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Bio-efficacy, crop safety and implications of premix herbicide combination (metamifop 8%, imazethapyr 4% and imazomox 3% me) on soybean and residual effect on green gram

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ABSTRACT

A field trial was conducted for two consecutive years, 2021-2022, to assess the performance, crop safety and profitability of soybean on the effects of pre-mix herbicide combinations and residual effect on green gram. Weed management in soybean faces significant challenges due to the prevalence of diverse and competitive weed species, the limited availability of effective post-emergence herbicides, and the necessity to balance effectiveness with crop safety and profitability. The higher dose combination of Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate @ 1250 ml ha^{-1} (T_6) demonstrated superior performance, achieving remarkable weed suppression with a reduction in weed density ranging from 79-95%, 78-86%, and 80-90% at 15, 30 and 45 DAA, alongside a decrease in weed dry weight by 79-86%, 87-93%, and 77-93% compared to untreated control plots. The weed control efficiency for T_6 surpassed 77% at all intervals recorded. Correspondingly, soybean plants in T_6 plots reached average heights of 33-34 cm, produced between 6.9 and 7.6 lateral branches, set 8.8 to 9.3 pods per plant, and yielded between 1.95 and 1.98 t ha^{-1}, values statistically on par with hand weeded control (T_{10}), which measured 35.6-36.3 cm in height, 7.3-8.0 branches, 9.3-9.7 pods, and yielded 2.15-2.23 t ha^{-1}. The moderate dose combination of Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate @ 1000 ml ha^{-1} (T_5) recorded almost similar agronomic results, with plants measuring 33.0–33.8 cm in height and achieving a seed yield of 1.94-1.98 t ha^{-1}, suggesting that an application dose of 1,000 ml ha^{-1} is optimum for effective weed management. Economic analysis indicated that T_5 has recorded the highest net returns and benefit-cost ratio, followed by treatment T_6. These results suggest that the post-emergence application of the Metamifop-Imazethapyr-Imazamox mixture combined with Ammonium Sulphate at 1,000-1,250 ml ha^{-1} helps in effective weed control and achieves higher grain yield and economic returns in soybean cultivation. The study identifies an optimal herbicide dose for effective weed suppression, ensuring crop safety and profitability, thus providing a viable alternative to labour-intensive manual weeding in soybean production systems.

Keywords: *Grain Yield, Green Gram, Soybean, Phytotoxicity, Pre-mix herbicide, Weed control efficiency, Bio efficacy, Germination percentage, Economics*

INTRODUCTION

Soybean (*Glycine max* L.) is one of the best sources of protein and oil. It contains a higher amount of protein (40%) and oil (20%) compared to other oil seeds, which contain only 20-25% of protein [1]. Hence, the soybean is termed as a miracle crop. In comparison to other oilseed crops, which are grown during the Kharif season, soybean is found to be the most tolerant and adaptable crop to various soil and climatic aberrations, and also a great source of protein and oil content [2]. Soybean, being a rainy season crop, is severely infested by sedges like *Cyperus* species, broadleaf weeds like *Corchorus acutangulus*, *Commelina benghalensis*, *Phyllanthus niruri*, *Eclipta alba* and *Euphorbia* species and includes grasses like *Echinochloa colona* [3].

The wider plant spacing which needed to support branch emergence and slow growth during the initial phases, causing the soybean to be susceptible to weeds [4]. As the canopy closure occurs relatively late, weeds will be established readily in the soybean crop compared to other crops [5]. The early emergence of weeds causes smothering of the soybean crop, which affects the growth and development, ultimately reducing the yield and quality of grains [6]. The studies have reported that soybean productivity can decline by 27-77 % under varying weed species, soil types, and seasonal conditions and in worst scenarios, it may reduce up to 84 % [7].

Even though manual weeding is very effective in controlling the weeds, it needs more manpower and is economically not feasible due to high wage costs, and labour shortage is also one of the major concerns. The erratic rainfall conditions during the rainy season and heavy weed infestation during early growth stages are making it very difficult to control the weeds in soybean [2]. Most of the weed management in soybeans is carried out using herbicides (90%). Hence, it is one of the major consumers of herbicides in India. The use of suitable herbicides in the right dose can be the most effective solution for managing the most problematic weeds in the soybean crop.

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In this context, it is important to study suitable premix formulations of post-emergence herbicides to control composite weeds, including perennial sedges. Therefore, the present study aims to assess the performance, crop safety and profitability of soybean on the effects of pre-mix herbicide combinations and residual effect on green gram. The aim is to identify an effective herbicide combination along with a suitable dose for weed control in soybeans.

Materials and Methods

A field experiment was carried out during rainy (*kharif*) seasons for two consecutive years, 2021 & 2022, to assess the performance, crop safety and profitability of soybean on the effects of pre-mix herbicide combinations and residual effect on green gram at the instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India. The farm is situated at $26^0$19`86” N latitude and $89^0$23`53” E longitude. The experimental soil was sandy loam with slightly acidic pH (5.48), with medium organic carbon (0.72%), with poor bases due to high rainfall, with moderate availability of available nitrogen, phosphorus and potassium (357, 25 and 200 kg ha^{-1}, respectively). The varieties used for the experiment are RVSM-2011-35 for soybean and TMB-119 for green gram. The experiment was laid in randomized block design with 3 replications and 11 treatments i.e., T_1- Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME @ 800 ml/ha, T_2- Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME @ 1000 ml/ha, T_3- Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME @ 1250 ml/ha, T_4- Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate @ 800 ml/ha, T_5- Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate @ 1000 ml/ha, T_6- Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate @ 1250 ml/ha, T_7- Imazethapyr 10% SL @ 750-1000 ml + MSO adjuvant @ 2 ml/l water, T_8- Imazethapyr 35% + Imazamox 35% WG @ 100 g MSO Adjuvant @ 2 ml/l water, T_9-Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME @ 2000 ml/ha, T_{10}- Hand Weeding at 20 and 40 DAS, T_{11}- Weedy Check. These herbicides were applied 15 days after sowing (DAS). The herbicide combination of Metamifop, Imazethapyr, and Imazamox under the trade name *Vostrix* is used in the present experiment. The weed data was recorded from each plot using a 1 sq. m quadrate at 15, 30 and 45 days after application (DAA). The collected weed data was transformed to a square root transformation ($\sqrt{X+0.5}$) for statistical analysis. The growth and yield attributes were recorded from each plot at the time of harvest. The phytotoxicity analysis was carried out up to 15 DAA on the a scale of 0 to 10. The statistical analysis (ANOVA) was done using the OP Stat software.

