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Enhancing Profitability and Yield Potential of Weed Controlling in Green Gram (*Vigna radiata* L.) under Central Plains of Punjab

L.S. Vyvahare [1], S. Menon[1], P.J. Khose[1], M.S Na-Allah Sale[2], V. Dhamapurkar[3]

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ABSTRACT

Background: The first 30 DAS are crucial for the green gram crop while competing with crop weeds. Weed competition with light, water, nutrients and space has an impact on the development and growth of crops. Green gram yield loss is reduced by weed by about 50–80%. The switch of unwanted plant throughout the early stages of crop development is crucial.

Methods: The methodology was lead in the two successive years of *Kharif*, 2021 and 2022 eight weed-controlling treatments were used in an RBD. The weed count of each plot remained measured in field using two quadrates measuring 25 cm × 25 cm. The weight of seeds, straw and dry biomass of weeds were measured by weighing balance. The collected samples of green gram were determined by yield attributes, yield and net monetary returns.

Result: The consequences of finding are minimum weed population (6.01 m^{-2}) and weed dry biomass (0.37 g m^{-2}), maximum weed control effectiveness (87.51%), achieve yield characteristics for instance number of pods per plant (21.26), number of grains per pod (11.99), test weight (32.86 g), straw yields (24.48 q ha^{-1}) were noted with Pendimethalin (1000 g ha^{-1}) 2 DAS (PE) combined with Imazethapyr (50 g ha^{-1}) 30 DAS (PoE). It can be used for extremely active weed control to upper seed yield (7.25 q ha^{-1}) and maximum net profits (` 36738 ha^{-1}) besides higher benefit cost ratio (1:96 respectively) of green gram.

Key words: *Commelina benghalensis* L., Green gram, Herbicides, Weed population, Weed biomass, Yield.

INTRODUCTION

Green gram (*Vigna radiata* L.) is one of greatest significant and widely grown pulse crop in India. It contains about 25 % protein, 62.6 % carbohydrate, 1.1 % fat, total dietary fiber 16.3 % and quite a lot of essential amino acid as well as lysine, which is commonly lacking in cereals and provided that protein rich regime to vegaetarians population of the nation (IIPR, 2019).

Weed growth not only reduces grain output, but it also has an adverse effect on seed quality. Weed invasion and its strength at initial phase is a identical significant biotic constraint in irrigated green gram and has remained create toward lessen 50-80 % yield in green gram [Das *et al*., (2012), Nandan *et al*., (2011), Nagender *et al*., (2016), Singh *et al*., (2019), Osari *et al*., (2019); Verma *et al*., (2020)]. Pendimethalin efficiently control the monocot and dicot weeds during early phase of crop rising at 3 to 4 leaf stage and increases productivity of green gram Singh *et al*., (2019). Imazethapyr has also been noted to offer active weed switch in green gram after emergence [Singh *et al*., (2014); Singh *et al*., (2017)]. Imazethapyr, a wide-ranging herbicide, it is stays in soil for long time and less toxic effect on soil health Tamang *et al*., (2015). For active managing of difficult weed flora, there is necessity to usage combination of different new weedicides Devi *et al*., (2017b). It would have broad range of weed controllers causing no harm to plant, have little lasting effect on the crop and boost agricultural yield and profitability in green gram crop Devi *et al*., (2017a). The research work was carried out with following objectives: i) To study the effect of herbicides use on weed density in green gram field. ii) To study the effect of herbicides use on growth and yield of green gram and iii) To study the effect of herbicides use on benefit cost ratio in green gram crop.

[1]Department of Agronomy, Lovely Professional University, Phagwara-144411, Punjab, India.
[2]Department of Crop Science, Kebbi State University of Science and Technology, Aliero Nigeria.
[3]Krishi Vigyan Kendra, Sindhudurng-416 616, Maharashtra, India.

