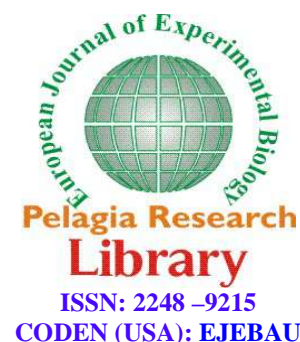




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Nutrient uptake and yield of soybean (*Glycine max* L.) as influenced by pre and post-emergence herbicides

¹Sylvestre Habimana*, ¹K. N. Kalyana Murthy, ¹B. C. Shankaralingappa, ²M. T. Sanjay and ³C. Ramachandra

¹Department of Agronomy, University of Agricultural Sciences, GKVK- Bengaluru India

²All India Coordinated Research Project on Weed Control, Hebbal-Bengaluru India

³All India Coordinated Research Project on Rice, V.C Farm Mandya India

ABSTRACT

A field experiment was conducted in zonal agricultural research station, University of agricultural sciences, (UAS) GKVK Bengaluru during Kharif, 2012 to study the nutrient uptake and yield of soybean as influenced by Pre and Post-emergence herbicides. The experiment was laid out in Randomized Complete Block Design (RCBD) with ten treatments replicated thrice. The treatments constituted of application of pre and post-emergence herbicides (pendimethalin 30 EC, metribuzin 70 WP and fenoxaprop-p-ethyl 9 EC, imazethapyr 10 SC, respectively), farmer's practice of intercultivation fb hand weeding at 20 and 40 DAS as well as unweeded check. The study revealed that intercultivation fb. hand weeding at 20 and 40 DAS recorded significantly higher plant height and dry matter production of crop and thus resulted in higher uptake of nutrients (N, P and K) by the soybean as well as higher grain yield over other herbicide treatments and unweeded check except pre-emergence application of metribuzin 70 WP fb. imazethapyr and metribuzin 70 WP fb. intercultivation at 30 DAS which remained at par each other.

Keywords: Nutrient uptake, pre emergence herbicides, post emergence herbicides, soybean, yield.

INTRODUCTION

Soybean (*Glycine max*), is an important oil-yielding rainy-season (*kharif*) crop having multiple uses. Weeds are the major biotic factor responsible for poor yield in soybean. Simultaneous emergence and rapid growth of large number of weed species causes severe crop-weed competitions and reduction in crop yields (30-80 %) depending upon the type of weed flora and weed density [1].

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 [2]. Nutrient uptake at 40 DAS was significantly higher in weeds associated with soybean [3]. An experiment conducted in 1994, the author reported that crop under weed free check accumulated maximum nutrients (132.7 kg N, 70.5 kg P₂O₅ and 98.2 kg K₂O ha⁻¹) [4].

The incessant rains do not permit timely intercultivations and manual control of weeds is also difficult on large scale on account of high cost and labour shortage during weeding peaks.

Therefore, there is a need for alternative methods of reducing the weed load during early crop growth period of soybean *i.e.* first 30-45 DAS [5]. The herbicides presently available are either pre-emergence (PRE) or pre-plant incorporated (PPI) and have a narrow spectrum weed control. The biology of some weeds that occur in soybean makes it difficult to achieve effective weed control with single application of herbicides; PPI or PRE or post-emergence (POST).

Recent studies [6] clearly indicated that sequential application of herbicides (PRE followed by (fb) (POST) will provide more consistent weed control than single application. A well planned PRE fb POST herbicide application would provide more consistent weed control and helps to minimize the weed menace. Hence, present investigation was undertaken to study the nutrient uptake and yield of soybean as influenced by pre and post-emergence herbicides.

