



E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(6): 269-273
Received: 23-09-2019
Accepted: 27-10-2019

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Studies on bio-efficacy of metsulfuron methyl 20% WG as post - emergent applications against weeds in sugarcane (*Saccharum officinarum* L.)

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Abstract

Field investigations were carried out during early seasons of both 2015 and 2016 at Sugarcane Research Station, Cuddalore to ascertain the bio-efficacy of Metsulfuron Methyl 20% WG as Post - emergence application against the control of broad leaf weeds in sugarcane. The treatments constituted of early post emergence application of Metsulfuron methyl 20%WG @8.0 &6.0 g.a.i / ha along with 0.2 % non-ionic surfactant exerts comparable suppression of weeds especially almost all broad leaved weeds and resulted with highest weed control efficiency of 79.1 and 84.2 respectively on 30 and 60 days after application (DAA) during 2014 and with 79.1 and 84.0 during 2015 were accounted with the above treatments. Moreover the maximum values of varied growth, yield parameters viz., cane length (283 and 278 cm), cane girth (3.2 and 3.4 cm) individual cane weight (2.20 and 2.24 kg), millable canes (1,25,000 and 1,23,600) cane yield (140.43 and 137.84 t / ha) and sugar yield (16.86 and 15.67 t / ha) in respective years of study. Regardless the cropping years, the control registered the lowest values of all the above parameters.

Keywords: Metsulfuron Methyl 20 % WG, Post – emergence, weed control, sugarcane

Introduction

Among the gardenland field crop weeds are competitive to sugarcane crop is higher due to adoption of wider spacing, its slow growth habit at initial growth stages, indiscriminate fertilization and frequent irrigations. Unlike other crops weeds cause high economic loss to sugarcane through harbouring pest and disease which reduces tonnage in field, sucrose recovery in mills and it also minimises the ratoon productivity. The extent of loss in cane yield caused by weeds is from 20 percent to total crop failure depending upon composition and intensity of weed population (Srivastva and Chauhan, 2002) [2]. Weeds compete with sugarcane for nutrients, moisture, light, CO₂, space and its depression effect through its allelochemicals. Weeds compete throughout the life cycle of main crop but it is more sensitive to prevalence of weeds at critical period (0-90 days after planting) of its life cycle. Although the hand weeding is of much effective, it is of costlier and less effective against perennials like nut sedge. Further, the problems and difficulties associated with cultural and mechanical methods necessitates the use of chemicals for weed control in sugarcane. Chemical weed control is time saving, easier, economical and can be adopted timely, particularly where scarcity of agricultural labour exists. Hence, the usage of pre and post emergence herbicides application might be economical and viable strategy. Zimdahl, (1980) [3] claimed that the weed-crop competition of 3, 6, and 9 weeks after planting reduces 77.6 %, 50.6 %, and 41.7 % yield of sugarcane, respectively. Keeping the points in view, the present study was undertaken to formulate an effective weed control strategy in sugarcane, especially in areas wherein dicot weeds are comparatively higher.

Materials and Methods

Field experiments were conducted during 2015 - 2016 cropping season at Sugarcane Research Station, Tamil Nadu Agricultural University, Cuddalore to evaluate the bio-efficacy of Metsulfuron methyl 20 % WG of M/S E.I DuPont India Ltd as post emergent application especially against broad leaved weeds in sugarcane. The treatments consisted of post-emergence foliar application of doses of Metsulfuron methyl 20 % WG @4.0, 6.0 and 8.0g.a.i/ha with and without surfactant in comparison with 2,4-D Amine salt 58 % SL @ 3.5kg / ha and the untreated check. The same set of herbicides based weed control treatments was repeated during the subsequent 2016-2017 cropping season. The details of treatments imposed were given in the table 1.

