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Effect of herbicidal weed control measures for enhancing sugarcane yield, quality and weed control efficiency in West Bengal

K. BANERJEE, B. RAY PRAMANIK[1] AND A. M. PUSTE[2]

Sugarcane Research Station, Bethuadahari, Nadia,West Bengal
[1]Directorate of Agriculture, Bundwan Block, Purulia, West Bengal
[2]Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur - 741 252

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ABSTRACT

A field experiment was conducted during two consecutive spring seasons of 2011 and 2012 at the Sugarcane Research Station, Bethuadahari (Nadia) to asses the various herbicidal weed control measures to enhance sugarcane yield, quality and weed control efficiency in West Bengal. The pooled data of both the years revealed that among the different weed control treatments, application of herbicide metribuzine @ 1.25 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP exhibited the maximum control of weeds and effectively lowered the weed density, weed dry matter accumulation as well as obtained higher weed control efficiency. The highest brix (20.33%), sucrose (17.16%), CCS (11.59%), CCS (9.49 t ha^{-1}) and cane yield (82.39 t ha^{-1}) were recorded with this treatment also. However, this result was statistically at par with the treatment receiving hoeing and weeding at 30, 60 and 90 DAP (days after planting). The highest net return of INR 1,05,390.00 ha^{-1} and B : C ratio of 2.63 were recoded under the application of metribuzine @ 1.25 kg ai ha^{-1} (PE) + Almix @ 20 g ha^{-1} at 75 DAP, which was closely followed by those of three hoeing and weeding (net return of INR 99,519.00 ha^{-1} and B : C ratio of 2.49).

Keywords: Cane yield and economics, herbicides, **s**ugarcane, weed control efficiency

Sugarcane (*Saccharum* hybrid complex) is an important agro-industrial crop grown primarily for sugar production in India, and plays a pivotal role in agricultural and industrial economy of the country. In India, the crop is cultivated broadly under two distinct agro-climatic condition commonly referred to as tropical and subtropical belts. The area, production and productivity of sugarcane in the tropical and sub-tropical belts are 2.18 and 2.78 million ha, 178 and 159 mt and 81.65 and 57.19 t ha^{-1}, respectively (Mohanty and Mishra, 2011).

The competition caused by weeds is a major factor limiting sugarcane production. This crop presents a low competitive ability at the beginning of its cycle due to its slow initial growth and wide spacing between planting rows. Without weed control, the yield may be reduced by 40%, depending on the species and density (Kuva *et al.*, 2003). Weed competition can decrease millable stalks by 32% and stalk thickness by 15% and sugar yield by 31% compared to weed- free plots (EL Shafai, *et al.,* 2010). Among the available weed control methods, those most widely used in sugarcane crops include chemical suppression. Use of herbicides has a good effect on weed control as well as obtaining higher weed control efficiency (Tironi *et al.*, 2012). Tripathy et al. (2013) have demonstrated that different weed management practices significantly redueced weed density and increased yield of onion. These stand out because of their high efficiency, speed, and lower operational costs. However, the misuse of such products can cause serious environmental impacts (Mitchell *et al.*, 2005). Keeping these points in view, field experiment was carried out to study the effect of various herbicidal weed control measures in sugarcane crop.

E-mail: keyasrs21oct@rediffmail.com

MATERIALS AND METHODS

A field experiment was conducted at the research farm of Sugarcane Research Station, Bethuadahari, Nadia (West Bengal) during two consecutive spring seasons of 2011 and 2012. The experimental site was located at the longitude of 88º22′22″E and 23º36′54″N latitude with 15m altitude, from mean sea level. The soil of the experimental field was sandy loam in texture and neutral in reaction. The available N status of the soil was low whereas available P and K contents were in medium range. The experiment was laid out in randomized block design with three replications, consisting of 10 treatments *viz*.