MATERIALS AND METHODS

A field experiment was conducted *in zonal* agricultural research station, University of agricultural sciences, GKVK Bengaluru during *Khariif*, 2012 to study the nutrient uptake and yield of soybean as influenced by pre and post-emergence herbicides. The soil of the experimental site was red sandy loam, with slightly acidic (pH 6.44), medium in organic carbon (0.55 %), in available Nitrogen (288.549 kg ha⁻¹), in available potassium (175.08kg ha⁻¹) and in phosphorus (38.49 kg ha⁻¹). The experiment was laid out in RCBD and composed of ten treatments replicated thrice *viz* **T₁**: Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS (days after sowing), **T₂**: Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS followed by (*fb*) intercultivation (IC) at 30 DAS, **T₃**: Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS *fb.* fenoxaprop-p-ethyl 9 EC at 70 g a.i ha⁻¹ at 20 DAS, **T₄**: Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS *fb.* imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS, **T₅**: Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS, **T₆**: Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS *fb.* IC at 30 DAS, **T₇**: Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS *fb.* fenoxaprop-p-ethyl 9 EC at 70 g a.i ha⁻¹ at 20 DAS, **T₈**: Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS *fb.* imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS, **T₉**: Intercultivation *fb.* hand weeding (HW) at 20 and 40 DAS, **T₁₀**: Unweeded check, all replicated thrice. Variety MAUS-2 was sown on 12th August 2012. Recommended fertilizer dose of 25 kg N, 60 kg P₂O₅ and 25 kg K₂O ha⁻¹ was applied in the form of urea, single super phosphate and muriate of potash, respectively. The observations on nutrient uptake by both weeds and crop as well as yield and yield attributes were recorded.

The data were analyzed statistically for test of significance [7]. The level of significance on “F” test was tested at 5 per cent. The interpretation of data was done by using CD values calculated at p \geq 0.05.

The major weed flora observed in the experimental plot was the following: *Eleusine indica*, *Digitaria marginata*, *Dactyloctenium aegyptium*, *Eragrostis pilosa*, *Amaranthus viridis*, *Oldenlandia corymbosa*, *Parthenium hysterophorus*, *Commelina benghalensis*, *Acanthospermum hispidum*, *Borreria hispida* and *Cyperus rotundus*.

RESULTS AND DISCUSSION

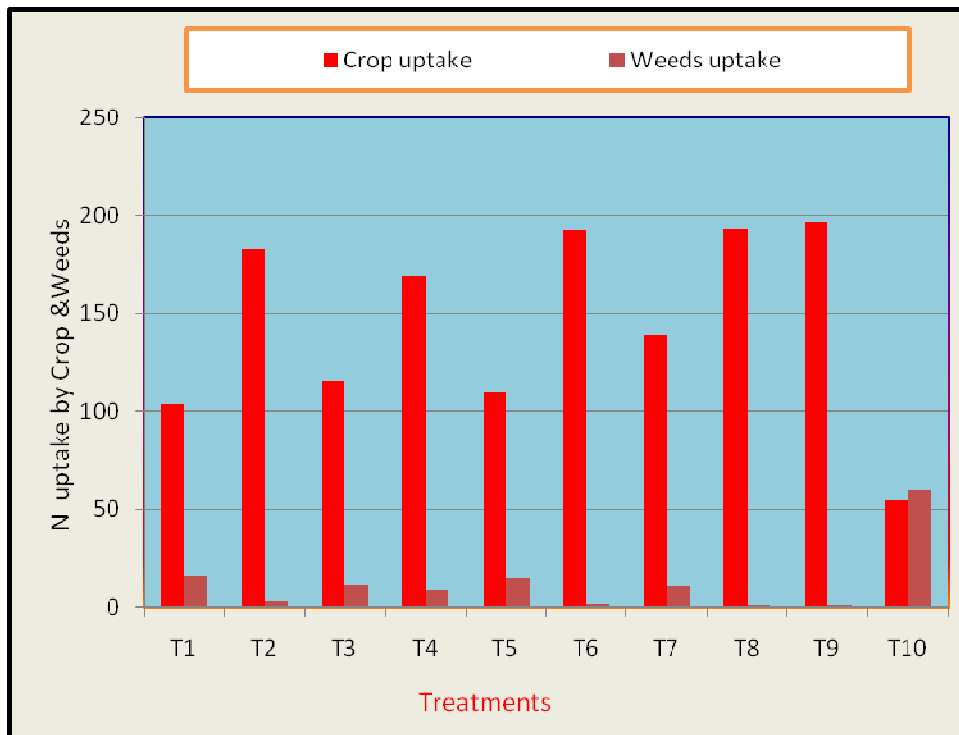
The uptake of N, P and K by the soybean crop decreased with increase in weed population and increased with decrease in weed competition.

