

Nutrient uptake by weeds and soybean crop as influenced by weed management practices in Vertisols

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ABSTRACT

A field experiment was conducted during kharif season of 2021 to study the effect of weed management practices on uptake of nutrients by weed and soybean at Kota (Rajasthan). The results indicated that weeds in soybean depleted the soil fertility by removing 69.2 kg ha⁻¹ N, 12.4 kg ha⁻¹ P and 76.7 kg ha⁻¹ K under unweeded check. All weed management practices reduced weed dry matter and nutrient uptake by weeds at 30 and 60 days after sowing (DAS). Two hand weedings and ready mixture of fomesafen + fluazifop-p-butyl @ 220 g a.i. ha⁻¹ proved significantly superior in reducing weed dry matter and nutrient uptake by weeds at 30 and 60 DAS over rest of the treatments. All weed control measures significantly enhanced seed and straw yield of soybean over weedy check. Two hand weedings and mixture of fomesafen + fluazifop-p-butyl @ 220 g a.i. ha⁻¹, sodium acifluorfen + clodinafop-propargyl @ 245 g a.i. ha⁻¹ and propaquizafop + imazethapyr @ 125 g a.i. ha⁻¹ as post emergence (PoE) were at par and were found to be significantly superior over rest of the treatments in enhancing seed and straw yield. Ready mix application of fomesafen + fluazifop-p-butyl @ 220 g a.i. ha⁻¹, propaquizafop + imazethapyr @ 125 g a.i. ha⁻¹ and sodium acifluorfen + clodinafop-propargyl @ 245 g a.i. ha⁻¹ (PoE) significantly reduced the NPK uptake by total weeds and significantly improved nutrient uptake by soybean and consequently resulted higher seed yields.

Keywords: Nutrient uptake, weed, weed management, soybean

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill.) often designated as miracle crop of twenty first century, contains about 20% of oil, 40% high quality proteins, 23% carbohydrates and reasonable amount of minerals, vitamins and dietary fibres. Soybean is a rainy season crop and it faces severe crop weed competition during active phase of growth. The initial slow growth of soybean with lateral spread, offers severe infestation of a large number of weeds which reduces the yield to an extent of 31 to 84% (Kachroo *et al.* 2003; Sharma *et al.* 2016). Although weeds pose problems during the entire crop period but maintaining weed free condition during critical period (first 45 days after sowing) is very much essential (Hosmath 2014; Jadon *et al.* 2019). Similarly, nutrients uptake by crop mainly depends on the dynamics of biomass accumulation. Decreased uptake of nutrients by the crop was noticed with increase in severity and duration of weed infestation. Nutrient uptake by crop at 40 DAS was significantly higher in weeds associated with soybean (Habimana *et al.* 2013). Among the oilseed crops, soybean is mainly worst affected, where nutrient depletion was estimated around 54.0, 5.6, 60.4 NPK kg ha⁻¹

¹ (Dev *et al.* 1998). Poor control of weeds is one of reason for the lowered fertilizer use efficiency as well as productivity. To minimize the magnitude of nutrient drain by weeds and more effective utilization of fertilizer by crop plant require the control of weeds. Herbicides cause an appreciable decrease in nutrient depletion by weed growth as a consequence of which considerable improvement in nutrient uptake at the crop plants and enhancement in crop yields occurred. Therefore, there is a need to develop the suitable weed management measures for decreasing the nutrient removal by weeds and increasing the uptake by soybean crop.

MATERIALS AND METHODS

A field experiment was conducted at Research Farm, Agricultural Research Station, Umedganj, Kota Rajasthan during kharif 2021. The soil of experimental site was clay loam in texture with alkaline reaction (pH 7.7), EC (2.9 dSm⁻¹), low in organic carbon (4.9 g kg⁻¹), available N (210 kg ha⁻¹), P₂O₅ (18 kg ha⁻¹) and K₂O (310 kg ha⁻¹). The experiment was laid out in randomized block design with sixteen weed management treatments and three replications. The treatments, included weedy check, two

