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Effect of pre-emergence and post-emergence herbicides for weed management in Mungbean [*Vigna radiata* (L.) Wilczek]

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Abstract
A field experiment was conducted during *kharif* season, 2022 at Research Farm, School of Agriculture, Suresh Gyan Vihar University, Jaipur (Rajasthan) to study the "Effect pre- emergence and post- emergence harbicides for weed management in mungbean [*Vigna radiata* (L.) Wilczek]". The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice based on one year of experimentation (T_1: Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE, T_2: Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* handweeding at 30 DAS, T_3: Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1} POE, T_4: Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE, T_5: Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE, T_6: Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* handweeding at 30 DAS, T_7: Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1} POE, T_8: Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE, T_9: Weed free and T_{10}: Weedy check each replicated thrice. The lowest weed population, dry weight, highest percent weed control efficiency and productivity of mungbean were recorded by the weed free treatment. Among all the herbicidal treatments, the lowest weeds count, weeds dry weight and highest percent weed control efficiency; high growth and productivity of mungbean were recorded under treatment T_4: Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE which can be recommended to the farmer.

Keywords: Mungbean, pre-emergence, post-emergence, growth and yield

1. Introduction
Weed management is an important key factor for enhancing the productivity of mung bean, as weeds compete for nutrient, water, light and space with crop plants during early growth period. Moreover, besides low yield of crop, they increase production cost, harbor insect-pest and diseases, decreasing quality of farm produce and reduce land value of the different factors known for reduction in crop production, among them weed stand first. Weeds spread easily, because of their enormous seed production and once established are not easily eradicated. Life cycle of most of them coincide with that of crop they invade, thus ensuring mixing of their seed with those of the crops (Mahroof *et al.* 2009) [6]. Depending on weed type and crop weed competition it reduces crop yield up to 96.5%, whereas the loss of mung bean yield due to weeds ranges from 65.4 to 79.0%. The magnitude of losses largely depends upon the composition of weed flora, period of weed-crop competition and its intensity. Weeds emerge with the summer sown crops and create severe competition unless controlled timely and effectively. Inter-row cultivation is not sufficient and intra-row hand weeding is necessary under most conditions. Therefore, there is an urgent need to move from costly manual-mechanical weed control to an integrated weed control. This paper deals with the objective of to study different weed flora, effect of different weed control practices on growth and yield and efficacy of different herbicide for controlling weeds in mung bean (Verma *et al.* 2018) [14].
Pre-emergence herbicides play a crucial role in weed management and can significantly impact the growth and yield of crops like mung bean (*Vigna radiata*). These herbicides are applied before weed emergence and target weed seeds or seedlings, preventing their establishment and

competition with the main crop. When used appropriately, pre-emergence herbicides can effectively control weeds, reduce crop yield losses, and improve crop quality Raju *et al.* (2018) [8].
When applied at the right time and dosage, pre-emergence herbicides can help create a weed-free environment, allowing mung bean plants to grow with reduced competition for water, nutrients, and sunlight. As a result, the crop can establish a better root system and allocate more energy towards above-ground growth. With fewer weed pressures, mung bean plants can achieve higher photosynthetic rates and produce healthier leaves, which leads to better overall growth and development Suresh *et al.*, (2016) [13].

2. Materials and Methods
This experiment was conducted during the *kharif* season of 2022 at Research Farm, School of Agriculture, Suresh Gyan Vihar University, Jaipur (Rajasthan), located at 75° 51'44" E longitude and 26°48'35'' N latitude and an altitude of 431 m mean sea level. This area is located near Akshyapatra temple, about 19 km from Jaipur city. Organic carbon (0.37%), accessible nitrogen (225 kg/ha), phosphorus (41.8 kg/ha), and potassium (261.2 kg/ha) are the most abundant elements. The region has a subtropical climatic condition. The region has a semi-arid subtropical climate. Two hand weeding were performed 30 days and 60 DAS following sowing to prevent crop-weed competition. The growth characteristics observations were recorded using conventional technique at 25-day intervals and displayed at harvest. Yield metrics were measured on harvest day, Sep.30th, 2022. All of the parameters were recorded and statistically analysed using appropriate analysis of variance techniques as described by Gomez and Gomez (1984) [3].