Corresponding Author: L.S. Vyvahare, Department of Agronomy, Lovely Professional University, Phagwara-144411, Punjab, India. Email: vyvaharelaxman2@gmail.com

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MATERIALS AND METHODS

In the years 2021 and 2022 in *kharif*, the experiment was carried out. Two year of a field trial has been completed at the research farm, Lovely Professional University, Jalandhar, (Punjab). The investigation was conducted in sandy loam soil with low levels of organic matter and pH (6.5-7.5). Data of the maximum and minimum temperature of the experimental field is shown in (Fig 1) on a month wise (Source: Punjab Agriculture University Ludhiana, Punjab,

India). For *kharif* green gram, the evaluation of five herbicides (Imazethapyr as (PE and PoE), Pendimethalin as (PE) and following herbicides are use at (PoE) Quizalofop-p-ethyl, Imazethapyr + Imazamax and Sodium Acifulourfen and Clodinafop-propargyl) was study with comparing weedy check. The study considered eight treatment such as T_1: Imazethapyr (60 g ha^{-1}) as PE, T_2: Pendimethalin (1000 g ha^{-1}) as PE, T_3: Pendimethalin (1000 g ha^{-1}) as PE + Imazethapyr (50 g ha^{-1}) as PoE, T_4: Hand weeding twice 20 then 40 DAS, T_5: Quizalofop-p-ethyl (75 g ha^{-1}) as PoE, T_6: Imazethapyr + Imazamax (75 g ha^{-1}) as PoE, T_7: Sodium Acifulourfen and Clodinafop-propargyl (180 g ha^{-1}) as PoE, T_8: Unweeded check (Control). The green gram test was led in a RBD. The net pot extent of wheat trial was 8 meter length and 7 meter width with variety ML 818.

Five tagged randomly chosen characteristic plants from each plot individually were counted in terms of plant population, plant height and no of branches per plant and yield and yield-attributing characteristics were recorded in accordance with standard techniques. The net plot area of each plot was used to record the seed and straw yield. According to seed yield calculating by weed index. The information is gathered by the plant using various features and this data is then computed using a statistical approach in Gomez and Gomez, (1984). The unwanted plant (weed fora) count remained recorded in species wise and total under each plot as well as measuring species wise and total weed dry biomass. On the basis of weed dry biomass calculating species wise and total weed control efficiency.

RESULTS AND DISCUSSION

Influence of herbicides on weeds in *kharif* green gram

Both monocot and dicot weeds were found, although both weeds predominated more over the entire field. Among mentioned five weed species in the *kharif* of 2021 and 2022; for there were two grasses *Commelina benghalensis* L., *Digitaria sanguinalis* L., sedges *Cyperus rotundus* L. and

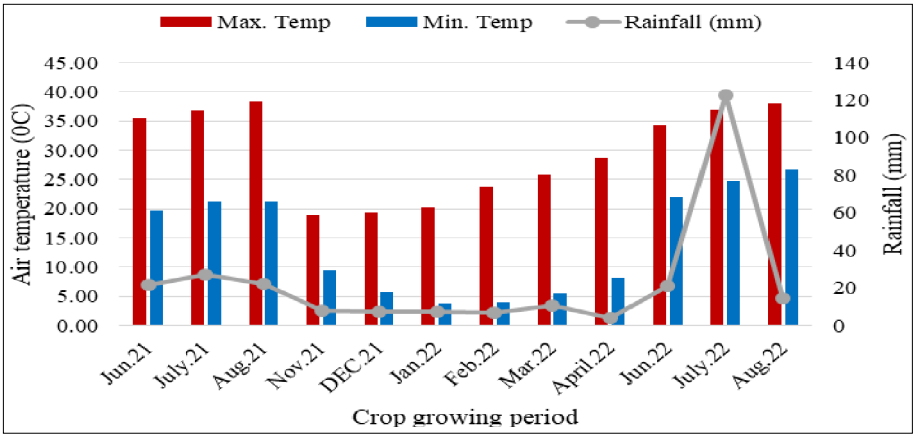

Fig 1: Month wise average of maximum, minimum temperature (°C) and rainfall (mm) at the experimental site from June 2021 to August 2022.