hand weeding at 20 and 40 DAS, pendimethalin 30% EC @ 1.0 kg a.i.ha⁻¹ pre emergence (PE), imazethapyr 10 % SL @ 100 g a.i.ha⁻¹, fluthiacet-methyl 10.3 EC @ 12.5 g a.i.ha⁻¹, clodinafop-propargyl 15 % WP @ 60 g a.i.ha⁻¹, fomesafen 25 % SL @ 250 g a.i.ha⁻¹, fluazifop-p-butyl 13.4 % EC @ 250 g a.i.ha⁻¹, propaquizafop 10 % EC @ 50 g a.i.ha⁻¹ as PoE, pendimethalin 30 % EC + imazethapyr 2 % EC @ 960 g a.i.ha⁻¹ (PE), propaquizafop 2.5 % @ 50 g /ha + imazethapyr 3.75 % (93.7 and 125 g a.i.ha⁻¹ , sodium acifluorfen 16.5 % EC + clodinafop-propargyl 8 % EC @ 183.7 and 245 g a.i.ha⁻¹ and fomesafen 11.1 % + fluazifop-p-butyl 11.1 % SL @ (165 and 220 g a.i.ha⁻¹) as PoE in weed management treatments. Appropriate management practices were adopted to raise the soybean cv. "JS 20 34". Soybean cv. "JS 20 34" inoculated with *Rhizobium* culture and was sown with the on set of monsoon on 14 July, 2021. The observations on weed dry matter were recorded using 0.25 m² quadrat. Pre-emergence herbicides were applied just after sowing and post emergence herbicides were applied 16 days after sowing. Individual weed samples were collected and then oven dried. Individual weed samples were collected and then drying in oven at 60 °C. The plant samples (weeds, soybean seed and straw) for N, P and K content were analyzed following standard procedures (Jackson 1973). The uptake of nutrients (N, P and K) was calculated by multiplying per cent nutrient content and yield. Statistical methods based on analysis of variance technique as described by Gomez and Gomez (1984) was employed.

RESULTS AND DISCUSSION

Nutrient removal by weeds

Weeds depleted the soil fertility by taking 18.4 kg N ha⁻¹, 8.6 kg P ha⁻¹ and 13.2 kg K ha⁻¹ under unweeded check. Maximum nitrogen depletion was recorded under weedy check (8.5 kg ha⁻¹) and minimum with two hand weeding at 20 and 40 DAS which was significantly superior over herbicidal treatments (Table 1). Results indicated that a significant decrease in total N, P and K depletion by weeds were recorded with all weed control treatments compared to weedy check. Lowest N, P and K uptake by weeds with two hand-weedings was reported by Sharma *et*

al. 2016. The minimum N, P and K depletion (1.3, 0.2 & 1.0 kg ha⁻¹, respectively) at 30 and 60 DAS was recorded under two hand weeding at 20 & 40 DAS. Among herbicidal treatments, ready mixture herbicide of fomesafen 11.1% + fluazifop-p-butyl 11.1% SL @ 220 g a.i. ha⁻¹, propaquizafop 2.5% + imazethapyr 3.75% @ 125 g a.i. ha⁻¹ and sodium acifluorfen 16.5% EC + clodinafop-propargyl 8 % EC @ 245 g a.i. ha⁻¹ registered significantly lower N, P and K depletion as compared to rest of the treatments and weedy check. Application of alone fomesafen 25% SL @ 250 g a.i. ha⁻¹, imazethapyr 10% SL @ 100 g a.i. ha⁻¹, fluthiacet-methyl 10.3 EC @ 12.5 g a.i. ha⁻¹, fluazifop-p-butyl 13.4% EC @ 250 g a.i. ha⁻¹, propaquizafop 10% EC @ 50 g a.i. ha⁻¹ and clodinafop propargyl 60 g ha⁻¹ also significantly reduced depletion of N, P and K by weeds over weedy check but lagged behind ready mixtures applied post emergence herbicides. Application of fomesafen + fluazifop-p-butyl 220 g a.i. ha⁻¹ noted significantly lowest depletion of nitrogen (3.48 kg ha⁻¹), phosphorus (1.67 kg ha⁻¹), and potash (2.49 kg ha⁻¹), being at par with propaquizafop + imazethapyr 125 g a.i. ha⁻¹ (3.38, 1.63, 2.43 kg ha⁻¹) and sodium acifluorfen + clodinafop-propargyl 245 g a.i. ha⁻¹ (3.63, 1.75, 2.59 kg ha⁻¹) significantly reduced the nitrogen depletion by weeds compared to weedy check and rest of the herbicides either mixture and alone. Post emergence application of sole herbicides viz., imazethapyr 100 g a.i. ha⁻¹, fomesafen 250 g a.i. ha⁻¹, fluthiacet-methyl 12.5 g a.i. ha⁻¹, clodinafop-propargyl 60 g a.i. ha⁻¹, fluazifop-p-butyl 250 g a.i. ha⁻¹ and propaquizafop 50 g a.i. ha⁻¹ were found significantly effective in reducing NPK depletion. Ready mixture of as POE was found more effective in decreasing N, P and K removal by weeds than alone herbicidal treatments. N, P and K uptake by weeds almost followed the footsteps of weed biomass in trend. Grassy herbicides imazethapyr, clodinafop propargyl, fluazifop-p-butyl, propaquizafop, pendimethalin+ imazethapyr (PE) significantly reduced the nutrient depletion by monocot weeds while post-emergence application of fomesafen and fluthiacet-methyl were effective on broad leaf weeds. The results were in close conformity with the Kumber *et al.* (2014).