Results and Discussion

Weed density

Weed density varied significantly among the treatments at 15, 30, and 45 DAA, demonstrating the herbicide's effectiveness in managing various weed species (Table 1). At 15 DAA, treatment T_6 (Metamifop 8% + Imazethapyr 4% + Imazamox 3% ME + Ammonium Sulphate at 1250 ml ha^{-1}) recorded the lowest weed density among the herbicidal treatments, achieving maximum suppression (56-86%) across all weed species. This treatment exhibited higher efficacy against *Cyanotis axillaris* (79-86%), *Celosia argentea* (77-79%), and *Commelina benghalensis* (76-78%). During this stage, the sedge *Cyperus rotundus* was the most difficult weed to control.

However, T_6 has shown remarkable performance (56-65% control) against it, proving its broad-spectrum efficiency. The treatments that combined ammonium sulphate namely T_4 to T_6 (Metamifop 8% + Imazethapyr 4% + Imazamox 3% ME + Ammonium Sulphate at 800-1250 ml ha^{-1}) showed maximum efficacy in reducing weed density (60-85%) across the majority of weed species compared to standalone herbicidal treatments (T_1 to T_3: 50-77%), with increased efficacy observed at higher doses. The commercial herbicides demonstrated moderate performance, with treatment T_7 (Imazethapyr 10% SL + MSO adjuvant at 750-1000 ml ha^{-1}) achieving 44-61%, T_8 (Imazethapyr 35% + Imazamox 35% WG + MSO adjuvant at 100 g ha^{-1}) achieving 45-72%, and T_9 (Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME at 2000 ml ha^{-1}) achieving 40-73% efficacy against most of the weeds.

A similar trend was observed at 30 and 45 DAA, where treatment T_6 has reported maximum weed control, reducing weed density by 60-84% and 55-81%, respectively, compared to the unweeded control (Tables 2 and 3). The lower dose treatments T_4 and T_5 also exhibited similar performance to T_6, with weed density reductions of 42-80% and 41-77% at 30 and 45 DAA, respectively. The standalone treatments (T_1-T_3) reported an increasing trend in weed control with dosage, achieving 40-78% and 45-71% suppression of various weeds at 30 and 45 DAA, respectively. However, the commercial herbicides (T_7-T_9) continued to underperform, recording weed suppression ranging from 26-72% and 28-74%, reflecting their limited effectiveness against mixed weed flora. This highlights the necessity of applying herbicides with diverse modes of action to manage mixed weed flora effectively. Meanwhile, the hand weeding at 20 and 40 DAS (T_{10}) achieved nearly 100% weed control, but it remains a labour-intensive and expensive approach. These results are in close agreement with the findings of [8] and [9], who also reported similar outcomes.

Weed dry weight

Herbicidal treatments had a significant impact on the dry weight of various weed species, including grasses, sedges, and broad-leaved weeds (BLW). Notably, treatment T_6 (Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate @ 1250 ml ha^{-1}) resulted in a maximum reduction in the density of all weed species by 73-89% compared to the unweeded control (Table 4). The weed species like *Dinebra arabica* (86-87%), *Celosia argentea* (79-83%), *Commelina benghalensis* (82-89%), *Physalis minima* (73-88%), and *Cyperus rotundus* (77-80%) are effectively controlled, similar to the weedy check. The results indicate that treatments T_4 (Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate @ 800 ml ha^{-1}) and T_5 (Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate @ 1000 ml ha^{-1}) performed similarly to T_6 regarding weed suppression, achieving a reduction of 58-85%. In contrast, treatments without surfactant (T_1-T_3) demonstrated moderate efficacy, with weed control in the range of 57-80%, which increased with dosage. The commercial formulations T_7-T_9, however, exhibited inadequate performance, reducing weed biomass by only 45-78% across all species compared to the unweeded control.

A similar trend was observed at 30 and 45 DAA, where treatment T_6 exhibited the highest weed control efficiency, ranging from 74-91% and 71-98%, respectively. This treatment demonstrated higher performance, particularly against *Dinebra arabica* (87-91% and 90-92%), *Cyanotis axillaris* (83-85% and 71-79%), and *Physalis minima* (79-83% and 81-84%) at 30 and 45 DAA (Tables 5 and 6).

The combinations involving ammonium sulfate, specifically T_4-T_6, showed maximum efficacy in reducing weed biomass (64-91% and 71-98%) compared to standalone herbicidal treatments (T_1-T_3: 60-88% and 69-96%), with improvement observed at higher doses. The commercial herbicides demonstrated marginal effectiveness, with T_7 (Imazethapyr 10% SL + MSO adjuvant @ 750-1000 ml ha^{-1}) achieving 54-88%, T8 (Imazethapyr 35% + Imazamox 35% WG + MSO adjuvant @ 100 gm ha^{-1}) 57-88%, and T9 (Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME @ 2000 ml ha^{-1}) 58-87%, particularly against various weed types. The performance of the commercial herbicides was substandard during these stages, with T_7-T_9 exhibiting inconsistency (54-85% and 64-89%) at 30 and 45 DAS, respectively. The application of post-emergence herbicides significantly reduced weed dry biomass, with results comparable to those observed under hand weeding. These findings are similar to the studies of [10] and [11], who also reported effective weed dry weight reduction after the application of post-emergence herbicides.

Weed control efficiency

Weed control efficiency (WCE) varied significantly among treatments at 15, 30, and 45 DAA, highlighting the efficacy of herbicides in managing different weed species (Table 3). At 15 DAA, the treatment T_6 (Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate at 1250 ml ha^{-1}) recorded the highest weed control efficiency, ranging from 73 to 89% across all weed species (Table 7). This combination recorded higher efficacy against *Cyperus rotundus* (77-79%) and *Celosia argentea* (79-83%), showcasing its broad-spectrum efficacy. The treatment combinations, along with ammonium sulphate, specifically T_4-T_6 (Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate at 800-1250 ml ha^{-1}), reported higher weed control efficiency (58%-89%) compared to standalone herbicidal treatments (T_1-T_3: 57-81%). The commercial herbicides exhibited sub-optimal effectiveness, with T_7 (Imazethapyr 10% SL + MSO adjuvant at 750-1000 ml ha^{-1}) achieving 45-68%, T_8 (Imazethapyr 35% + Imazamox 35% WG + MSO adjuvant at 100 gm ha^{-1}) reaching 51-75%, and T_9 (Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME at 2000 ml ha^{-1}) recording 63-78%, particularly against broad-leaved weeds and sedges.