Nitrogen (N) uptake by crop and weeds:

Significantly higher N uptake by crop (196.51 kg ha⁻¹) was significantly recorded with intercultivation *fb* two hand weedings at 20 and 40 DAS and remained at par with metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS *fb.* imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS (193.10 kg ha⁻¹) as well as metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS *fb.* intercultivation at 30 DAS (192.66 kg ha⁻¹).

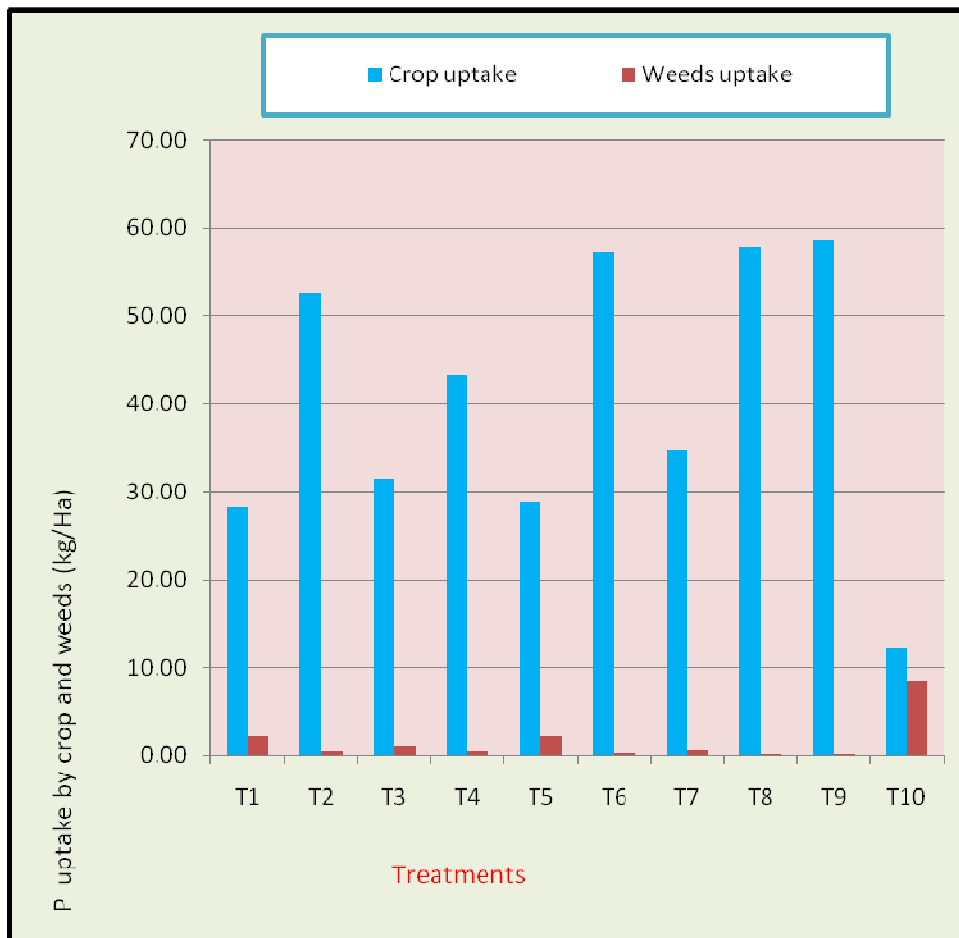
Similarly, lower N uptake by weeds (1.36 kg ha⁻¹) was recorded with intercultivation *fb* two hand weedings at 20 and 40 DAS and remained at par with metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS *fb.* imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS (1.52 kg ha⁻¹) as well as metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS *fb.* intercultivation at 30 DAS (1.60 kg ha⁻¹). The unweeded check recorded lower N uptake by crop and higher uptake by weeds (Fig.1). The

maximum plant height and crop total dry matter might have resulted in higher uptake of nitrogen. Similar results were noticed [8].