Table 1: Effect of weed control measures on weed biomass (kg ha⁻¹) and total N, P and K uptake (kg ha⁻¹) by weeds in soybean crop

Treatments	Weed biomass		N uptake		P uptake		K uptake	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Weedy check	4107	7792	8.49	18.37	4.34	8.60	5.99	13.16
2 HW 20 & 40 DAS	189	609	0.38	1.26	0.19	0.66	0.27	0.95
Pendimethalin 1.0 kg	1112	3479	2.23	8.03	1.12	3.80	1.57	5.68
Imazethapyr 100 g/ha	1040	2791	2.16	6.55	1.08	3.01	1.52	4.45
Fluthiacet-methyl 12.5g/ha	2105	4374	4.31	10.29	2.17	4.71	3.03	7.27
Clodinafop propargyl 60 g/ha	2319	4592	4.58	10.40	2.30	4.85	3.14	7.24
Fomesafen 250 g/ha	2092	4371	4.28	10.28	2.16	4.59	3.01	7.17
Fluazifop-p-butyl 250 g/ha	2323	4324	4.60	9.77	2.34	4.63	3.24	6.91
Propaquizafop 50 g/ha	2328	4597	4.68	10.60	2.35	5.02	3.29	7.50
Pendi. + Imaz 960 g/ha	964	2834	1.83	6.19	0.92	2.93	1.29	4.38
PropaqF. + Imaz 93.7 g/ha	1099	2683	2.10	5.82	1.06	2.81	1.48	4.16
PropaqF. + Imaz 125 g/ha	616	1559	1.18	3.38	0.59	1.63	0.83	2.42
Sod.Aciff.+ Clodi.F 183.7 g/ha	1133	2761	2.18	6.04	1.10	2.91	1.53	4.31
Sod.Aciff. + ClodinaF 245 g/ha	641	1615	1.27	3.63	0.64	1.75	0.89	2.59
Fomsaf. + FluaziFB 165 g/ha	1100	2682	2.21	6.12	1.09	2.95	1.55	4.37
Fomsaf.+ FluaziFB 220 g/ha	593	1551	1.17	3.48	0.59	1.67	0.83	2.49
SEm ±	94	219	0.17	0.47	0.12	0.29	0.16	0.37
CD (P=0.05)	272	631	0.48	1.37	0.36	0.85	0.45	1.06

Nutrient uptake by soybean

Sole and ready mixture application of herbicides significantly increased N, P and K uptake by crop over weedy check. Maximum uptake of N (189.7 kg ha⁻¹), P (17.33 kg ha⁻¹) and K (97.51 kg ha⁻¹) was recorded under two hand weeding at 20 and 40 DAS compared to weedy check (Table 2). Among herbicidal treatments, ready mix of fomesafen 11.1 % + fluazifop-p-butyl 11.1 % SL 220 g a.i.ha⁻¹ recorded significantly higher total N (165.0 kg ha⁻¹), P (15.27 kg ha⁻¹) and K (86.92 kg ha⁻¹) being at par with propaquizafop 2.5% + imazethapyr 3.75 % @ 125 g a.i.ha⁻¹ and sodium acifluorfen 16.5 % EC + clodinafop-propargyl 8% EC @ 245 g a.i.ha⁻¹ proved superior to rest of the herbicidal treatments. Weedy conditions throughout the growing season resulted in 65.1, 63.9 and 61.2% reduction in N, P and K uptake by crop (Seed +Straw). The improvement under these treatments was because of reduced competition due to effective weed control resulting more availability to the crop plants. Sole and ready mix application of herbicides significantly increased N, P & K uptake by crop over weedy check. Maximum NPK uptake by soybean crop reported under two hand weeding and herbicide mixture (Singh *et al.* 2006).