A comparable trend was reported at 30 and 45 DAA, with T_6 showing the highest weed control efficiency of 74-91% and 71-98%, respectively. This treatment has shown outstanding performance, especially against *Commelina benghalensis* (74-81% and 82-84%), *Dinebra arabica* (87-91% and 90-92%) and *Cyperus rotandus* (85-88% and 96-98%) at 30 and 45 DAA, respectively. The ammonium sulphate combinations, i.e., T_4-$T_{6,}$ have shown superior performance in terms of weed control efficiency (61-91% and 71-97%) compared to standalone herbicidal treatments (T_1-T_3: 60-87% and 69-96%) at 30 and 45 DAA, with improvement noticed at higher doses. The commercial herbicides reflected the marginal effectiveness, with T_7 (Imazethapyr 10% SL + MSO adjuvant @ 750-1000 ml ha^{-1}) showing 54-82%, T_8 (Imazethapyr 35% + Imazamox 35% WG + MSO adjuvant @ 100 gm ha^{-1}) 57-88% and T_9 (Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME @ 2000 ml ha^{-1}) 58-87%, particularly against broad-leaved weeds and sedges. The commercial herbicides showed substandard performance at these stages, with T_7-T_9 remaining inconsistent (54-85% and 68-89%) at 30 and 45 DAS, respectively.

The progressive decline in performance of commercial herbicides compared to Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME combinations highlights these combinations' superior residual activity. The enhanced weed control efficiency under post-emergence herbicide treatments was due to the reduced weed dry weight, similar to the findings of [12], [13], and [14].

Growth and yield

The study highlights the effect of various herbicide treatments on the growth and yield of soybean (Table 8). Among the different treatments, T_6 (Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate at 1250 ml ha^{-1}) has reported the highest plant growth, recording a plant height of 75-76 cm, with 7.3-7.7 branches per plant, 51-52 pods per plant, and a seed yield of 2.22-2.29 t ha^{-1} (Table 8). These results are comparable to those of the weed-free control, which recorded plant heights of 35.6-36.3 cm, 4.33-4.67 branches per plant, 34-36 pods per plant, and a yield of 1.24-1.29 t ha^{-1}. The findings indicate that the higher dosage, combined with ammonium sulphate surfactant, provided nearly complete weed control, allowing the crop to utilize resources more effectively. Treatment T_5 (Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate at 1000 ml ha^{-1}) has recorded a similar trend in both plant growth and yield, with plant heights of 71-73 cm, 6.3-6.5 branches per plant, 48-50 pods per plant, and a seed yield of 2.20-2.26 t ha^{-1}. In contrast, the lower dose T_4 (Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME + Ammonium Sulphate at 800 ml ha-^{1}) showed moderate performance, significantly lower than the higher doses of T_5 and T_6, indicating that this lower dose resulted in only partial weed control.

Among the standalone treatments, T_1 and T_2 with lower doses have shown marginal performance compared to the unweeded control, resulting in moderate growth characterized by plant heights of 67-69 cm, 4.0-4.4 branches per plant, 41-46 pods per plant, and seed yields of 1.46-1.49 t ha^{-1}. In contrast, the standalone treatment T_3 with a higher dose reported higher performance relative to T_1 and T_2. Conversely, the commercial formulations T_7 (Imazethapyr 10% SL + MSO adjuvant at 750-1000 ml ha^{-1}) and T_8 (Imazethapyr 35% + Imazamox 35% WG + MSO adjuvant at 100 g ha^{-1}) recorded suboptimal results, with reduced heights (67-69 cm), fewer branches per plant (6.33-6.67), decreased pod numbers per plant (45-47), and lower seed yields (1.51-1.71 t ha^{-1}). However, treatment T_9 (Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME at 2000 ml ha^{-1}) showed marginally better performance when compared to treatments T_7 and T_8. The improvement in crop growth attributes can be attributed to effective suppression of weed competition, enabling better utilization of available resources by the crop reported by [15] and [16].

Bio efficacy on succeeding green gram

The investigation has evaluated the residual effects of Metamifop 8% + Imazethapyr 4% + Imazamox 3% ME on a subsequent green gram crop and found no significant phytotoxic effects on germination, growth, or yield (Table 8). Germination rates remained consistently high (77-84%) across all treatments, comparable to those of hand-weeded and untreated plots. There is no significant differences were observed in plant height (36.4-40.2 cm), branching (5.7-7.7 branches per plant), and the number of pods per plant (29.3-33.5), seeds per pod (6.4-7.6), and seed yield (0.99-1.17 t ha^{-1})

among all treatments, indicating the absence of residual effects. Treatments that included ammonium sulfate (T_4-T_6) showed a marginal improvement in growth vigour, although these differences were not statistically significant. Other herbicide treatments (T_7-T_9) showcased slightly lower germination (79%) without adversely affecting crop yield. Overall, the application of Metamifop 8% + Imazethapyr 4% + Imazamox 3% ME, even at higher doses, resulted in no harmful residues, thereby confirming its safety and appropriateness for sustainable soybean and green gram rotations.

Phytotoxicity

The phytotoxicity assessment of a combination of Metamifop 8%, Imazethapyr 4%, and Imazamox 3% ME, along with a surfactant, on soybean and green gram reflected that it is safe at all tested concentrations. Throughout the assessments conducted at 1, 3, 7, 10, and 15 DAA, no signs of stunting, yellowing, necrosis, chlorosis, wilting, epinasty, or hyponasty were observed in either crop. The consistent absence of phytotoxic effects across all treatments confirms the formulation's safety for crops. These findings provide strong assurance of its safety when utilized in soybean-green gram cropping systems.

Economics

The economic analysis revealed that treatment T_5 recorded the highest net returns, ranging from Rs 93,800 to Rs 98,000, along with a benefit-cost (B: C) ratio of 2.49 to 2.61. The higher dose treatment, T_6, also reported strong profitability with net returns of Rs 94,150 to Rs 99,950 and a B: C ratio between 2.48 and 2.59, showcasing its economic viability due to improved weed control (Table 8). In contrast, while hand weeding recorded higher gross returns, the associated labour costs (50,000 Rs ha^{-1}) with lower B: C ratios of 1.93 to 1.98. The use of a standalone herbicide without ammonium sulphate proved to be less profitable, with a B: C ratio of 1.37 to 1.50, showcasing its crucial role of the surfactant. Meanwhile, unweeded control plots exhibited the lowest net returns, ranging from Rs 39,400 to Rs 42,400, with B: C ratios of 1.13 to 1.21.

CONCLUSION

The research findings indicate that the post-emergence application of Metamifop 8% + Imazethapyr 4% + Imazomox 3% ME, in conjunction with Ammonium Sulphate at rates of 1000–1250 ml ha^{-1}, reflects an effective, safe, and economically viable solution for weed management in soybean cultivation. These treatments led to a significant reduction in weed density and dry weight, while simultaneously enhancing crop growth, yield, and net returns, comparable to a weed-free control. These results highlight the potential of this combination to enhance both yield and economic outcomes in soybean farming under similar agroecological conditions.