- Legend**
- T1:** Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS (days after sowing)
 - T2:** Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS fb. IC at 30 DAS
 - T3:** Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS fb. fenoxaprop-p-ethyl 9 EC at 70 g a.i ha⁻¹ at 20 DAS
 - T4:** Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS
 - T5:** Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS
 - T6:** Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. IC at 30 DAS
 - T7:** Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. fenoxaprop-p-ethyl 9 EC at 70 g a.i ha⁻¹ at 20 DAS
 - T8:** Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS
 - T9:** Intercultivation followed by HW at 20 and 40 DAS
 - T10:** Unweeded check

Fig.1. Nitrogen uptake (kg ha⁻¹) by weed and soybean as influenced by weed management practices of soybean



Legend	
T1:	Pendimethalin 30 EC at 0.75 kg a.i ha ⁻¹ at 3 DAS (days after sowing)
T2:	Pendimethalin 30 EC at 0.75 kg a.i ha ⁻¹ at 3 DAS fb. IC at 30 DAS
T3:	Pendimethalin 30 EC at 0.75 kg a.i ha ⁻¹ at 3 DAS fb. fenoxaprop-p-ethyl 9 EC at 70 g a.i ha ⁻¹ at 20 DAS
T4:	Pendimethalin 30 EC at 0.75 kg a.i ha ⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha ⁻¹ at 20 DAS
T5:	Metribuzin 70 WP at 0.5 kg a.i ha ⁻¹ at 3 DAS
T6:	Metribuzin 70 WP at 0.5 kg a.i ha ⁻¹ at 3 DAS fb. IC at 30 DAS
T7:	Metribuzin 70 WP at 0.5 kg a.i ha ⁻¹ at 3 DAS fb. fenoxaprop-p-ethyl 9 EC at 70 g a.i ha ⁻¹ at 20 DAS
T8:	Metribuzin 70 WP at 0.5 kg a.i ha ⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha ⁻¹ at 20 DAS
T9:	Intercultivation followed by HW at 20 and 40 DAS
T10:	Unweeded check

Fig.2. Phosphorus uptake (kg ha⁻¹) by weed and soybean as influenced by weed management practices of soybean

Phosphorus (P) uptake by crop and weeds:

Significantly higher P uptake by crop (58.46 kg ha⁻¹) was recorded with intercultivation fb two hand weeding at 20 and 40 DAS and remained at par with metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS (57.84 kg ha⁻¹) as well as metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. intercultivation at 30 DAS (57.22 kg ha⁻¹). Similarly, significantly lower P uptake by weeds (0.17 kg ha⁻¹) was recorded with intercultivation fb two hand weeding at 20 and 40 DAS and remained at par with metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS (0.21 kg ha⁻¹) as well as metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. intercultivation at 30 DAS (0.23 kg ha⁻¹). The unweeded check recorded lower P uptake by crop and higher uptake by weeds (Fig.2). Higher weed control efficiency of this treatment offered a better crop growth condition thereby enhancing the uptake of phosphorus. These results are in line with the findings of [9].

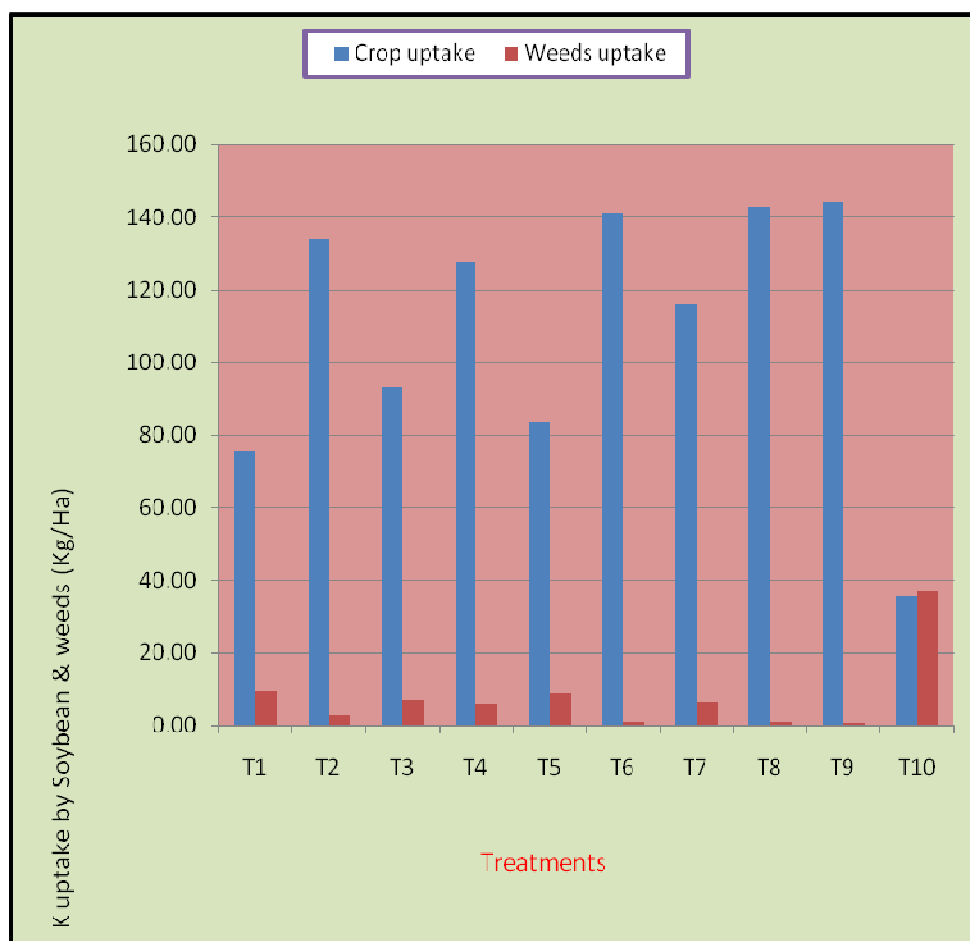
Potassium (K) uptake by crop and weeds:

Significantly higher K uptake by crop (144.15 kg ha⁻¹) was recorded with intercultivation fb two hand weeding at 20 and 40 DAS and remained at par with metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS (142.74 kg ha⁻¹) as well as metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. intercultivation at 30 DAS (141.24 kg ha⁻¹). Similarly, significantly lower P uptake by weeds (0.76 kg ha⁻¹) was recorded with intercultivation fb two hand weeding at 20 and 40 DAS and remained at par with metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS (0.87 kg ha⁻¹) as well as metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. intercultivation at 30 DAS (1.13 kg ha⁻¹). The unweeded control recorded lower K uptake by crop and higher uptake by weeds (Fig.3). Higher uptake of potassium by crop might be due to lack of phytotoxicity, higher weed control efficiency, crop total dry matter and crop growth. Similar findings were reported by [10].

Yield and yield attributes of soybean as influenced by pre and post-emergence herbicides:

The yield attributes of soybean *viz* number of pods plant⁻¹, pod weight, number of grains pod⁻¹ and hundred grains weight are important parameters which govern and have direct influence on the yield of the soybean crop (Table1). Significantly higher number and weight of the aforementioned parameters were recorded with intercultivation fb two hand weedings at 20 and 40 DAS (165 pods, 77 g plant⁻¹, 2.79 grains and 19.18 g, respectively) and remained at par with metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS (144 pods, 73 g plant⁻¹, 2.71 grains and 18.99 g, respectively) as well as metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. intercultivation at 30 DAS (140 pods, 71 g plant⁻¹, 2.67 grains and 18.73 g, respectively). This might be due to lack of phytotoxicity, efficient weed management practices which increased the nutrient uptake and assimilation by crop plants at the reproductive stage resulted to higher crop total dry matter thereby enhancing the hundred grains weight, increasing the number of grains pod⁻¹, pods number plant⁻¹ as well as pod weight. These results are in conformity with the report of [11, 12].

The soybean grain yield was recorded in all the plots after harvest. The grain yield for the different treatments ranged between 496 and 2570 kg ha⁻¹(Table1). Among all treatments higher grain yield of 2570 kg ha⁻¹ was 80.70 per cent increase over the control registered with intercultivation fb two hand weedings at 20 and 40 DAS and remained at par with metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS (2497 kg ha⁻¹) as well as metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. intercultivation at 30 DAS (2491 kg ha⁻¹). However, lower yield of 496 kg ha⁻¹ was recorded with unweeded check. The parameters such as plant height and total dry matter of soybean accompanied by an increase in nutrient uptake in the various weed management practices resulted in better yield attributes and increased grain yield.