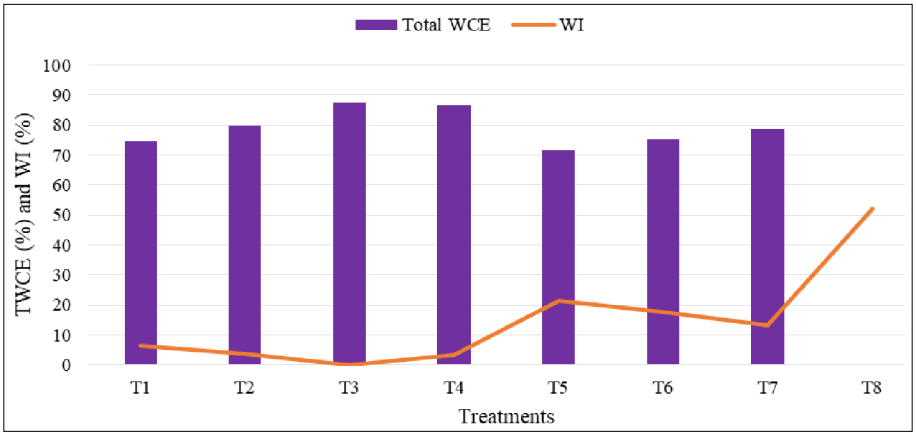

Fig 2: Impact of different weed management treatment on weed control efficiency (%) and weed index (%) in green gram. T_1: Imazethapyr 10% SL @ 60 g ha^{-1} (PE), T_2: Pendimethalin 30% EC @ 1000 g ha^{-1} (PE), T_3: Pendimethalin 30% EC @ 1000 g ha^{-1} (PE) as + Imazethapyr @ 50 g ha^{-1} (PoE), T_4: Hand weeding twice (20 and 40 DAS), T_5: Quizalofop-p-ethyl 5% EC @ 75 g ha^{-1} (PoE), T_6: Imazethapyr 35% + Imazamax 35% WG @ 75 g ha^{-1} (PoE), T_7:Sodium Acifulourfen 16.5 % and Clodinafop-propargyl 8% EC @ 180 g ha^{-1} (PoE), T_8: Unweeded check (Control)".

two broadleaf weeds such as *Cassia tora* L., *Celosia argentea* L. Similar weed flora were also observed in [Singh *et al*.,(2019); Sasode *et al*., (2020)].

Results from weed-free treatments reveal lower weed species diversity, total weed population and dry biomass. Herbicidal usages had a considerable impact in weed count and weed dry biomass. The population and biomass of together narrow and broad leaf weeds were suggestively lowest by all weed controller treatments likened to control, though, weed free (two hand weeding) noted minimum count of dicot, monocot and total weeds than the remaining of the managements. The lowermost weed count as well as weed dry biomass remained seen for use of pendimethalin (1000 g ha^{-1}) as PE with after that Imazethapyr (50 g ha^{-1}) as PoE by 60 days after sowing (Table 1 and 2). Higher weed population were count under weedy check as liken to herbicidal treatment. Similar outcome were detected in Yadav *et al*., (2019).

The full extent of the dry biomass decrease caused by various weed treatments is revealed by weed removal effectiveness (Fig 2). At 60 days following seeding, the weed removal effectiveness of various weed management techniques varied (Table 3). In the weed removal effectiveness, the total weed dry biomass, which consist of different weed species with different proportions, was taken into account. With the combination application of Pendimethalin (1000 g ha^{-1}) fb Imazethapyr (50 g ha^{-1}) after that hand weeding twice, greatest weed control effectiveness (86.94%) and weeding index (0.00) of grasses, sedges and broadleaf weeds were reported at 60 DAS. Lowermost weed control effectiveness and higher weed index logged in weed control in both years. This outcome was quite alike to that of Singh *et al*., (2019).

Table 1: Influence of herbicides on different species and total weed density (no. m^{-2}) at 60 days after sowing of *kharif* green gram by weed controlled treatments (Pooled data of years 2021 to 2022).