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Table 1: Treatments Details

Sl. No.	Treatments	Dosage		Method and time of application	Spray fluid (litres/ha)
		g a.i. /ha	Formulation (g/ha)		
I Bio – efficacy study					
1	MSM 20 % WG without surfactant	4	20	At 2-4 leaf Stage of Weeds	Foliar spray with knapsack sprayer fitted with flat fan nozzle using water volume of 500 litres/ha
2	MSM 20 % WG without surfactant	6	30		
3	MSM 20 % WG without surfactant	8	40		
4	MSM 20 % WG without surfactant (0.2% NIS)	4	20		
5	MSM 20 % WG without surfactant (0.2% NIS)	6	30		
6	MSM 20 % WG without surfactant (0.2% NIS)	8	40		
7	2-4 D Amine salt 58 % SL	3.5kg	5.0 lit		
8	Untreated Check	-	-		
II Phytotoxicity study					
1	MSM 20 % WG without surfactant	6	30	At 2-4 leaf Stage of Weeds	Foliar spray with knapsack sprayer fitted with flat fan nozzle using water volume of 500 litres/ha
2	MSM 20 % WG without surfactant	12	60		
3	MSM 20 % WG without surfactant (0.2% NIS)	6	30		
4	MSM 20 % WG without surfactant (0.2% NIS)	12	60		
5	Untreated Check	-	-		

Note: NIS: Non Ionic Surfactant (OctylPhenoxyethanol 12.5%)

The experiments were laid out in randomized block design with three replications. The Metsulfuron methyl 20%WG and 2, 4-D Amine salt were applied as and when the broad leaved weeds reached 2-4 leaf stage by using a Knapsack sprayer fitted with flat fan nozzle. Recommended crop package of practices for sugarcane were followed. In both the cropping seasons the observations were made on weed density before the imposition of weed control treatments for both the experiments. The dry weights of weeds were recorded at 30 and 60 days after application and analysed statistically for estimating weed dry matter production (Table 2 & 3). The yield attributes and yield of sugarcane for the respective crops are documented at harvest and are given in tables 4 and 5 respectively.

In both the seasons a separate evaluation study was also conducted in the same field adjoining to the experimental sites to assess the residual effect of Po. E application of Metsulfuron methyl 20%WG @6.0&12.0g.a.i/ha with and without surfactant in comparison with untreated control in the succeeding crop of black gram. The succeeding crop was raised as per the recommended package of practices. In succeeding black gram also the visual phytotoxicity ratings

viz., discoloration, chlorosis, deformation, wilting and vein clearing were recorded at 7, 14, 21 & 30 days after sowing using the rating scale of 0-10 where, 0= no effect on plant and 10= complete death of the plant, germination count on 30 DAS and plant height at 30 & 45 DAS were documented. Grain yield at harvest was also recorded and presented in tables 6 and 8 respectively.

Table 2: Phytotoxicity ratings (for sugarcane)

Score	Per cent crop health affected
0	No Phytotoxicity
1	1-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

Table 3: Broad leaved weeds dry weight and weed control efficiency (WCE) under varied weed control treatment on 30 & 60 DAA 2015 Season

Sl. No.	Treatments	30 DAA		60 DAA	
		BLW (g/m ²)	WCE (%)	BLW (g/m ²)	WCE (%)
1	MSM 20% WG without surfactant	13.04(170.0)	69.64	14.49(210.0)	72.36
2	MSM 20% WG without surfactant	12.0(144.0)	74.30	13.13(175.0)	77.0
3	MSM 20% WG without surfactant	11.20(125.60)	77.67	11.30(127.8)	83.18
4	MSM 20% WG with surfactant (0.2% NIS)	12.0(144.0)	74.30	13.04(170.0)	77.63
5	MSM 20% WG with surfactant (0.2% NIS)	11.0(121.0)	78.39	11.20(125.5)	83.48
6	MSM 20% WG with surfactant (0.2% NIS)	10.84(117.0)	79.10	10.95(120.0)	84.21
7	2-4D Amine salt 58% SL	12.12(147.0)	73.75	13.78(190.0)	75.0
8	Untreated Check	23.67(560.5)	-	27.56(760.0)	-
	CD (P=0.05)	0.98	NA	1.12	NA

Note- Values within the parentheses are original. Data are subjected to square root transformation ($\sqrt{x+1}$)

NA – Not analyzed

Table 4: Sugarcane Yield attributes and cane yield as influenced by varied weed management in sugarcane (2015 Season)