T_1 - Control (weedy check),

T_2 - Hoeing at 30, 60 and 90 DAP (days after planting),

T_3 - Atrazine @ 2 kg ai ha^{-1} (PE) followed by 2,4-D (1 kg ai ha^{-1}) at 60 DAP,

T_4 - Atrazine @ 2 kg ai ha^{-1} after first irrigation and hoeing followed by 2,4-D (1 kg ai ha^{-1}) at 75 DAP,

T_5 - Metribuzine @ 1.25 kg ai ha^{-1} (PE) followed by 2, 4-D (1 kg ai ha^{-1}) at 75 DAP,

T_6 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP

T_7 - Metribuzine @ 1.25 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP,

T_8 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Ethoxysulphuron 50 g ai ha^{-1} at 75 DAP,

T_9 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Dicamba 350g ai ha^{-1} at 75 DAP,

T_{10} - Metribuzine @ 1.25 kg ai ha^{-1} (PE) + Dicamba 350 g ai ha^{-1} at 75 DAP.

The sugarcane variety BO 91 was planted at 90 cm row to row apart and was applied as per the recommended doses of N, P_2O_5 and K_2O @ 200: 100: 100 kg ha^{-1}, respectively. The crop was managed as per the standard package of practices. All the recommended plant protection measures were undertaken during the course of investigation. The observations on the weed density sq m^{-1} at 120 DAP (days after planting), weed dry weight (g sqm^{-1}) at 120 DAP and weed control efficiency (%),germination (%), number of cane at harvest ('000 ha^{-1}), number of millable cane (NMC) at harvest ('000 ha^{-1}), single cane weight (SCW) at harvest (kg), commercial cane sugar (CCS) in %, brix (%), sucrose (%), purity (%) of cane juice at harvest were also recorded systematically. The observations thus recorded in the field and laboratory were statistically analysed for interpretations (Gomez and Gomez, 1984) and presented in Tables. For determination of qualitative parameters of sugarcane juice, polarimeter, hand refractometer instruments were used in the laboratory.

RESULTS AND DISCUSSION

A mixed weed flora was recorded from the experimental plots during both the year 2011 and 2012. The major weed flora at 90 DAP (days after planting) were : *Cyperus rotundus, Cynodon dactylon, Panicum sp., Trianthema monogyna, Solanum nigrum, Echinochloa colona, Digitaria sanguinalis, Amaranthus viridis, Phylanthus niruri, Dactyloctanium aegyptium, Convolvulus arvensis* etc.

The observations related with the impact of different weed control measures, particularly on weed density (sqm^{-1}) and dry weight of weed (g sqm^{-1}) observed at 120 DAP were remarkably influenced by

Table 1: Weed density, dry weight of weeds and weed control efficiency due to different weed control measures in sugarcane (Pooled data)

Treatments	Weed density at 120 DAP (sq m^{-1})	Weed dry wt. at 120 DAP (g sq m^{-1})	Weed control efficiency (%)
T_1 - Control (weedy check)	410	261.1	——
T_2 - Hoeing and weeding at 30, 60 and 90 DAP	101	78.8	69.87
T_3 - Atrazine @ 2 kg ai ha^{-1} (PE) followed by 2,4-D (1 kg ai ha^{-1}) at 60 DAP	215	164.78	36.55
T_4 - Atrazine @ 2 kg ai ha^{-1} after 1st irrigation and hoeing followed by 2,4-D (1 kg ai ha^{-1}) at 75 DAP	127.5	102.47	60.76
T_5 - Metribuzine @ 1.25 kg ai ha^{-1} (PE) followed by 2,4-D (1kg ai ha^{-1}) at 75 DAP	113	94.02	64.00
T_6 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP	141	120.6	53.69
T_7 - Metribuzine@ 1.25 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP	93.5	77.74	70.15
T_8 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Ethoxysulphuron 50 g ai ha^{-1} at 75 DAP	254	168.6	35.43
T_9 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Dicamba 350g ai/ha at 75 DAP	157.5	133.84	48.58
T_{10} - Metribuzine @ 1.25 kg ai ha^{-1} (PE) + Dicamba 350 g ai ha^{-1} at 75 DAP	136	109.92	57.92
SEm (±)	**7.92**	**5.53**	——
LSD (0.05)	**23.75**	**16.58**	——

