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RESEARCH NOTE

Effect of herbicides on weed dynamics and productivity of soybean

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ABSTRACT

A field experiment was conducted at Birsa Agricultural University, Ranchi, Jharkhand, during rainy *(Kharif)* season of 2019 to study the efficacy of herbicides on weed dynamics and productivity of soybean. The treatments comprised of: post-emergence application (PoE) of imazethapyr 75g/ha at 20 days after sowing (DAS), imazethapyr + imazamox 75 g/ ha PoE 20 DAS, quizalofop-ethyl 50 g/ha PoE 20 DAS, sodium-acifluorfen + clodinafop-propargyl 125 g/ha PoE, imazethapyr + pendimethalin 1.0 kg/ha PoE, hand weeding twice at 20 and 40 DAS, weed free (hand weeding thrice at 20, 40 and 60 DAS), and weedy check. A randomized block design with three replications was used. Quizalofop-ethyl 50 g/ha PoE recorded maximum yield attributes, *viz.* number of pods /plant (48), number of seeds/pod (2.73), 100 seeds weight (12.46) and yield of soybean (2.15 t/ha) owing to reduced weed biomass and higher weed control efficiency (73.33%) during initial crop growth stage and realized maximum net return (₹ 57221/ha) and B:C ratio (2.34).

Keywords: Productivity, Soybean, Quizalofop-ethyl, Weed control efficiency

Soybean [*Glycine max* (L.) Merril] is one of the important oilseed crops with its immense potential for food, oil, fuel and numerous industrial products (Gandhi 2009). Soybean is rich in high quality protein (40-42%) and other nutrients like calcium and iron. The area, production and productivity of soybean in world, is 121.5 m ha, 334.89 m t, and 2.76 t/ha, respectively (DES 2018). Soybean crop area is 10.56 m ha in India with a productivity of 1.08 m t. In Jharkhand soybean is grown as rainfed crop in upland and medium land situations with low productivity of 1.26 t/ha (Soybean NFSM). There is tremendous scope of soybean cultivation in Jharkhand. Among different production factors limiting soybean productivity, weeds are considered to be the major as the yield reduction due to uncontrolled weed is about 84 % (Kachroo *et al.* 2003). It, being a rainy season crop, heavily infested with grasses, broad-leaved and sedges weeds which compete for light, food, water and space against the soybean crop, and ultimately reduce the crop yield. Hence, for effective weed control in soybean crop, application of appropriate herbicides or other control measures is needed.

A field experiment was conducted at Birsa Agricultural University, Ranchi during rainy *(Kharif)* season of 2019 on sandy loam soil, moderately acidic in nature (pH 5.4), having EC 0.17/dSm, low organic carbon (4.2 g/kg) and available nitrogen (160 kg/ha), medium phosphorus (19 kg/ha) and potassium (146 kg/ha). The experiment was laid out in randomized block design with 8 treatments replicated thrice. The treatments consisted of eight different weed management treatments, *viz*. post-emergence application (PoE) of imazethapyr 75 g /ha at 20 DAS, imazethapyr + imazamox ready mix (RM) 75 g/ha PoE, quizalofop-ethyl 50 g/ha PoE, sodium-acifluorfen + clodinafop-propargyl (RM) 125 g/ha PoE, imazethapyr + pendimethalin (RM) 1.0 kg/ha PoE, hand weeding twice at 20 and 40 days after seeding (DAS), weed free (hand weeding thrice at 20, 40 and 60 DAS) and weedy check. Herbicides were applied on 20 DAS using 500 liters of water/ha with flat fan nozzle fitted knapsack sprayer. The observations on weeds were recorded at 30, 45 and 60 DAS. Weeds were counted using a quadrat of 0.25 square meter (0.5 x 0.5 m), and data obtained were expressed as density (no./m^2). The percent composition of weed flora was estimated from weedy check plot. Data on weeds were subjected to square root transformation ($\sqrt{x+0.5}$) before its statistical analysis.