3. Result and Discussion
3.1 Weed Attributes
Weed management treatments showed significantly reflective effect on managing weeds. Among weed management treatments, metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE showed significantly greater efficacy in reducing total weed population and weed dry weight and found equally effective with sequential application of Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100g *a.i.* ha^{-1} POE and Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70g *a.i* ha^{-1} POE, at 25 DAS. The maximum weed control efficiency was recorded with Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE (82.23%) followed by sequential application of Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100g *a.i.* ha^{-1} POE (74.40%) and Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100g *a.i.* ha^{-1} POE, respectively. Due to minimized losses in seed yield (weed index) and efficient weed infestation control, lower weed index (4.87) was observed in Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE (T_8) followed by Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE (T_4) (7.42). The results were in accordance and close conformity with those of Kumar *et al.*, (2014) [4], Meena *et al.*, (2015) [7] (Shaker *et al.*, (2014) [10] and Sharma *et al.*, (2019) [12].
Among the weed management practices, application of the Pendimethalin 30% EC @1 kg/ha PE + HW, 30 DAS recorded significantly lower weed density than remaining other treatments at all the stages of crop growth. Weedy check recorded significantly higher weed population at all the stages of crop growth. Pendimethalin 30 EC @ 1 kg/ha + Imazethapyr 10 SL @ 0.075 kg/ha at PoE, 20 DAS recorded significantly lower weed density as compare imazethapyr alone at 30 and 45 DAS but the difference was not significant at 60 DAS and harvest stage reported by Ramanathan and Chaudhary (2016). Among the weed management practices, application of Pendimethalin 30% EC @1 kg/ha PE + HW 30 DAS was recorded significantly higher weed control efficiency over other treatments. In other weed management treatments, Pendimethalin 30% EC @1 kg/ha PE + Imazethapyr 10% SL @ 0.075 k /ha PoE, 20 DAS recorded significantly higher weed control efficiency than Imazethapyr 10%@ 0.075 kg/ha PoE, 20 DAS and Weedy check. Lowest weed control efficiency was recorded in Imazethapyr 10% @ 0.075 kg/ha PoE, 20 DAS. Reported by Rao *et al*. (2015) [9].

3.2 Growth parameters
Among the various weed management treatments, highest plant height was recorded in treatment T_9 (Weed Free) (68.55 cm) which was found statistically at par with treatment T_4 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (67.74 cm) and T_8 (Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (66.36 cm). Highest dry matter accumulation was recorded in treatment T_9 (Weed Free) (106.23 gm) which was found statistically at par with that treatment T_4 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (105.65 cm), T_8 (Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (104.47 cm) and T_3 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1} POE) (104.03 cm). Number of branches at harvest was found highest (6.13) in treatment T_9 (Weed Free). However, it was found that treatment T_4 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (5.98) was statistically at par with treatment T_9 (Weed Free). Number of nodules/plant was found highest (32.26) in treatment T_9 (Weed Free). However, it was found that treatment T_4 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (31.87) was statistically at par with treatment T_9 (Weed Free).
Imazethapyr was more selective than metribuzin, which meant that it had less of an impact on the plant height of the mung bean crop. This is a crucial concern because herbicides can harm the environment if they are not utilized appropriately. The study's findings indicate that imazethapyr is an excellent alternative for weed management in mung bean in Telangana's Warangal district. However, the herbicide should be selected on an individual basis, taking into account the specific weed species present, the crop being cultivated, and the environmental conditions. Suresh *et al.* (2016) [13]. Pendimethalin, Imazethapyr, Quizalofop-p- ethyl, 2,4-D, Metribuzin, and a combination of Pendimethalin and Imazethapyr were the herbicides examined. Mung bean weed density, biomass, weed control efficacy, and yield parameters were assessed. All herbicide treatments considerably reduced weed density and biomass when compared to the control. The combination of Pendimethalin and Imazethapyr provided the most effective weed control. In terms of yield characteristics, herbicide treatments increased the number of nodules per plant and the number of branches per pod of mung bean. Sharma *et al.* (2017) [11]. The effect of three different herbicides (pendimethalin, imazethapyr, and acifluorfen) on the number of branches per plant of mung bean. The herbicides were applied either pre-emergence or post-emergence. The results showed that the number of branches per plant was significantly higher in the treatments with pre-emergence herbicides than in the treatments with post-

emergence herbicides. The study also found that the herbicide pendimethalin was the most effective at increasing the number of branches per plant Dhankhar *et al.* (2016) [2]. The effect of three different herbicides (pendimethalin, oxyfluorfen, and imazethapyr) on the dry weight of mung bean. The herbicides were applied either pre- emergence or post-emergence.