Future Scope

While the current study demonstrates the effectiveness and economic viability of the evaluated post-emergence herbicide combination in groundnut, future research should concentrate on conducting multi-location trials to validate performance across different environments. Additionally, long-term studies on soil residue behaviour, ecological interactions, and the integration of non-chemical approaches will be essential for developing sustainable and resilient weed management strategies.

Conflict of Interest

The authors declare that there are no conflicts of interest concerning the publication of this article.

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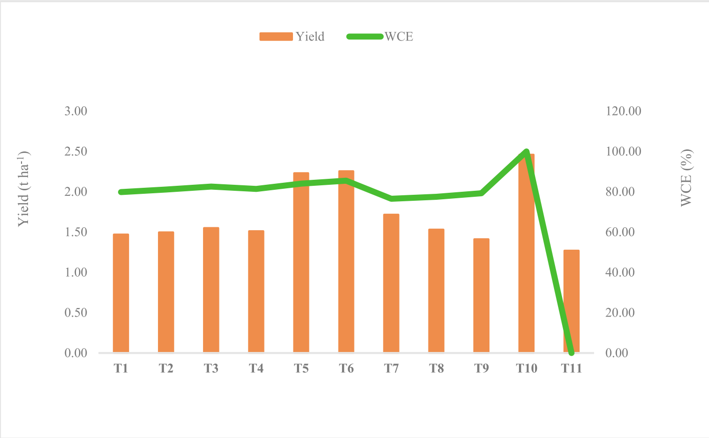

Figure 1. Effect of different weed management practices on yield and WCE at 45 DAA

Table 1: Effect of herbicides on weed density (No. m^{-2}) in soybean at 15 DAA

Treatment	*Dinebra arabica*		*Echinochloa colona*		*Physalis minima*		*Commelina benghalensis*		*Cyanotis axillaris*		*Celosia argentea*		*Cyperus rotundus*	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
T1	5.1 (2.37)	5.2 (2.39)	5.4 (2.43)	6.8 (2.70)	4.2 (2.17)	4.2 (2.17)	5.1 (2.37)	5.2 (2.39)	4.4 (2.21)	5.1 (2.37)	4.1 (2.14)	3.8 (2.07)	1.2 (1.30)	1.2 (1.30)
T2	4.4 (2.21)	4.7 (2.28)	5.2 (2.39)	6.4 (2.63)	3.9 (2.10)	4.1 (2.14)	4.1 (2.14)	3.9 (2.10)	4.1 (2.14)	4.8 (2.30)	3.3 (1.95)	3.1 (1.90)	1.1 (1.26)	1.1 (1.26)
T3	4.1 (2.14)	4.3 (2.19)	4.8 (2.30)	5.1 (2.32)	3.3 (1.95)	3.1 (1.90)	3.6 (2.02)	3.3 (1.95)	3.7 (2.05)	2.1 (1.61)	2.4 (1.70)	2.5 (1.73)	0.9 (1.18)	1.0 (1.22)
T4	3.8 (2.07)	3.5 (2.00)	5.0 (2.44)	6.0 (2.64)	3.7 (2.16)	3.3 (2.08)	4.0 (2.23)	3.7 (2.15)	3.3 (2.08)	2.3 (1.82)	2.7 (1.91)	3.0 (2.00)	1.0 (1.38)	1.7 (1.63)
T5	3.3 (1.95)	3.0 (1.87)	4.7 (2.37)	5.7 (2.58)	3.0 (1.99)	2.3 (1.82)	3.0 (1.99)	3.3 (2.08)	2.7 (1.91)	1.7 (1.63)	1.3 (1.52)	2.0 (1.72)	1.0 (1.52)	1.3 (1.52)
T6	2.8 (1.82)	2.5 (1.73)	4.0 (2.21)	4.3 (2.31)	2.3 (1.82)	2.7 (1.91)	2.7 (1.91)	2.7 (1.91)	2.0 (1.72)	1.3 (1.52)	1.7 (1.63)	1.7 (1.61)	0.7 (1.63)	1.0 (1.38)
T7	6.2 (2.59)	5.8 (2.51)	6.7 (2.77)	8.7 (3.10)	4.7 (2.38)	5.3 (2.52)	4.7 (2.38)	6.3 (2.71)	5.0 (2.44)	4.7 (2.38)	3.3 (2.08)	3.71 (2.15)	1.3 (1.52)	1.7 (1.63)
T8	6.0 (2.55)	6.4 (2.63)	6.3 (2.70)	6.7 (2.76)	4.3 (2.29)	4.3 (2.29)	5.3 (2.51)	5.7 (2.58)	3.7 (2.16)	3.0 (1.99)	2.3 (1.82)	3.0 (1.97)	0.7 (1.38)	1.7 (1.63)
T9	6.8 (2.70)	7.0 (2.74)	4.0 (2.23)	4.0 (2.23)	2.3 (1.82)	3.3 (2.08)	3.3 (2.08)	5.3 (2.52)	2.7 (1.91)	2.7 (1.91)	2.3 (1.82)	3.3 (2.08)	1.0 (1.14)	1.3 (1.52)
T10	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)
T11	11.4 (3.45)	10.3 (3.29)	12.3 (3.65)	12.3 (3.64)	11.3 (3.5)	8.0 (3.00)	12.3 (3.65)	11.3 (3.51)	9.7 (3.26)	9.3 (3.21)	8.3 (3.05)	7.3 (2.88)	2.0 (1.82)	2.3 (1.82)
SEm±	**0.12**	**0.10**	**0.12**	**0.11**	**0.13**	**0.10**	**0.11**	**0.09**	**0.11**	**0.10**	**0.09**	**0.11**	**0.11**	**0.13**
LSD (p=0.05)	**0.28**	**0.33**	**0.48**	**0.36**	**0.31**	**0.31**	**0.33**	**0.28**	**0.33**	**0.31**	**0.27**	**0.32**	**0.32**	**0.38**