Effect on weeds

The dominant weeds, associated with soybean crop in the experimental field, comprised of all category of weeds, *viz*. broad-leaved weeds like

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Stellaria media, Commelina benghalensis and *Phyllanthus niruri*, among grassy weeds *Dactyloctenium aegyptium, Echinochloa colona, Eleusine indica* and *Digitaria sanguinalis* and the sedge *Cyperus rotundas.*

Quizalofop-ethyl 50 g/ha PoE suppressed grassy weeds to the extent of 60.24 per cent at 30 DAS and 100 per cent at 45 and 60 DAS compared to weedy check (**Table 1**). Mean biomass of grassy and broad-leaved weeds increased from 30 DAS to 45 DAS by 91.54 and 74.63 per cent, respectively. Later at 60 DAS it decreased due to different herbicide treatments. The total mean weed biomass decreased 7.88 per cent from 30 to 60 DAS. Quizalofop-ethyl is quickly absorbed by the weeds; hence rain, even one hour after spray does not affect its effectiveness. Kushwah *et al.* (2006) also proved that quizalofop -p-ethyl 15 g/ha PoE was very effective against *Commelina benghalensis* and *Echinochloa colona*.

Hand weeding twice recorded maximum weed control efficiency *i.e.* 97.46, 93.96 and 96.40% at 30, 45 and 60 DAS (**Table 2)**. Among herbicides, maximum weed control efficiency was recorded by quizalofop-ethyl 50 g/ha PoE *i.e.* 73.33, 69.10 and 69.37% at 30, 45 and 60 DAS, respectively, as it curbed the growth of the grassy weeds effectively and resulted in the lowest weed biomass which may be the main reason for higher weed control efficiency.

Table 1. Weed biomass as influenced by weed control treatments

Treatment	Weed biomass (g/m^2)										
	30 DAS				45 DAS				60 DAS		
	NL	BLW	S	Total	NL	BLW	S	Total	NL	BLW	Total
Imazethapyr 75 g/ha PoE	9.83 (98.19)	7.96 (63.88)	2.59 (6.45)	12.09 (168.52)	10.98 (120.32)	8.43 (76.64)	3.02 (8.64)	14.29 (205.60)	8.35 (71.36)	9.57 (91.25)	12.74 (162.61)
Imazethapyr + imazamox 75 g/ha PoE	10.16 (103.52)	8.54 (72.8)	3.34 (10.99)	13.68 (187.31)	12.98 (168.64)	7.51 (59.68)	3.07 (9.55)	15.35 (237.87)	11.52 (135.68)	4.27 (18.27)	12.28 (153.95)
Quizalofop-ethyl 50 g /ha PoE	0.71 (0)	9.64 (92.69)	3.96 (15.41)	10.41 (108.11)	0.71 (0)	14.13 (199.79)	0.71 (0)	14.13 (199.79)	0.71 (0)	10.62 (112.80)	10.62 (112.80)
Sodium-acifluorfen + clodinafop 125 g/ha PoE	7.44 (55.09)	6.54 (46.4)	6.33 (39.57)	11.80 (141.07)	9.55 (95.47)	11.30 (132.27)	6.09 (36.88)	16.05 (264.61)	7.61 (57.52)	5.08 (28.96)	9.27 (86.48)
Imazethapyr + pendimethalin 1.0 kg /ha PoE	7.88 (62.61)	8.44 (71.2)	4.25 (17.71)	12.29 (151.52)	15.49 (239.89)	11.02 (121.81)	2.17 (7.11)	19.22 (368.81)	9.38 (89.36)	9.30 (89.97)	13.38 (179.33)
Hand weeding twice at 20 and 40 DAS	1.56 (1.97)	1.85 (3.07)	2.15 (4.75)	3.17 (9.79)	3.01 (9.39)	4.44 (19.25)	3.18 (9.71)	6.23 (38.35)	1.18 (1.33)	3.55 (12.4)	3.7 (13.73)
Weed free	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.94 (0)
Weedy check	13.67 (187)	12.59 (159)	7.81 (17.92)	20.14 (406.67)	18.24 (339.99)	16.72 (279.52)	5.29 (27.84)	25.41 (647.35)	14.30 (205.76)	12.88 (165.87)	19.24 (371.63)
LSD(p=0.05)	1.67	2.12	1.04	1.97	2.99	2.52	1.03	2.39	2.30	2.10	1.77