Sl. No.	Treatment	No. of millable cane /m ²	Cane length (cm)	Cane girth (cm)	Cane wt./cane (g.)	Cane yield (t/ha)
1	MSM 20% WG without surfactant	9.0	268.0	2.4	1.2	120.00
2	MSM 20% WG without surfactant	9.0	278.0	2.6	1.4	125.00
3	MSM 20% WG without surfactant	11.0	282.0	2.9	2.0	134.00
4	MSM 20% WG with surfactant +0.2% NIS surfactant	9.0	272.0	2.5	1.4	126.60

5	MSM 20% WG with surfactant +0.2% NIS surfactant	11.0	283.0	2.9	2.2	136.20
6	MSM 20% WG with surfactant +0.2% NIS surfactant	12.0	285.0	3.0	2.2	138.40
7	2-4D Amine salt 58% SL	9.0	272.0	2.4	1.2	124.20
8	Untreated Check	7.0	251.0	2.0	0.80	110.00
	CD (P =0.05)	1.0	7.0	0.20	0.20	6.00

Table 5: Weeds dry wt. (g/m²) and weed control efficiency (WCE) influenced by weed management treatments on sugarcane at 30 & 60 DAA (2016 Season)

Sl. No.	Treatment	30 DAA		60 DAA	
		BLW (g/m ²)	WCE (%)	BLW (g/m ²)	WCE (%)
1	MSM 20% WG without surfactant	12.08 (146.0)	74.38	13.74(189.0)	74.96
2	MSM 20% WG without surfactant	12.00 (144.0)	74.73	13.11(172.0)	77.21
3	MSM 20% WG without surfactant	11.18(125.0)	78.07	11.27(127.0)	83.17
4	MSM 20% WG with surfactant +0.2% NIS surfactant	11.96(143.0)	74.91	13.92(167.0)	77.88
5	MSM 20% WG with surfactant +0.2% NIS surfactant	11.04(122.0)	78.59	11.13(124.0)	83.57
6	MSM 20% WG with surfactant +0.2% NIS surfactant	10.91(119.0)	79.12	11.00(121.0)	84.00
7	2-4D Amine salt 58% SL	12.92(167.0)	70.70	14.38(207.0)	72.58
8	Untreated Check	23.87(570.0)	-	27.47(755.0)	-
	CD (P =0.05)	0.45	-	0.70	-

Note-Values within the parentheses are original. Data are subjected to square root transformation ($\sqrt{x+1}$)

Table 6: Effect of Yield attributes and cane yield (Metsulfuron methyl 20 % on WG) of sugarcane during (2016 Season)

Sl. No.	Treatment	No. of millable cane /m ²	Cane length (cm)	Cane girth (cm)	Cane wt./cane (Kg.)	Cane yield (t/ha)
1	MSM 20% WG without surfactant	8.	270.0	2.4	1.40	124.00
2	MSM 20% WG without surfactant	9.0	271.0	2.6	1.60	124.50
3	MSM 20% WG without surfactant	11.0	277.0	2.8	2.00	134.50
4	MSM 20% WG with surfactant +0.2% NIS surfactant	10.0	271.0	2.6	1.60	125.60
5	MSM 20% WG with surfactant +0.2% NIS surfactant	12.0	278.0	3.0	2.10	136.40
6	MSM 20% WG with surfactant +0.2% NIS surfactant	12.0	278.0	3.0	2.20	137.50
7	2-4D Amine salt 58% SL	8.0	270.0	2.5	1.50	120.60
8	Untreated Check	7.0	251.0	2.0	0.80	109.50
	CD (P =0.05)	0.60	6.00	0.15	0.20	5.00

Table 7: Visual symptoms of Phytotoxicity effect of varied doses Metsulfuron methyl 20 % WG on succeeding Black gram during 2014(Season-I).