Table 2: Effect of herbicides on weed density (No. m^{-2}) in soybean at 30 DAA

Treatment	*Dinebra arabica*		*Echinochloa colona*		*Physalis minima*		*Commelina benghalensis*		*Cyanotis axillaris*		*Celosia argentea*		*Cyperus rotundus*	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
T1	4.4 (2.21)	4.3 (2.19)	7.8 (2.88)	7.6 (2.85)	8.1 (2.63)	6.7 (2.68)	7.1 (2.76)	8.1 (2.94)	5.4 (2.43)	5.8 (2.51)	4.1 (2.14)	3.7 (2.05)	3.4 (1.97)	3.9 (2.10)
T2	3.8 (2.07)	3.9 (2.10)	7.1 (2.76)	6.9 (2.72)	7.6 (2.92)	5.9 (2.53)	6.8 (2.70)	7.8 (2.88)	4.8 (2.30)	4.7 (2.28)	3.8 (2.07)	3.2 (1.92)	3.1 (1.90)	3.3 (1.95)
T3	3.1 (1.90)	3.0 (1.87)	6.2 (2.59)	5.6 (2.47)	6.5 (2.74)	4.6 (2.26)	5.7 (2.49)	6.2 (2.59)	3.9 (2.10)	3.9 (2.10)	3.6 (2.02)	3.0 (1.87)	3.0 (1.82)	2.8 (1.87)
T4	3.4 (1.97)	3.3 (1.95)	7.0 (2.81)	6.3 (4.16)	7.3 (2.90)	5.0 (3.96)	6.3 (1.81)	7.0 (2.89)	4.7 (2.70)	4.0 (2.83)	3.7 (2.38)	4.3 (2.23)	3.3 (2.16)	3.7 (2.31)
T5	2.8 (1.82)	2.8 (1.82)	5.7 (2.58)	5.3 (2.70)	6.7 (2.70)	5.3 (2.58)	6.0 (3.70)	5.3 (2.44)	3.0 (2.64)	3.3 (2.51)	3.3 (1.99)	2.7 (2.08)	2.7 (2.08)	3.3 (1.91)
T6	2.2 (1.64)	2.4 (1.70)	4.0 (2.23)	5.0 (2.52)	4.7 (2.52)	4.3 (2.52)	4.7 (2.88)	5.0 (2.52)	2.7 (2.38)	2.7 (2.44)	2.3 (1.91)	2.3 (1.90)	2.3 (1.82)	2.3 (1.82)
T7	5.6 (2.47)	5.8 (2.51)	9.0 (3.16)	8.0 (2.88)	8.3 (2.88)	8.3 (2.83)	7.3 (2.58)	7.0 (2.88)	7.3 (3.05)	6.3 (2.71)	4.0 (2.82)	5.3 (2.94)	3.7 (2.71)	4.3 (2.23)
T8	7.9 (2.90)	8.1 (2.93)	7.7 (2.94)	7.3 (2.70)	8.7 (2.92)	7.3 (2.71)	7.3 (2.37)	8.3 (2.58)	7.0 (2.88)	5.7 (2.88)	3.3 (3.05)	5.7 (2.88)	4.0 (2.58)	3.6 (2.08)
T9	6.8 (2.70)	6.9 (2.72)	3.7 (2.16)	6.3 (2.44)	5.7 (2.16)	5.7 (2.31)	5.3 (2.76)	6.7 (2.31)	4.3 (2.51)	5.0 (2.77)	3.7 (2.30)	3.3 (2.83)	3.3 (2.44)	3.7 (2.16)
T10	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)
T11	14.0 (3.81)	13.8 (3.78)	13.6 (3.05)	14.3 (3.00)	14.0 (3.74)	11.3 (3.00)	15.0 (3.11)	16.7 (3.87)	10.0 (3.51)	11.0 (4.00)	8.7 (4.20)	10.3 (3.31)	5.7 (3.46)	7.3 (3.11)
SEm±	**0.1**	**0.13**	**0.13**	**0.09**	**0.12**	**0.09**	**0.14**	**0.09**	**0.11**	**0.1**	**0.12**	**0.12**	**0.1**	**0.08**
LSD (p=0.05)	**0.27**	**0.36**	**0.39**	**0.27**	**0.37**	**0.27**	**0.42**	**0.28**	**0.34**	**0.32**	**0.36**	**0.37**	**0.31**	**0.26**

Table 3: Effect of herbicides on weed density (No. m^{-2}) in soybean at 45 DAA

Treatment	*Dinebra arabica*		*Echinochloa colona*		*Physalis minima*		*Commelina benghalensis*		*Cyanotis axillaris*		*Celosia argentea*		*Cyperus rotundus*	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
T1	4.2 (2.17)	4.5 (2.24)	6.3 (2.53)	6.1 (2.57)	5.9 (2.53)	5.7 (2.49)	7.0 (2.74)	6.4 (2.53)	4.3 (2.19)	4.7 (2.28)	4.0 (2.12)	4.1 (2.14)	3.9 (2.10)	3.6 (2.02)
T2	3.7 (2.05)	3.8 (2.07)	6.0 (2.38)	6.0 (2.55)	5.2 (2.39)	5.2 (2.39)	6.6 (2.66)	6.0 (2.46)	3.9 (2.10)	3.8 (2.07)	3.7 (2.07)	3.8 (2.05)	3.4 (1.97)	3.3 (1.95)
T3	3.1 (1.90)	3.3 (1.95)	5.4 (2.33)	5.5 (2.45)	4.8 (2.30)	4.9 (2.32)	6.1 (2.57)	5.1 (2.30)	3.4 (1.97)	3.5 (2.00)	3.5 (1.97)	3.5 (2.00)	2.8 (1.82)	2.9 (1.84)
T4	3.4 (1.97)	3.6 (2.02)	6.3 (2.24)	5.7 (1.82)	5.3 (1.82)	4.0 (1.81)	6.3 (1.63)	6.2 (2.48)	3.9 (2.17)	3.3 (1.38)	3.3 (1.82)	3.7 (1.99)	3.0 (1.63)	3.0 (1.72)
T5	2.8 (1.82)	2.6 (1.76)	5.0 (2.23)	5.3 (1.72)	4.7 (1.82)	5.3 (1.58)	6.0 (1.28)	5.0 (2.24)	3.0 (2.08)	3.0 (1.52)	2.9 (2.23)	2.3 (1.91)	2.3 (1.52)	2.7 (1.73)
T6	2.1 (1.61)	2.2 (1.64)	3.7 (2.00)	4.3 (1.49)	4.0 (1.72)	3.3 (1.58)	4.7 (1.38)	4.3 (1.82)	2.7 (1.82)	2.7 (1.63)	2.3 (2.08)	2.0 (1.82)	2.3 (1.41)	2.3 (1.41)
T7	5.2 (2.39)	5.0 (2.35)	8.0 (2.72)	7.3 (2.08)	6.7 (1.87)	7.7 (1.99)	7.3 (1.91)	7.0 (2.16)	7.7 (2.29)	5.3 (1.52)	3.7 (2.07)	4.7 (2.16)	3.7 (1.82)	4.0 (1.82)
T8	6.6 (2.66)	6.9 (2.72)	7.3 (2.72)	7.0 (1.90)	7.7 (2.06)	7.3 (1.88)	7.3 (1.63)	7.7 (2.16)	6.3 (2.23)	5.0 (1.38)	3.0 (1.91)	5.3 (2.07)	3.0 (1.63)	3.3 (1.73)
T9	6.2 (2.59)	6.0 (2.55)	3.7 (1.52)	6.3 (1.38)	5.7 (1.47)	5.7 (1.27)	5.3 (1.38)	5.3 (2.07)	4.0 (2.16)	4.0 (1.14)	3.7 (1.99)	3.3 (1.82)	2.7 (1.63)	3.7 (1.63)
T10	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)
T11	10.5 (3.32)	11.1 (3.41)	14.7 (3.61)	12.7 (3.36)	12.7 (2.55)	10.7 (2.39)	15.0 (2.51)	15.0 (2.91)	9.3 (2.88)	10.0 (1.82)	8.0 (2.38)	9.3 (3.83)	5.0 (3.65)	6.0 (2.00)
SEm±	**0.12**	**0.14**	**0.14**	**0.21**	**0.21**	**0.25**	**0.14**	**0.1**	**0.11**	**0.14**	**0.09**	**0.1**	**0.09**	**0.07**
LSD (p=0.05)	**0.34**	**0.4**	**0.44**	**0.63**	**0.63**	**0.77**	**0.43**	**0.43**	**0.33**	**0.43**	**0.26**	**0.32**	**0.29**	**0.23**