Treatment	Grasses		Sedges	Broadleaf		Total weed density
	C. benghalensis	*D. sanguinalis*	*C. rotundus*	*C. tora*	*C. argentea*	
T_1: Imazethapyr (60 g ha^{-1})	2.00** (4.02)*	1.77 (3.14)	2.26 (5.09)	1.24 (1.54)	1.24 (1.54)	4.09 (16.77)
T_2: Pendimethalin (1000 g ha^{-1})	1.40 (1.97)	1.54 (2.38)	1.78 (3.17)	1.18 (1.40)	1.18 (1.40)	3.30 (10.87)
T_3: Pendimethalin (1000 g ha^{-1}) *fb* Imazethapyr (50 g ha^{-1})	1.17 (1.37)	1.37 (1.88)	1.16 (1.35)	1.02 (1.05)	1.02 (1.05)	2.45 (6.01)
T_4: HW twice (20 and 40 DAS)	2.12 (1.25)	2.14 (4.60)	2.88 (8.28)	1.08 (1.18)	1.08 (1.18)	2.74 (7.51)
T_5: Quizalofop-p-ethyl (75 g ha^{-1})	1.46 (2.14)	2.52 (6.33)	3.78 (14.28)	1.36 (1.84)	1.36 (1.84)	4.59 (21.06)
T_6: Imazethapyr + Imazamax (75 g ha^{-1})	1.57 (2.46)	2.60 (6.79)	3.58 (12.78)	1.39 (1.93)	1.39 (1.93)	4.29 (18.42)
T_7: Sodium Acifulourfen and Clodinafop-propargyl (180 g ha^{-1})	1.43 (2.05)	2.50 (6.27)	3.73 (13.94)	1.11 (1.24)	1.11 (1.24)	4.09 (16.69)
T_8: Unweeded check (Control)	4.14 (17.17)	3.28 (10.79)	4.59 (21.03)	3.19 (10.19)	3.19 (10.19)	8.92 (79.62)
SEm±	0.14	0.14	0.16	0.18	0.17	0.15
CD (p = 0.05)	0.43	0.42	0.50	0.53	0.51	0.46

*Values given in parenthesis are the mean of original values, **Data subjected to ("x+0.5) square root transformation), SEm±: Standard error of mean and CD: Critical difference.

Table 2: Effect of herbicides on weed species and total dry biomass (g m^{-2}) 60 days after sowing of *kharif* green gram by weed treatment (Pooled data of years 2021 to 2022).

Treatment	Grasses		Sedges	Broadleaf		Total weed density
	C. benghalensis	*D. sanguinalis*	*C. rotundus*	*C. tora*	*C. argentea*	
T_1: Imazethapyr (60 g ha^{-1})	0.50**(0.25)*	0.25(0.09)	0.37(0.14)	0.39(0.14)	0.30(0.09)	0.34(0.69)
T_2: Pendimethalin (1000 g ha^{-1})	0.42(0.17)	0.26(0.08)	0.33(0.11)	0.36(0.12)	0.27(0.07)	0.77(0.59)
T_3: Pendimethalin (1000 ha^{-1}) *fb* Imazethapyr (50 g ha^{-1})	0.38(0.14)	0.27(0.07)	0.21(0.04)	0.31(0.09)	0.24(0.05)	0.61(0.37)
T_4: HW twice (20 and 40 DAS)	0.34(0.11)	0.24(0.05)	0.34(0.11)	0.30(0.10)	0.25(0.06)	0.63(0.40)
T_5: Quizalofop-p-ethyl (75 g ha^{-1})	0.50(0.24)	0.31(0.09)	0.37(0.14)	0.41(0.18)	0.35(0.12)	0.92(0.85)
T_6: Imazethapyr + Imazamax (75 g ha^{-1})	0.53(0.28)	0.30(0.09)	0.31(0.09)	0.42(0.17)	0.34(0.11)	0.85(0.73)
T_7: Sodium Acifulourfen and Clodinafop-propargyl (180 g ha^{-1})	0.49(0.24)	0.26(0.06)	0.33(0.11)	0.40(0.16)	0.35(0.11)	0.80(0.64)
T_8: Unweeded check (Control)	0.93(0.90)	0.47(0.33)	0.66(0.44)	0.96(0.93)	0.88(0.77)	1.73(3.01)
SEm±	0.03	0.02	0.04	0.04	0.03	0.08
CD (p = 0.05)	0.08	0.05	0.10	0.12	0.09	0.20

*Values given in parenthesis are the mean of original values, **Data subjected to (√x+0.5) square root transformation), SEm±: Standard error of mean and CD: Critical difference.

Effect of herbicides on *kharif* green gram

According to the results gathered (Table 4), PE application of Pendimethalin (1000 g ha^{-1}) as PE after that Imazethapyr (50 g ha^{-1}) as PoE *fb* Imazethapyr (60 g ha^{-1}) PE significantly increased plant population after 60 days after planting compared to control.