Treatments	Dosage (g a.i./ha)	Crop discoloration				Chlorosis				Deformation				Wilting				Vein clearing			
		7 DAS	14 DAS	21 DAS	30 DAS	7 DAS	14 DAS	21 DAS	30 DAS	7 DAS	14 DAS	21 DAS	30 DAS	7 DAS	14 DAS	21 DAS	30 DAS	7 DAS	14 DAS	21 DAS	30 DAS
MSM 20% WG without surfactant	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSM 20% WG without surfactant	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSM 20% WG with surfactant (0.2% NIS)	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSM 20% WG with surfactant (0.2% NIS)	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Untreated Check	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: Values within the parentheses are original. Data are subjected to square root transformation ($\sqrt{x+1}$)

Table 8: Effect of Metsulfuron methyl 20 % WG doses on yield attributes and yield of succeeding Black gram during 2014 (Season-I).

Treatments	Dosage (g a.i./ha)	Plant population (m ²)		Plant height (cm)		Seed Yield (Kg/ha)
		15 DAS	30 DAS	30 DAS	45 DAS	
MSM 20% WG without surfactant	6	33.0	33.0	30.0	40.0	867.5
MSM 20% WG without surfactant	12	32.0	32.0	30.0	40.0	926.0
MSM 20% WG with surfactant (0.2% NIS)	6	32.0	32.0	32.0	42.0	897.4
MSM 20% WG with surfactant (0.2% NIS)	12	33.0	33.0	30.0	41.0	978.5
Untreated Check	-	33.0	33.0	33.0	41.0	748.6
	CD(P=0.05)	-	NS	NS	NS	NS

NS: Non-significant

Table 9: Visual symptoms of residual Phytotoxicity effect of varied doses of Metsulfuron methyl 20 % WG on succeeding Black gram during 2015 (Season-II)

Treatments	Dosage (g a.i./ha)	Crop discoloration				Chlorosis				Deformation				Wilting				Vein clearing			
		7 DAS	14 DAS	21 DAS	30 DAS	7 DAS	14 DAS	21 DAS	30 DAS	7 DAS	14 DAS	21 DAS	30 DAS	7 DAS	14 DAS	21 DAS	30 DAS	7 DAS	14 DAS	21 DAS	30 DAS
MSM 20% WG without surfactant	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSM 20% WG without surfactant	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSM 20% WG with surfactant (0.2% NIS)	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSM 20% WG with surfactant (0.2% NIS)	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Untreated Check	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10: Effect of Metsulfuron methyl 20 % WG doses on yield attributes and yield of succeeding Black gram during 2015 (Season-II)

Treatments	Dosage (g a.i./ha)	Plant population/m ²		Plant height (cm)		Seed Yield (kg/ha)
		15 DAS	30 DAS	30 DAS	45 DAS	
MSM 20% WG without surfactant	6	32.0	32.0	30.0	40.0	848.3
MSM 20% WG without surfactant	12	31.0	31.0	32.0	41.0	876.9
MSM 20% WG with surfactant (0.2% NIS)	6	33.0	33.0	30.0	41.0	853.7
MSM 20% WG with surfactant (0.2% NIS)	12	33.0	33.0	33.0	42.0	928.2
Untreated Check	-	33.0	33.0	33.0	41.0	826.5
CD (P=0.05)	NS	NS	NS	NS	NS	NS

NS- Non-significant

Results and Discussion

Weed flora

The predominant broad leaved weed species observed in the experimental sites were *Amaranthusviridis*, *Ipomea sp.*, *Cleome viscosa*, *Euphorbia hirta*, *Phyllanthusniruri*, *Trianthema portulacastrum*, and *Commelina bengalensis*.

Efficacy against weeds

Weed density

Regardless the cropping years, the total broad leaved weed population declined drastically after the imposition of varied weed control treatments. Similarly, in both the cropping years the total weed density of broad leaved weeds were observed to be in gradually decreasing trend with the increasing doses of post emergence. Metsulfuron methyl 20 %WG from 4.0 to 8.0 g.a.i / ha with and without surfactants. Among the treatments, Po.E application of Metsulfuron methyl 20 % WG @ 8.0 g.a.i / ha along with 0.2 % surfactant registered the lowest density of broad leaved weeds and it was at par with the Po.E application of Metsulfuron methyl 20 % WG @ 6.0 g.a.i / ha with surfactant. The maximum density of the above listed broad leaved weeds species were recorded with the untreated check in both the cropping seasons and at all the stages of crop growth.