Table 4: Effect of herbicides on weed dry weight (g m^{-2}) in soybean at 15 DAA

Treatment	*Dinebra arabica*		*Echinochloa colona*		*Physalis minima*		*Commelina benghalensis*		*Cyanotis axillaris*		*Celosia argentea*		*Cyperus rotundus*	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
T1	3.8 (2.07)	3.9 (2.10)	6.2 (2.59)	5.5 (2.45)	3.8 (2.07)	5.1 (2.37)	3.8 (2.07)	4.1 (2.14)	3.9 (2.10)	4.0 (2.12)	3.8 (2.07)	4.1 (2.14)	3.6 (2.02)	3.4 (1.97)
T2	3.0 (1.87)	2.8 (1.82)	5.8 (2.51)	5.3 (2.41)	3.3 (1.95)	4.9 (2.32)	3.3 (1.95)	3.7 (2.05)	3.4 (1.97)	3.7 (2.05)	3.2 (1.92)	3.5 (2.00)	3.4 (1.97)	3.3 (1.95)
T3	2.7 (1.79)	2.5 (1.73)	4.8 (2.30)	4.1 (2.14)	2.6 (1.76)	4.7 (2.28)	2.5 (1.73)	2.9 (1.79)	2.9 (1.84)	3.4 (1.97)	2.6 (1.76)	3.0 (1.87)	3.1 (1.90)	3.0 (1.87)
T4	2.8 (1.80)	3.0 (1.87)	5.4 (2.53)	4.3 (2.30)	2.9 (1.97)	5.0 (2.46)	2.6 (1.90)	3.1 (2.02)	3.0 (1.99)	3.6 (2.14)	2.7 (2.04)	3.4 (1.91)	3.4 (2.03)	3.1 (2.10)
T5	2.0 (1.58)	2.1 (1.61)	4.6 (2.36)	3.9 (2.20)	2.3 (1.79)	3.5 (2.13)	2.2 (1.77)	2.3 (1.81)	3.3 (1.91)	3.2 (2.06)	2.0 (2.05)	2.8 (1.82)	3.2 (1.84)	2.4 (1.94)
T6	1.7 (1.48)	1.8 (1.52)	4.1 (2.25)	3.4 (2.08)	1.3 (1.47)	3.2 (2.05)	1.3 (1.52)	1.8 (1.66)	2.7 (2.03)	2.9 (1.98)	1.7 (1.91)	2.7 (1.61)	2.7 (1.75)	2.3 (1.89)
T7	5.3 (2.41)	5.6 (2.47)	7.2 (2.86)	5.0 (2.45)	4.9 (2.43)	5.2 (2.18)	5.0 (2.45)	3.1 (2.03)	5.2 (2.49)	4.5 (2.34)	5.3 (2.14)	4.2 (2.52)	3.6 (2.11)	3.5 (2.29)
T8	6.3 (2.61)	6.2 (2.59)	7.4 (2.90)	4.7 (2.39)	3.3 (2.06)	3.8 (2.50)	5.3 (2.48)	2.8 (1.94)	5.0 (2.44)	3.9 (2.21)	3.3 (2.07)	4.0 (2.06)	3.3 (1.93)	2.7 (2.24)
T9	4.6 (2.26)	4.3 (2.20)	5.0 (2.44)	4.1 (2.26)	4.1 (2.06)	4.3 (2.29)	3.4 (2.10)	2.4 (1.84)	4.2 (2.27)	3.3 (2.07)	2.2 (1.98)	2.8 (1.73)	2.9 (1.86)	2.5 (1.95)
T10	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)
T11	13.2 (3.70)	12.8 (3.65)	17.3 (4.27)	13.7 (3.80)	10.3 (3.35)	11.9 (3.60)	11.3 (3.51)	9.8 (3.28)	12.3 (3.63)	11.7 (3.57)	9.7 (3.53)	13.1 (3.26)	11.5 (3.48)	11.1 (3.75)
SEm±	**0.17**	**0.1**	**0.11**	**0.08**	**0.2**	**0.09**	**0.13**	**0.07**	**0.18**	**0.05**	**0.11**	**0.13**	**0.15**	**0.1**
LSD (p=0.05)	**0.48**	**0.27**	**0.34**	**0.26**	**0.6**	**0.26**	**0.41**	**0.22**	**0.56**	**0.15**	**0.34**	**0.39**	**0.45**	**0.29**