Legend	
T1:	Pendimethalin 30 EC at 0.75 kg a.i ha ⁻¹ at 3 DAS (days after sowing)
T2:	Pendimethalin 30 EC at 0.75 kg a.i ha ⁻¹ at 3 DAS fb. IC at 30 DAS
T3:	Pendimethalin 30 EC at 0.75 kg a.i ha ⁻¹ at 3 DAS fb.fenoxaprop-p-ethyl 9 EC at 70 g a.i ha ⁻¹ at 20 DAS
T4:	Pendimethalin 30 EC at 0.75 kg a.i ha ⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha ⁻¹ at 20 DAS
T5:	Metribuzin 70 WP at 0.5 kg a.i ha ⁻¹ at 3 DAS
T6:	Metribuzin 70 WP at 0.5 kg a.i ha ⁻¹ at 3 DAS fb. IC at 30 DAS
T7:	Metribuzin 70 WP at 0.5 kg a.i ha ⁻¹ at 3 DAS fb. fenoxaprop-p-ethyl 9 EC at 70 g a.i ha ⁻¹ at 20 DAS
T8:	Metribuzin 70 WP at 0.5 kg a.i ha ⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha ⁻¹ at 20 DAS
T9:	Intercultivation followed by HW at 20 and 40 DAS
T10:	Unweeded check

Fig.3. Potassium uptake (kg ha⁻¹) by weed and soybean as influenced by weed management practices of soybean

Table 1: Growth, yield and yield components of soybean as influenced by pre and post-emergence herbicides

Treatments	Plant Height (cm)	TDM g plant ⁻¹	Pod plant ⁻¹	Pod weight (g plant ⁻¹)	No. grains pod ⁻¹	100 grains weight	Grain yield	% increase over control
T ₁	62.85	31.76	59	27	2.32	16.39	1500	66.93
T ₂	72.21	39.70	98	46	2.41	17.26	2105	76.43
T ₃	67.37	34.16	79	37	2.29	16.79	1767	71.92
T ₄	69.22	35.12	92	43	2.30	17.22	2087	76.23
T ₅	66.87	32.26	75	35	2.29	16.58	1733	71.37
T ₆	76.60	61.08	140	71	2.67	18.73	2491	80.08
T ₇	68.29	34.76	81	38	2.46	16.91	1850	73.18
T ₈	77.63	65.40	144	73	2.71	18.99	2497	80.13
T ₉	83.66	71.40	165	77	2.79	19.18	2570	80.70
T ₁₀	56.67	14.87	16	8	2.26	9.62	496	0.00
CD(P= 0.05)	8.24	5.15	37.26	9.14	0.18	1.23	405.72	-

Plant height, Total dry matter of crop (TDM) analysed data were taken at harvest.

T₁: Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS (days after sowing), T₂: Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS followed by (fb) intercultivation (IC) at 30 DAS, T₃: Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS fb.fenoxaprop-p-ethyl 9 EC at 70 g a.i ha⁻¹ at 20 DAS, T₄: Pendimethalin 30 EC at 0.75 kg a.i ha⁻¹ at 3 DAS fb imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS, T₅: Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS, T₆: Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb IC at 30 DAS, T₇: Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb fenoxaprop-p-ethyl 9 EC at 70 g a.i ha⁻¹ at 20 DAS, T₈: Metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS, T₉: Intercultivation (IC) fb hand weeding (HW) at 20 and 40 DAS, T₁₀: Unweeded check

Weed management practices had remarkable effect on the grain yield of soybean crop. Effective weed management improved the crop total dry matter production, crop nutrient uptake and yield attributes. These in turn increased the grain yield. Higher grain yield significantly recorded with metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS might be due to lack of phytotoxicity registered with this treatment and optimal weed management, thereby boosting the crop growth, yield parameters and consequently higher grain yield. These findings are in conformity with the reports of [9].

CONCLUSION

Weed management practices had remarkable effect on the grain yield of soybean crop since it has decreased the nutrient uptake by the weeds, improved nutrient uptake by the crop, increased total dry matter production of soybean and yield attributes. These in turn increased the grain yield. Pre-emergence application of metribuzin 70 WP at 0.5 kg a.i ha⁻¹ at 3 DAS fb. imazethapyr 10 SC at 100 g a.i. ha⁻¹ at 20 DAS found to be promising to control weeds of soybean crop and would play an important role in areas where labor is too expensive and time is a constraint.

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