3.3 Yield parameters

Highest number of pods plant^{-1} (20.23) was observed with the application of treatment T_9 (Weed Free. However, it was found that treatment T_4 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (19.56) was statistically at par with treatment T_9 (Weed Free). Number of seeds pod^{-1} was found highest (7.01) in treatment T_9 (Weed Free). However, it was found that treatment T_4 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (8.09) and T_8 (Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (7.87) were statistically at par with treatment T_9 (Weed Free). Maximum seed yield (1210.76 kg ha^{-1}) was observed under the treatment T_9 (Weed Free). However, treatment T_4 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (1147.05 kg ha^{-1}) and T_8 (Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (1138.65 kg ha^{-1}) remained statistically at par with treatment T_9 (Weed Free). Maximum straw yield (2404.36 kg ha^{-1}) was observed with T_9 (Weed Free). However, treatment T_4 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (2348.54 kg ha^{-1}), T_8 (Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (2296.47 kg ha^{-1}) and T_3 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1} POE) (2248.56 kg ha^{-1}) remained statistically at par with treatment T_9 (Weed Free). Maximum biological yield (3615.12 kg ha^{-1}) was observed with T_9 (Weed Free). However, treatment T_4 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (3495.59 kg ha^{-1}), T_8 (Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE) (3435.12 kg ha^{-1}) and T_3 (Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1} POE) (3345.01 kg ha^{-1}) remained statistically at par with treatment T_9 (Weed Free).

The influence of three different herbicides on the quantity of pods per plant of mung bean (pendimethalin, imazethapyr, and acifluorfen). Herbicides were administered either before or after emergence. The results showed that the number of pods per plant was much larger in pre-emergence herbicide treatments than in post-emergence herbicide treatments. The herbicide pendimethalin was also shown to be the most efficient in increasing the number of pods per plant in the study by Sharma *et al.* (2017) [11]. The pre-emergence herbicide pendimethalin was more effective than the post-emergence herbicide imazethapyr at increasing the number of pods per plant, pod weight, and grain yield of mung bean. The study also found that pendimethalin was more effective at reducing weed competition, which allowed the mung bean plants to grow more vigorously and produce more pods. Chhodavadia *et al.* (2015) [1]. The pre-emergence herbicide pendimethalin was more effective than the post-emergence herbicide imazethapyr at increasing the number of pods per plant, pod weight, and grain yield of mung bean. The study also found that pendimethalin was more effective at reducing weed competition, which allowed the mung bean plants to grow more vigorously and produce more pods. Badruddin *et al.* (2019). Pendimethalin herbicide is effective in weed control and improving the yield of mung bean. The herbicide treatment positively influenced the yield attributes of mung bean, resulting in higher yields. This research highlights the significance of pendimethalin as an effective tool in weed management practices for mung bean cultivation, contributing to increased productivity and sustainable crop production. Kumar and Singh (2018) [5].

Table 1: Effect of herbicides on weed parameters at different growth stage of Mungbean.