Table 5: Effect of herbicides on weed dry weight (g m^{-2}) in soybean at 30 DAA

Treatment	*Dinebra arabica*		*Echinochloa colona*		*Physalis minima*		*Commelina benghalensis*		*Cyanotis axillaris*		*Celosia argentea*		*Cyperus rotundus*	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
T1	4.9 (2.32)	4.6 (2.26)	8.8 (3.05)	8.9 (3.07)	5.8 (2.39)	6.3 (2.33)	5.7 (2.47)	6.3 (2.61)	5.4 (2.43)	5.8 (2.51)	6.2 (2.59)	5.9 (2.53)	4.7 (2.28)	3.9 (2.10)
T2	4.6 (2.26)	3.7 (2.05)	8.3 (2.97)	8.5 (3.00)	5.3 (2.37)	5.6 (2.26)	5.4 (2.29)	5.9 (2.43)	5.3 (2.47)	5.6 (2.47)	5.6 (2.47)	5.4 (2.43)	4.5 (2.24)	3.8 (2.07)
T3	3.7 (2.05)	2.8 (1.82)	7.7 (2.86)	7.9 (2.90)	4.4 (2.05)	4.6 (2.05)	4.7 (2.28)	5.4 (2.43)	4.7 (2.28)	4.7 (2.30)	4.8 (2.30)	4.4 (2.21)	4.1 (2.14)	3.2 (1.92)
T4	4.2 (2.17)	3.1 (1.90)	8.0 (2.99)	8.3 (3.05)	5.1 (2.69)	6.3 (2.48)	5.1 (2.62)	6.6 (2.95)	5.3 (2.76)	5.4 (2.90)	5.8 (2.61)	5.0 (2.44)	4.4 (2.32)	3.4 (2.09)
T5	3.0 (1.87)	2.3 (1.67)	7.1 (2.84)	6.2 (2.68)	3.9 (2.21)	5.9 (2.21)	4.4 (2.32)	4.9 (2.24)	4.1 (2.34)	4.2 (2.23)	4.5 (2.34)	4.0 (2.23)	3.8 (2.18)	2.7 (1.92)
T6	2.5 (1.73)	2.0 (1.58)	6.7 (2.76)	5.8 (2.61)	3.7 (2.18)	5.2 (2.18)	4.2 (2.49)	4.5 (2.32)	3.4 (2.34)	4.0 (2.23)	4.3 (2.30)	3.7 (2.16)	3.1 (2.03)	2.6 (1.89)
T7	4.1 (2.14)	4.3 (2.19)	9.9 (3.29)	9.6 (3.25)	5.3 (2.51)	8.5 (2.43)	5.8 (2.30)	7.8 (2.97)	6.1 (2.67)	5.4 (2.67)	7.2 (2.87)	5.9 (2.62)	5.4 (2.52)	3.9 (2.21)
T8	4.3 (2.19)	4.0 (2.12)	7.1 (2.85)	8.6 (3.10)	4.3 (2.31)	8.2 (2.31)	5.2 (2.49)	7.2 (2.92)	4.2 (2.48)	5.2 (2.48)	5.9 (2.63)	5.5 (2.55)	4.8 (2.41)	3.7 (2.17)
T9	3.4 (1.97)	3.7 (2.05)	7.1 (2.85)	6.3 (2.70)	4.0 (2.24)	6.8 (2.24)	4.6 (2.36)	7.1 (2.85)	4.0 (2.23)	5.1 (2.23)	4.7 (2.39)	4.7 (2.39)	3.9 (2.21)	3.2 (2.04)
T10	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)
T11	19.3 (4.45)	22.7 (4.82)	25.6 (5.11)	22.0 (4.74)	22.3 (4.77)	25.0 (4.41)	22.1 (4.75)	17.0 (4.18)	21.8 (4.72)	23.7 (4.69)	17.0 (4.18)	21.8 (4.72)	20.7 (4.60)	21.4 (4.68)
SEm±	**0.14**	**0.09**	**0.12**	**0.09**	**0.07**	**0.11**	**0.09**	**0.06**	**0.12**	**0.04**	**0.08**	**0.03**	**0.05**	**0.05**
LSD (p=0.05)	**0.42**	**0.25**	**0.35**	**0.27**	**0.23**	**0.33**	**0.26**	**0.19**	**0.38**	**0.11**	**0.24**	**0.09**	**0.14**	**0.15**

Table 6: Effect of herbicides on weed dry weight (g m^{-2}) in soybean at 45 DAA

Treatment	*Dinebra arabica*		*Echinochloa colona*		*Physalis minima*		*Commelina benghalensis*		*Cyanotis axillaris*		*Celosia argentea*		*Cyperus rotundus*	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
T1	4.8 (2.30)	5.2 (2.39)	9.1 (3.10)	9.0 (3.08)	8.3 (2.97)	8.9 (3.07)	7.9 (2.90)	8.3 (2.97)	9.7 (3.19)	10.4 (3.30)	3.4 (1.97)	3.2 (1.92)	1.7 (1.48)	1.9 (1.55)
T2	4.3 (2.19)	4.7 (2.28)	8.9 (3.07)	8.6 (3.03)	7.9 (2.79)	7.5 (2.90)	7.5 (2.83)	7.9 (2.90)	9.0 (3.08)	10.1 (3.26)	3.3 (1.95)	3.1 (1.90)	1.3 (1.34)	1.8 (1.52)
T3	3.7 (2.05)	3.8 (2.07)	8.4 (2.98)	8.3 (2.97)	6.9 (2.72)	7.4 (2.81)	6.7 (2.68)	7.3 (2.79)	8.3 (2.97)	9.6 (3.18)	3.2 (1.92)	2.9 (1.84)	1.1 (1.26)	1.6 (1.45)
T4	3.9 (2.10)	4.0 (2.12)	8.7 (3.12)	8.7 (3.11)	7.6 (2.93)	8.2 (3.03)	7.4 (2.89)	7.5 (2.91)	9.9 (3.30)	10.0 (3.32)	3.0 (1.99)	3.0 (1.99)	1.0 (1.38)	1.7 (1.63)
T5	3.2 (1.92)	3.1 (1.90)	7.9 (2.97)	8.1 (3.02)	6.5 (2.74)	6.1 (2.65)	6.2 (2.68)	6.8 (2.79)	7.6 (2.93)	9.3 (3.20)	2.9 (1.97)	2.7 (1.91)	1.0 (1.38)	1.3 (1.52)
T6	2.3 (1.67)	2.2 (1.64)	6.3 (2.70)	7.3 (2.87)	6.2 (2.69)	5.9 (2.63)	5.9 (2.63)	6.2 (2.69)	7.1 (2.84)	9.8 (3.28)	2.7 (1.91)	2.3 (1.82)	0.7 (1.28)	1.0 (1.38)
T7	6.8 (2.70)	9.1 (3.10)	9.5 (3.24)	8.4 (3.07)	9.8 (3.29)	8.4 (3.07)	8.9 (3.14)	9.9 (3.29)	9.9 (3.30)	10.7 (3.41)	4.3 (2.08)	3.79 (2.16)	3.3 (1.52)	3.7 (1.63)
T8	7.4 (2.81)	8.3 (2.97)	8.6 (3.10)	9.0 (3.16)	7.9 (2.98)	8.1 (3.02)	7.6 (2.92)	9.3 (3.22)	9.7 (3.27)	10.2 (3.35)	4.6 (1.99)	4.3 (2.07)	3.7 (1.28)	3.7 (1.63)
T9	5.6 (2.47)	5.9 (2.53)	6.4 (2.72)	9.1 (3.18)	6.5 (2.74)	7.7 (2.95)	6.3 (2.70)	9.6 (3.26)	7.2 (2.86)	10.4 (3.38)	5.9 (1.96)	5.3 (1.82)	4.0 (1.41)	4.3 (1.52)
T10	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)	0.0 (1.00)
T11	24.1 (4.96)	25.9 (5.14)	33.4 (5.82)	34.2 (5.89)	33.4 (5.82)	37.1 (6.13)	32.3 (5.73)	37.8 (6.19)	34.2 (5.89)	34.1 (5.88)	31.3 (5.64)	32.3 (5.73)	32.0 (5.70)	32.3 (5.73)
SEm±	**0.1**	**0.12**	**0.08**	**0.06**	**0.07**	**0.1**	**0.07**	**0.08**	**0.07**	**0.1**	**0.09**	**0.11**	**0.14**	**0.13**
LSD (p=0.05)	**0.29**	**0.33**	**0.17**	**0.25**	**0.21**	**0.32**	**0.22**	**0.24**	**0.21**	**0.31**	**0.27**	**0.33**	**0.4**	**0.38**