Soybean yield

Seed yield of soybean was significantly enhanced under all weeds management treatments (Table 2). Two hand weeding, fomesafen + fluazifop-p-butyl @220 g a.i. ha⁻¹, sodium acifluorfen + clodinafop-propargyl @ 245 g a.i. ha⁻¹ and propaquizafop + imazethapyr @125 g a.i. ha⁻¹ recorded significantly higher seed yield over all other weed management treatments. Two hand weeding recorded significantly higher seed (1970 kg ha⁻¹) and straw (2636 kg ha⁻¹) followed by ready mix of fomesafen + fluazifop-p-butyl 220 @ g a.i.ha⁻¹ (1760 and 2364 kg ha⁻¹), propaquizafop + imazethapyr @125 g a.i.ha⁻¹ (1730, 2323 kg ha⁻¹) and sodium acifluorfen + clodinafop-propargyl @245 g a.i.ha⁻¹ (1628, 2204 kg ha⁻¹) over weedy check which were increased seed yield to the tune of 214.7, 181.2, 176.4 & 160.0 per cent over weedy check, respectively. Pre-emergence application of herbicide pendimethalin 1.0 kg g a.i. ha⁻¹ proved to be least efficient in improving the seed yield. The greatest benefits of weed control in term of yield enhancement over weedy check were achieved by two hand weeding (214.7 per cent) followed by fomesafen + fluazifop-p-butyl @220 g a.i. ha⁻¹, propaquizafop + imazethapyr @125 g a.i. ha⁻¹ and sodium

acifluorfen + clodinafop-propargyl 245 g a.i. ha⁻¹ which accounted to 181.1, 176.3 and 160.0 per cent higher seed yield over weedy check. Yield increased due to preemergence application of pendimethalin 30 EC + imazethapyr 2 EC @ 960

g a.i. ha⁻¹ and pendimethalin 30 EC @ 1.0 g a.i. ha⁻¹ was only 80.0 and 54.9 per cent over weedy check, respectively. Similar results were reported by Sharma *et al.* (2016) and Jadon *et al.* (2019).

Table 2: Effect of weed control measures on nutrient uptake (kg ha⁻¹) by soybean, seed yield, oil content (%) and oil yield (kg ha⁻¹)

Treatments	Nitrogen	Phosphorus	Potash	Seed yield	Straw yield	Oil content	Oil yield
Weedy check	56.1	5.60	32.81	626	977	18.82	117.9
2 HW 20 & 40 DAS	189.7	17.33	97.51	1970	2636	19.92	392.4
Pendimethalin 1.0 kg	85.6	8.42	47.20	970	1328	19.34	187.4
Imazethapyr 100 g/ha	103.7	9.94	55.67	1145	1551	19.48	223.1
Fluthiacet-methyl 12.5 g/ha	97.7	9.66	53.47	1113	1510	18.83	209.6
Clodinafop-propargyl 60 g/ha	93.8	9.25	52.07	1072	1454	19.12	205.0
Fomesafen 250 g/ha	97.8	9.57	53.40	1103	1496	19.31	213.3
Fluazifop-p-butyl 250 g/ha	88.9	8.76	49.00	1014	1378	19.47	197.6
Propaquizafop 50 g/ha	91.9	9.15	50.75	1053	1435	19.40	204.1
Pendi. + Imaz 960 g/ha	100.2	9.72	54.48	1127	1527	19.42	218.9
PropaqF. + Imaz 93.7 g/ha	126.6	12.16	68.68	1407	1897	18.26	256.6
PropaqF. + Imaz 125 g/ha	160.4	14.97	84.63	1730	2323	18.82	325.5
Sod.Aciff.+ Clodi.F 183.7 g/ha	121.0	11.55	66.19	1340	1808	19.66	262.9
Sod.Aciff. + ClodinaF 245 g/ha	152.3	14.12	80.83	1628	2204	19.82	322.6
Fomsaf. + FluaziFB 165 g/ha	127.6	12.19	69.60	1413	1905	19.80	280.3
Fomsaf.+ FluaziFB 220 g/ha	165.0	15.24	86.92	1760	2364	19.84	349.1
SEm ±	5.1	0.46	2.69	63	82	0.35	12.2
CD (P=0.05)	14.6	1.34	7.76	181	238	NS	35.3

Oil content in soybean seed was not significantly influenced by different weed management treatments. However, significantly higher oil yield was recorded with various weed control measures over weedy check. Two hand weeding recorded maximum oil yield (392.4 kg ha⁻¹) followed by fomesafen + fluazifop-p-butyl @ 220 g a.i. ha⁻¹, propaquizafop + imazethapyr @ 125 g a.i. ha⁻¹ and sodium acifluorfen + clodinafop-propargyl @ 245 g a.i. ha⁻¹ which

increased to the tune of 253.2, 195.8, 175.8 and 173.4 per cent, respectively over weedy check.

It may be concluded that application of post emergence ready mix herbicide of fomesafen 11.1 % + fluazifop-p-butyl 11.1% SL @ 220 g a.i. ha⁻¹ effectively controlled grassy, broad leaved & sedge weeds and reduced their dry matter accumulation resulting in to more availability and uptake of nutrients by the soybean crop and ultimately gave higher seed and straw yield of soybean.

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