Figures in parentheses are original values subjected to square root ($\sqrt{x+0.5}$) transformation; NL = narrow-leaved weeds, BL = broad-leaved weeds, S= sedges; PoE = post-emergence application

Table 2. Weed Index (WI), weed control efficiency (WCE), yield components, Yield and harvest index (HI) of soybean as influenced by weed control treatments

Treatment	WI (%)	WCE (%)			No. of pods/ plant	No. of seeds/ pod	100 seeds weight (g)	Seed yield (t/ha)	Straw yield (t/ha)	HI (%)
		30 DAS	45 DAS	60 DAS						
Imazethapyr 75 g/ha PoE	26.02	58.30	67.66	55.82	41	2.00	11.76	1.93	3.91	32.82
Imazethapyr + imazamox 75 g/ha PoE	23.09	53.54	62.93	58.86	44	2.13	11.02	2.00	3.58	35.85
Quizalofop-ethyl 50 g/ha PoE	16.73	73.33	69.11	69.37	48	2.73	12.46	2.15	3.70	36.76
Sodium-acifluorfen + clodinafop 125 g/ha PoE	30.72	63.71	58.28	76.69	42	1.97	9.77	1.80	3.32	35.23
Imazethapyr + pendimethalin 1.0 kg/ha PoE	32.76	61.52	42.26	51.38	42	2.33	11.62	1.73	3.26	34.38
Hand weeding twice at 20 and 40 DAS	6.54	97.46	93.96	96.40	41	2.2	11.36	2.44	3.50	41.03
Weed free	0.00	100.00	100.00	99.40	52	2.47	10.97	2.60	3.55	42.34
Weedy check	57.44	0.00	0.00	0.00	24	1.53	9.78	1.11	1.85	37.47
LSD(p=0.05)	18.01	12.40	13.25	9.53	9.40	0.38	1.39	0.47	0.66	7.08

Table 3. Economics of soybean as influenced by weed control treatments

Treatment	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
Imazethapyr 75 g/ha PoE	23201	73632	50431	2.17
Imazethapyr + imazamox 75 g/ha PoE	24821	75853	51032	2.06
Quizalofop-ethyl 50 g /ha PoE	24416	81637	57221	2.34
Sodium-acifluorfen + clodinafop 125 g/ha PoE	24007	68439	44432	1.85
Imazethapyr + pendimethalin 1.0 kg /ha PoE	24946	65981	41035	1.64
Hand weeding twice at 20 and 40 DAS	37736	92119	54383	1.44
Weed free	44111	98373	54262	1.23
Weedy check	22436	42186	19750	0.88
LSD(p=0.05)		17741.28	17741.28	0.72

Effect on soybean yield attributes and yield

Quizalofop-ethyl 50 g/ha PoE was as effective as weed free and recorded significantly higher pods per plant (48), seeds per pod (2.73) and 100 seed weight (12.46 g) which was 78.43, 27.40, 50 percent higher compared to those in weedy check (**Table 2**). Similar results were reported by Benke *et al.* (2011).

Among different herbicides quizalofop-ethyl 50 g/ha PoE proved to be best treatment in producing significantly higher seed (2.15 t/ha) and straw yield (3.70 t/ha) followed by imazethapyr + imazamox 75 g/ha at 20 DAS compared to weedy check (**Table 2**). This treatment also recorded minimum weed index (16.73%).

Economics

Quizalofop-ethyl 50 g/ha PoE, recorded higher gross return (₹ 81637/ha), net return (₹ 57221/ha) and B:C ratio (2.34) compared to weedy check (₹ 42186/ha, ₹ 19750/ha and 0.88) (**Table 3**). Samant *et al*. (2014) and Pratap *et al*. (2019) also observed maximum economical yield and effective control of grassy weeds with quizalofop-ethyl in groundnut and soybean.

Thus, it can be summarized that quizalofop-ethyl 50 g/ha PoE was effective in reducing weed biomass resulting higher weed control efficiency (73.33%) during initial crop growth stage, produced maximum soybean yield (2.15 t/ha) and attained maximum net return ₹ 57221/ha and B:C ratio 2.34.

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