pendimethalin was not significant. Higher yield under these treatments was attributed to effective control of dominant grassy and broad-leaved weeds right from germination to critical period of weed competition and thereby providing weed-free conditions for the optimum growth and development of the crop. Bhalla *et al.* (1998) also postulated the similar views.

Monetary returns

The net return and benefit: cost ratio were minimum under weedy check and these values were increased in the range of Rs 6,222 to Rs 9,590 and 1.77 to 1.96, respectively, when weeds were controlled either by herbicides or by hand-weeding (Table 2). Application of metribuzin 0.5 kg/ha resulted in the maximum net return and benefit : cost ratio among all the treatments mainly because of lower investment on weed control. Though hand-weeding twice attained the highest gross return, it had lower net monetary return and benefit : cost ratio than Metribuzin at 0.5 kg/ha due to more investment on weed control. The results are in close conformity with the findings of Jain *et al.* (1988) at Jabalpur, Madhya Pradesh.

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