Total weed dry weight

All the weed control treatments were effective registering minimum dry weight of weeds at 30 and 60 days after application compared to untreated check in both the cropping years. The lowest dry weight of 117.0 and 120.0 gm² on 30 and 60 DAA respectively during 2015 and with 119.0 and 121.0 gm² on 30 and 60 DAA respectively during cropping seasons were recorded with Po.E application of Metsulfuron methyl 20 %WG @8.0g.a.i / ha along with 0.2 % surfactant treatment and it was on par with its lower @ 6.0g.a.i / ha with 0.2 % surfactant at 30 and 60 day after herbicides application. The maximum dry matter production was recorded with the untreated check in both the years.

Weed Control Efficiency (WCE %)

Regardless cropping years the highest weed control efficiency of 79.10 and 84.21 per cent respectively on 30 and 60 DAA during 2015 and with 79.12 and 84.0 per cent respectively on 30 and 60 DAA during 2016 cropping seasons were recorded with the Po.E application of Metsulfuron methyl 20 % WG @8.0g.a.i / ha with 0.2% surfactant which was on par with Po.E of Metsulfuron methyl 20 % WG @6.0g.a.i / ha with 0.2 % surfactant in both the stages of crop growth.

Effect on cane yield

The varied yield attributes viz., millable canes / m², cane length, cane girth and individual cane weight of sugarcane were positively enhanced by the weed control treatments compared to untreated check. Further, Irrespective of the cropping seasons, the maximum values of sugarcane yield attributes (12.5 and 12.6 of millable canes m², 285.6 and 278.4 cm of cane length, 3.4 and 3.2 cm of cane girth and 2.20 and 2.24 kg of individual cane weight respectively during 2014 and 2015 cropping season were resulted with the Po.E application of metsulfuron methyl 20 % WG @8.0g.a.i / ha along with 0.2 % surfactant. However, those values are comparable with the it's next lower dose of @ 6.0 of g.a.i / ha along with 0.2 % surfactant. The decreasing trend of the above yield parameters were recorded with other declining doses of Metsulfuron methyl, and the other herbicides. Regarding cane yield the maximum cane yield of 139.4 and 137.4 t / ha in the respective cropping years were accounted with the Po.E application of Metsulfuron methyl 20 % WG @ 8.0g.a.i / ha along with 0.2 % surfactant. In both the cropping years the untreated check resulted with minimum values of the yield parameters and yield of sugarcane.

Effect of Phytotoxicity on sugarcane

Regardless cropping seasons and the stages of sugarcane crop growth the varied doses of metsulfuron methyl 20 % WG with and without surfactant were found to be safer for usage in sugarcane which is evident from invaried visual and the

symptoms like yellowing, stunting and necrosis on 5, 10, 15, 20 & 30 days after herbicides applications which would not suppresses the establishment and growth of sugarcane. Moreover, sugarcane has some enzymes that are able to degrade the herbicide molecules in the plant and to reduce their toxicity (Azania *et al.*, 2005a;b)^[1]

Residual effect on succeeding crop Black gram

In both the cropping seasons the varied Po.E application doses of metsulfuron methyl 20 % WG with and without surfactant did not revealed any visual phytotoxic symptoms like discoloration, chlorosis, deformation, wilting, vein clearing at 7,14,21 & 30 DAS on the succeeding crop of black gram. Moreover, the plant population, plant height and the yield of succeeding black gram crop was found to be almost similar both with the X and 2X doses of Po.E. Metsulfuron methyl applications.

Conclusion

The early post - emergence application of metsulfuron methyl 20% WG @ 8.0 g.a.i / ha along with 0.2 % non-ionic surfactant resulted with maximum control of broad leaved weeds and resulted in enhanced values of varied growth, yield parameters and cane yield of sugarcane. Moreover, since any visual phytotoxicity symptoms were not observed on sugarcane and visual residual phytotoxicity effect on succeeding black gram, with any of the doses of Po.E application of Metsulfuron methyl 20%WG with and without surfactant, this herbicide @ 8.0 g.a.i / ha may be considered to be safe for usage in sugarcane for effective control of broad leaved weeds.

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