different treatments imposed on sugarcane (Table 1). As far as the effect of different management practices are concerned highest weed population and dry matter was recorded in weedy check plots. Significant reduction in weed density and weed dry matter were observed due to different treatments compared to those of weedy check. The application of herbicide metribuzine @ 1.25 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP (T_7) exhibited the maximum control of weeds and effectively lowered the weed density (93.5 sqm^{-1}) and weed dry matter accumulation (77.74 g sqm^{-1}) observed at 120 DAP compared to weedy check (410 sq m^{-1} and 261.1 g sqm^{-1}). However, this result was statistically at par with the treatment comprising three hoeing and weeding at 30, 60 and 90 DAP. The maximum weed control efficiency was found with the treatment involving the application of metribuzine @ 1.25kg ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP (Table 1). This is because of the fact that lowest weed density sq m^{-1} and lowest weed dry wt sq m^{-1} was obtained with this treatment. Efficiency of metribuzine in sugarcane has been reported by Sundara (2000) and Gana (2009).

Among the four crop performing characteristics of sugarcane, germination of sugarcane (%) and single cane weight (g) did not influence significantly with each other but other two characteristics like, number of cane at harvest ('000 ha^{-1}) and number of millable cane ('000 ha^{-1}) were significantly differed due to the application of different weed control measures on sugarcane including weedy check plots (Table 2). However, lowest number of tillers (84,000 ha^{-1}), millable canes (72,510 ha^{-1}) and cane yield (54.51 t ha^{-1}) were recorded under weedy check plot (T_1). Production of commercial cane sugar (both in % and t ha^{-1}) and sugarcane yield (t ha^{-1}) were remarkably influenced due to various weed control measures applied on sugarcane and among the treatments, highest cane yield (82.39 t ha^{-1}) was recorded with the

Table 2: Quantitative and qualitative characters of sugarcane as affected by different weed control measures (Pooled data)

Treatment	Germination (%)	No. of cane at harvest ('000 ha^{-1})	NMC ('000 ha^{-1})	SCW (kg)	Brix (%)	Sucrose (%)	Purity (%)
T_1 - Control (weedy check)	40.52	84.19	72.51	0.71	17.10	14.55	85.09
T_2 - Hoeing at 30, 60 and 90 DAP	39.61	96.12	87.49	0.86	20.20	16.89	83.60
T_3 - Atrazine @ 2 kg ai ha^{-1} (PE) followed by 2,4-D (1 kg ai ha^{-1}) at 60 DAP	43.77	92.03	80.61	0.78	17.64	14.88	84.38
T_4 - Atrazine @ 2 kg ai ha^{-1} after 1st irrigation and hoeing followed by 2,4-D (1 kg ai ha^{-1}) at 75 DAP	37.41	94.83	84.59	0.83	18.36	16.11	83.10
T_5 - Metribuzine @ 1.25 kg ai ha^{-1} (PE) followed by 2,4-D (1kg ai ha^{-1}) at 75 DAP	43.37	94.41	82.90	0.85	19.58	16.85	86.07
T_6 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP	35.66	90.68	83.02	0.81	17.89	15.02	83.99
T_7 - Metribuzine@ 1.25 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP	45.28	97.47	88.16	0.88	20.33	17.16	84.38
T_8 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Ethoxysulphuron 50 g ai ha^{-1} at 75 DAP	42.00	85.87	74.30	0.74	17.28	14.55	84.37
T_9 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Dicamba 350g ai/ha at 75 DAP	41.30	93.00	83.01	0.81	18.17	15.11	83.18
T_{10} - Metribuzine @ 1.25 kg ai ha^{-1} (PE) + Dicamba 350 g ai ha^{-1} at 75 DAP	38.61	93.68	84.40	0.84	18.86	15.91	84.37
S.Em (±)	**N.S.**	**1.25**	**0.86**	**N.S.**	**0.19**	**0.11**	**N.S.**
LSD (0.5)	**N.S.**	**3.75**	**2.59**	**N.S.**	**0.57**	**0.33**	**N.S.**

N.S., Not significant; NMC, Number of mill able cane; SCW, Single cane weight

treatment receiving metribuzine @ 1.25 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP observed at T_7 treatment (Table 2 and 3). This treatment was found to be at par with the treatment receiving three hoeing and weeding at 30, 60 and 90 DAP. The highest cane yield with these two treatments was primarily due to higher number of millable cane and cane weight in this treatment. The extent of cane yield increment of sugarcane in T_7 than that of T_1 and other treatments of the experiment were to the tune of 8.14 - 52.98%. Good herbicidal effect on the sugarcane yield including its characteristics have also observed by Mohanty and Mishra (2011).