Table 7: Effect of herbicides on weed control efficiency (%) in soybean at 15, 30 and 45 DAA

Treatment	*Dinebra arabica*			*Echinochloa colona*			*Physalis minima*			*Commelina benghalensis*			*Cyanotis axillaris*			*Cyperus rotundus*		
	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA
T1	70.37	77.18	80.00	62.05	62.59	80	60.15	74.34	73.21	62.26	68.75	75.58	67.05	68.23	89.61	69.03	79.53	94.45
T2	77.70	79.94	82.01	63.89	64.47	82.05	63.39	76.87	74.1	66.52	70.43	78.45	70.37	71.15	89.93	70.35	80.25	95.15
T3	80.01	84.25	84.99	71.16	66.96	84.99	67.63	80.9	75.29	75.15	73.45	79.69	73.68	75.79	90.4	73.005	82.62	95.85
T4	77.68	82.29	84.19	68.7	65.51	84.19	64.91	75.95	74.25	72.68	69.05	77.55	72.42	71.47	90.56	71.25	81.42	95.81
T5	84.22	87.17	87.38	72.47	72.05	87.35	74.13	79.41	76.35	78.53	75.635	82.05	72.91	77.59	91.18	75.275	84.51	96.43
T6	86.53	89.12	90.98	75.74	73.735	90.95	80.25	81.25	79.85	85.05	77.265	82.77	76.63	78.87	92.15	77.9	86.43	97.35
T7	58.05	79.91	68.32	60.94	58.84	76.99	54.36	71.04	73.5	62.06	63.94	74.01	59.63	65.29	87.25	68.58	77.85	89.15
T8	51.92	80.05	68.62	61.46	66.59	68.62	68.01	73.89	73.96	62.26	67.06	77.26	63.01	70.03	85.99	73.49	79.76	88.49
T9	65.78	83.04	76.99	70.58	71.81	68.32	65.91	77.37	77.15	72.71	68.75	79.89	68.82	75.39	82.37	76.13	83.15	87.09
T10	100.00	100.00	100.00	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
T11	0.00	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8. Effect of herbicides on the growth and yield of soybean and the residual effect on succeeding green gram

Treatment	Soybean												Green Gram									
	Plant height (cm)		Branches per plant		Pod per plant		Seed yield (t ha^{-1})		Net returns (Rs)		B: C Ratio		Germination (%)		Plant height (cm)		Branches per plant		Pods per plant		Seed yield (t ha^{-1})	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
T_1	67.80	67.90	4.00	4.12	41.35	47.00	1.48	1.46	51760	50560	1.40	1.37	81.0	83.2	37.2	38.4	7.12	7.33	32.2	30.6	1.03	1.03
T_2	68.60	69.10	4.17	4.37	41.58	46.33	1.50	1.49	52450	51850	1.40	1.38	82.2	83.3	36.4	38.1	7.23	7.05	31.6	30.1	1.04	1.04
T_3	69.90	69.70	4.37	5.00	43.12	42.00	1.59	1.51	57212	52412	1.50	1.37	83.1	80.2	38.2	39.2	7.35	6.95	32	30.3	1.04	1.03
T_4	66.70	68.30	4.67	5.33	42.33	41.67	1.52	1.50	54120	52920	1.46	1.43	81.7	83.6	37.7	36.9	7.33	6.67	32.7	31.2	1.05	1.01
T_5	71.00	73.00	6.33	6.33	49.67	48.33	2.26	2.20	98000	93800	2.61	2.49	81.3	77.5	38	37.5	7.00	7.33	32.9	33.1	1.01	1.01
T_6	76.00	75.30	7.67	7.33	51.67	51.00	2.29	2.22	99150	94950	2.59	2.48	83.4	83.4	40.2	38.8	7.67	7.67	30.2	31.4	1.12	1.06
T_7	67.30	69.70	6.33	6.33	45.67	47.00	1.71	1.72	65050	6565	1.73	1.75	81.4	79.6	38.3	37.9	7.67	6.33	31.9	29.7	0.99	1.12
T_8	69.30	68.30	6.67	6.67	45.67	46.33	1.51	1.55	53113	55513	1.42	1.48	81.3	83.8	37.3	38.1	6.67	6.33	33.5	30.8	1.17	1.05
T_9	68.70	69.00	5.67	6.00	42.00	42.00	1.40	1.42	45860	47060	1.20	1.23	81.3	83.4	38.6	38.2	7.00	5.67	30.1	29.3	1.06	1.04
T_{10}	76.30	76.70	8.33	8.67	56.33	54.67	2.48	2.44	98800	96400	1.98	1.93	83.5	83.4	40.7	39.6	7.67	7.33	33.6	30.8	1.04	1.03
T_{11}	62.30	58.70	4.33	4.67	35.67	34.67	1.24	1.29	39400	42400	1.13	1.21	82.4	77.5	37.5	38.3	6.67	6.33	34.9	30.6	1.23	0.98
SEm±	**1.11**	**0.91**	**0.33**	**0.33**	**1.23**	**1.23**	**0.05**	**0.04**	-	-	-	-	**2.69**	**3.91**	**2.53**	**2.49**	**0.92**	**0.83**	**1.14**	**1.11**	**0.56**	**0.54**
LSD (p=0.05)	**3.39**	**2.79**	**1.01**	**1.01**	**3.68**	**3.77**	**0.156**	**0.11**	-	-	-	-	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

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