The absence of weeds resulted in a considerable drop in plant height, which may have been caused by rivalry between the crop and the weed for resources including soil moisture, nutrients, sunshine and space during the crop's active development period. Green gram growth characters remained expressively pretentious through in control (Weedy check). However, combination of pre and post-emergence application of Pendimethalin (1000 g ha^{-1}) combined with Imazetapyr (50 g ha^{-1}) produced significantly taller plants (32.62 cm). Plant height of green gram under different herbicide combinations was comparable. This result revealed that Patel *et al*., (2020).

Higher number of branches per plant was produced by using Pendimethalin (1000 g ha^{-1}) before and after emergence application of herbicide in association with Imazethapyr (50 g ha^{-1}). Altered weed control method significantly affected no. of branches per plant as liken to weedy check. The similar result were observed in Patel *et al*., (2020).

Efficacy of herbicides on *kharif* green gram production, yield characteristics and profitability

Through admiration to yield characteristics, expressively greater no. of pods plant^{-1}, grains pod^{-1} besides test weight were recorded when Pendimethalin (1000 g ha^{-1}) combined with Imazetapyr (50 g ha^{-1}) was use (Table 5). Pre application of Imazetapyr (60 g ha^{-1}), Pendimethalin (1000 g ha^{-1}) and hands weeding double at 20 days interval produced comparable results in expressions of number of pods plant^{-1} and seeds pod^{-1}. More yield-attributing characteristics would emerge as a cause of improved weed management now these treatments, according to Muthuram *et al*.,(2018). The lowest number of pods plant^{-1} remained noted during the control. Better weed control in these treatments would favour increased resource-relatedness, leading to added yield-attaching traits Kaur *et al*., (2016); Muthuram *et al*., (2018). The lowest number of pods plant^{-1} was noted during the control.

The use of Pendimethalin (1000 g ha^{-1}) combined with Imazethapyr (50 g ha^{-1}) caused in a considerable improvement in the grain production and straw yield of green gram in the absence of crop weed competition observed significantly greater average grain yield as well as straw yield compared to control treatments (Table 5). The lower seed as well as straw yield observed in weedy check as compare to remaining the treatment. Like outcomes remained also reported by Patel *et al*., (2020). Amongst the weedicide treatment, the maximum net profits were recorded with Pendimethalin (1000 g ha^{-1}) combined with Imazethapyr (50 g ha^{-1}) (Table 5) *fb* Imazethapyr (60 g ha^{-1}) and the minimum Quizalofop-p-ethyl (75 g ha^{-1}). Highest benefit: cost ratio were achieved with Pendimethalin (1000 g ha^{-1}) combined with Imazethapyr (50 g ha^{-1}) and the lowermost

Table 3: Effect of herbicides on species, total weed control effectiveness 60 days after sowing and WI (%) of *kharif* green gram by weed management treatment (Pooled data of years 2021 to 2022).

Treatments	Grasses		Sedges	Broadleaf		Total WCE	Weed index
	C. benghalensis	*D. sanguinalis*	*C. rotundus*	*C. tora*	*C. argentea*	(%)	(%)
T_1: Imazethapyr (60 g ha^{-1})	71.17	70.42	68.05	84.27	88.52	74.49	6.49
T_2: Pendimethalin (1000 g ha^{-1})	80.22	71.00	73.87	86.63	90.66	79.66	3.86
T_3: Pendimethalin (1000 g ha^{-1}) *fb* Imazethapyr (50 g ha^{-1})	83.87	77.50	87.70	89.85	93.69	87.51	0.00
T_4: HW twice (20 and 40 DAS)	87.50	82.64	73.40	88.77	91.30	86.66	3.45
T_5: Quizalofop-p-ethyl (75 g ha^{-1})	71.84	71.50	66.47	80.21	84.01	71.69	21.53
T_6: Imazethapyr + Imazamax (75 g ha^{-1})	67.63	72.00	75.38	81.48	84.81	75.24	17.73
T_7: Sodium Acifulourfen and Clodinafop-propargyl (180 g ha^{-1})	72.43	79.61	78.20	82.55	85.41	78.56	13.18
T_8: Unweeded check (Control)	0.00	0.00	0.00	0.00	0.00	0.00	52.11
SEm±	-	-	-	-	-	-	0.54
CD (p = 0.05)	-	-	-	-	-	-	1.63

SEm±: Standard error of mean, CD: Critical difference, WCE: Weed control effectiveness and WI: Weed index.