S. No.	Treatments	Weed population (No./m^{-2})	Weed dry matter(g/m^{-2})	Weed Control Efficiency	Weed Index
T_1	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE	6.60 (43.11)	7.79 (60.13)	47.68	47.68
T_2	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Handweeding at 30 DAS	5.84 (33.78)	6.81 (45.88)	60.49	60.49
T_3	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1} POE	5.36 (28.42)	6.30 (39.37)	66.02	66.02
T_4	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE	4.45 (19.64)	5.45 (29.66)	74.40	74.40
T_5	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE	6.37 (40.20)	8.04 (64.20)	44.68	44.68
T_6	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Handweeding at 30 DAS	6.31 (39.52)	7.42 (54.65)	53.01	53.01
T_7	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1} POE	5.00 (24.55)	5.84 (33.74)	70.97	70.97
T_8	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE	3.62 (12.75)	4.59 (20.60)	82.23	82.23
T_9	Weed free	0.71 (0.00)	0.71 (00.00)	100.00	100.00
T_{10}	Weed check	14.05 (196.89)	10.80 (116.24)	0.00	0.00
	SEm±	0.20	0.23	1.19	1.19
	CD (p=0.05)	0.60	0.70	3.54	3.54
	CV (%)	6.07	6.44	5.06	5.06

Table 2: Effect of herbicides on growth parameters at different growth stage of Mungbean

S. No.	Treatments	Plant Height (cm)	Dry matter accumulation (g/m row length)	No. of Branches	No. of Nodules/plant
T_1	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE	62.33	100.37	4.33	26.79
T_2	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Handweeding at 30 DAS	63.36	103.32	4.95	28.75
T_3	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1} POE	65.53	104.03	5.49	29.95
T_4	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE	67.74	105.65	5.98	31.87
T_5	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE	61.36	99.54	4.19	26.38
T_6	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Handweeding at 30 DAS	62.98	102.25	4.59	27.75
T_7	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1} POE	64.49	103.78	5.11	29.47
T_8	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1} POE	66.36	104.47	5.68	30.32
T_9	Weed free	68.55	106.23	6.13	32.26
T_{10}	Weed check	59.46	97.36	4.12	25.54
	SEm±	1.86	3.28	0.18	0.93
	CD (p=0.05)	2.53	2.76	0.54	2.76
	CV (%)	5.12	5.54	6.25	5.57

Table 3: Effect of herbicides on yield attributes of Mungbean

S. No.	Treatments	No. of pods/plant	No. of seeds/pod	Seed yield (kg/ha)	Straw yield (kg/ha)	Biological Yield (kg/ha)
T_1	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE	14.95	7.01	836.54	1868.87	2705.41
T_2	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Handweeding at 30 DAS	16.26	7.36	969.54	2068.44	3037.98
T_3	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1} POE	17.76	7.79	1096.45	2248.56	3345.01
T_4	Pendimethalin 30 EC at 0.75 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1}POE	19.56	8.09	1147.05	2348.54	3495.59
T_5	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE	14.46	6.85	799.47	1801.14	2600.61
T_6	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Handweeding at 30 DAS	15.74	7.19	926.54	1967.65	2894.19
T_7	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Fenoxaprop–p-ethyl 9 EC at 70 g *a.i* ha^{-1}POE	16.69	7.53	1043.58	2158.63	3202.21
T_8	Metribuzin 70 WP at 0.5 kg *a.i* ha^{-1} PE *fb* Imazethapyr 10 SC at 100 g *a.i.* ha^{-1}POE	18.49	7.87	1138.65	2296.47	3435.12
T_9	Weed free	20.23	8.30	1210.76	2404.36	3615.12
T_{10}	Weed check	13.35	6.71	538.47	1697.45	2737.92
	SEm±	0.54	0.21	36.87	73.39	91.64
	CD (p=0.05)	1.62	0.65	109.56	218.05	272.30
	CV (%)	5.66	5.57	6.57	6.09	5.19

4. Conclusion

Weed management in mungbean is very difficult because of presence of complex weed flora. Usage of herbicidal combinations could be the solution as it controls the all types of weeds effectively and prevents the development of herbicide resistance in weeds. This study was carried out to find the suitable herbicidal combinations mungbean. Based on findings of investigation for one year, it may be concluded that application of T_4 (Pendimethalin 30 EC at 0.75 kg a.i. ha^{-1} PE fb Imazerthapyr 10 SC100 g a.i. ha^{-1} POE) which was at per with T_8 (Metributzin 70 WP at 0.75 kg a.i. ha^{-1} PE fb Imazerthapyr 10 SC at 100 g a.i. ha^{-1} POE) was equally effective to hand weeding thrice in controlling the weeds and improved yield.

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