The qualitative characteristics of sugarcane juice (brix and sucrose in %) was also greatly influenced by the weed controlling measures except purity percentage, which was not differed significantly among the treatments (Table 2). Highest brix (20.33%), sucrose (17.16%), CCS (11.59%) and CCS (9.51 t ha^{-1}) were obtained with the treatment receiving the application of metribuzine @ 1.25 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP closely followed by the treatment receiving three hoeing and weeding at 30, 60 and 90 DAP. Lowest value of brix (17.10%), sucrose (14.55%), CCS (9.98%) and CCS (5.38 t ha^{-1}) were recorded in weedy check treatment (Table 2 and 3).

Production economics of sugarcane (net income and B-C ratio) was greatly varied among the different treatments applied on the crop (Table 3). However, data presented in Table 3 reveals that the lowest net returns (INR 55,984.00 ha^{-1}) and B : C ratio (2.20) was observed in weedy check (T_1) because of lower yields obtained in this treatment. The highest net return of INR 1,05,390.00 ha^{-1} and B : C ratio of 2.63 were recoded under the application of metribuzine @ 1.25 kg ai ha^{-1} (PE) + Almix @ 20 g ha^{-1} at 75 DAP (T_7), which was closely followed by the treatment (T_2) comprising of three hoeing and weeding done during the crop period (net return of INR 99,519.00 ha^{-1} and B:C ratio of 2.49).

From the experimental data and crop performance it may be concluded that weed control measure is an imperative task to be performed well, more specifically it inferred that application of herbicide

Table 3: Production and production economics of sugarcane as influenced by different weed control measures (Pooled data)

Treatments	CCS (%)	Yield (t ha^{-1})	CCS (t ha^{-1})	Net income (INR ha^{-1})	B:C ratio
T_1 - Control (weedy check)	9.88	54.51	5.38	55,984	2.20
T_2 - Hoeing at 30, 60 and 90 DAP	11.36	79.45	8.99	99,519	2.99
T_3 - Atrazine @ 2 kg ai ha^{-1} (PE) followed by 2,4-D (1 kg ai ha^{-1}) at 60 DAP	10.06	67.08	6.73	77,850	2.61
T_4 - Atrazine @ 2 kg ai ha^{-1} after 1st irrigation and hoeing followed by 2,4-D (1 kg ai ha^{-1}) at 75 DAP	10.89	74.59	8.10	76,960	2.9
T_5 - Metribuzine @ 1.25 kg ai ha^{-1} (PE) followed by 2,4-D (1kg ai ha^{-1}) at 75 DAP	11.51	75.71	8.70	92,950	2.38
T_6 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP	10.13	70.66	7.14	84,445	2.45
T_7 - Metribuzine@ 1.25 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 DAP	11.59	82.39	9.51	1,05,394	2.63
T_8 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Ethoxysulphuron 50 g ai ha^{-1} at 75 DAP	9.82	59.45	5.83	61,935	1.74
T_9 - Atrazine @ 2.0 kg ai ha^{-1} (PE) + Dicamba 350g ai/ha at 75 DAP	10.14	70.22	7.09	81,225	2.10
T_{10} - Metribuzine @ 1.25 kg ai ha^{-1} (PE) + Dicamba 350 g ai ha^{-1} at 75 DAP	10.75	74.05	7.94	87,309	2.18
SEm (±)	0.18	0.82	0.09	—	—
LSD (0.05)	0.53	2.46	0.27	—	—

CCS - Commercial cane sugar

metribuzine @ 1.25 kg ai ha^{-1} (PE) + Almix 20 g ha^{-1} at 75 days after planting exhibited maximum weed control efficiency, which retuned better growth, production potential, economics and quality of sugarcane in the agro-zones of West Bengal including the country as a whole.

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