Table 4: Effect of herbicides on growth characters of *kharif* green gram at 60 days after sowing by weed management treatments (Pooled data of year 2021 to 2022).

Treatment	Plant population (m^{-2})	Plant height (cm)	No. of branches ($plant^{-1}$)
T_1: Imazethapyr (60 g ha^{-1})	29.75	40.00	3.00
T_2: Pendimethalin (1000 g ha^{-1})	28.55	40.26	3.15
T_3: Pendimethalin (1000 g ha^{-1}) *fb* Imazethapyr (50 g ha^{-1})	29.95	40.55	3.18
T_4: Hand weeding twice (20 and 40 DAS)	28.87	39.88	2.87
T_5: Quizalofop-p-ethyl (75 g ha^{-1})	27.98	37.87	2.69
T_6: Imazethapyr + Imazamax (75 g ha^{-1})	28.35	38.15	2.78
T_7: Sodium Acifulourfen and Clodinafop- propargyl (180 g ha^{-1})	29.00	39.71	2.85
T_8: Unweeded check (Control)	28.14	36.80	2.57
SEm±	0.40	0.79	0.22
CD (p = 0.05)	1.20	2.39	0.67

SEm±: Standard error of mean and CD: Critical difference.

Table 5: Impact of herbicides on yield and yield attributes and economics of *kharif* green gram (Pooled data of year 2021 to 2022).

Treatment	No. of pods $Plant^{-1}$	No. of grains pod^{-1}	Test weight (g)	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Gross returns (` ha^{-1})	Net returns (` ha^{-1})	B:C ratio
T_1: Imazethapyr (60 g ha^{-1})	20.15	10.47	31.88	6.78	22.77	51925	33640	1.84
T_2: Pendimethalin (1000 g ha^{-1})	21.00	11.36	32.65	6.97	23.72	53465	34590	1.85
T_3: Pendimethalin (1000 g ha^{-1}) *fb* Imazethapyr (50 g ha^{-1})	21.26	11.99	32.86	7.25	24.48	55575	36738	1.96
T_4: HW twice (20 and 40 DAS)	15.76	9.75	30.99	7.00	23.66	50271	28395	1.30
T_5: Quizalofop-p-ethyl (75 g ha^{-1})	15.98	8.26	28.79	5.69	20.51	43863	25165	1.35
T_6: Imazethapyr + Imazamax (75 g ha^{-1})	16.35	8.77	29.48	5.96	20.75	45854	26960	1.43
T_7: Sodium Acifulourfen and Clodinafop-propargyl (180 g ha^{-1})	18.96	9.57	30.46	6.29	21.18	48230	29189	1.54
T_8: Unweeded check (Control)	14.35	7.76	26.60	3.47	12.22	26690	9796	0.58
SEm±	0.54	0.50	0.83	49.47	53.63	-	-	-
CD (p = 0.05)	1.63	1.52	2.52	150.04	162.79	-	-	-

SEm±: Standard error of mean and CD: Critical difference.

Quizalofop-p-ethyl (75 g ha^{-1}) as compare to control. The maximum net profit for the pre-emergent use of Pendimethalin (1000 g ha^{-1}) combined with Imazethapyr (50 g ha^{-1}) it is similar to Sasode *et al*., (2020).

CONCLUSION

It can be concluded that in *kharif* green gram were controlled of both types of weed population (grasses: *Commelina benghalensis* L., *Digitaria sanguinalis* L., sedges: *Cyperus rotundus* L. and two broadleaf weeds such as *Cassia tora* L., *Celosia argentea* L.) by consecutive use of Pendimethalin (1000 g ha^{-1}) as pre-emergent combined with Imazethapyr (50 g ha^{-1}) as post-emergence as they provide better total weed control effectiveness (87.51%), minimum weed index (0.00%) with greater grain yield (7.25 q ha^{-1}), supreme net profits (` 36, 738 ha^{-1}) and higher benefit cost ratio (1:96).The use of premix herbicides can be beneficial for operational and environmentally friendly weed control in green gram.

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