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Effect of different sequential applications of herbicides on soil parameters in guava cv. L-49

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Abstract
In fruit orchards, weeds are considered as the unwanted crops which compete for nutrient, light, moisture and space with the associated crop. So, the present investigation was carried out with the objective to control the weeds by different weed control treatments. There were fifteen sequential applications of herbicides with three replications in randomized block design. Nine years old uniformly grown trees of cultivar L-49, spaced at 6m × 6m were selected. Data was recorded on Soil pH, ECe, available Nitrogen, Phosphorous, Potassium, Zinc and Iron. Among different weed control treatments glyphosate 1.26 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glyphosate 1.26 kg/ha (September) was found effective in improving the soil parameters.

Keywords: Sequential application, herbicides, nutrients, guava, L-49

Introduction
In India, all over the tropics and subtropics, Guava is one of the most popular fruit for its high yield, nutritive value, good processing quality, hardy in nature and wider adaptability and belongs to the family Myrtaceae (Das *et al.*, 2010) [3]. Guava is very profitable as it is very productive and bears fruit twice in a year. In fruit orchards, weeds compete for light, moisture, space and adversely affected yield, growth and quality of many plants and considered as unwanted plants (Das *et al.*, 2010) [3]. At all developmental stages, weeds compete with soil moisture, soil nutrient and light and harbor insects, pests and diseases. All the weed species could not control adequately by a single herbicide. Under various cropping systems, improved weed control could be achieved by alternate methods like tank mixed herbicide applications with glyphosate. Healthy citrus trees will not be injured if properly selected herbicides are applied at specific tree age, scion and soil type (Abouziena *et al.*, 2008) [1]. The ground management systems studies have shown substantially different effects on soil chemical, biological, and physical properties (Laurent *et al.*, 2008) as well as differential effects on root-zone microbial communities and tree root development (Yao *et al.*, 2005) [15]. For alleviating the infestation of weeds and higher yield herbicides are the most important tools (Ashiq *et al.*, 2007) [2]. Herbicidal weed control seems indispensable and has proved efficient in controlling weeds (Kahramanoglu and Uygur, 2010) [5] and hence presently about two-third, by volume, of the pesticides used worldwide in agricultural production are herbicides. In the orchards with a permanent ground cover all year round, negative influence on nutrition uptake was noticed under competition between weeds and trees (Merwin, 2003; Webster, 2005) [3, 14].

Material and methods
The experiment was carried out at experimental orchard of Chaudhary Charan Singh Haryana Agricultural University, Hisar in year 2019 and 2020, respectively. There were fifteen treatments with three replications each in randomised block design. Nine years old uniformly grown trees of cultivar L-49, spaced at 6m × 6m were selected. During the study period, all the cultural practices were followed as per the recommendation by Package of practices of HAU and trees were maintained under uniform conditions. Following treatments of sequential applications of herbicides were applied-

T_1: Glyphosate 1.26 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glyphosate 1.26 kg/ha (September)
T_2: Glyphosate 1.26 kg/ha (July) fb paraquat 0.6% (August) fb glyphosate 1.26 kg/ha (September)
T_3: Paraquat 0.6% (July) fb paraquat 0.6% (August) fb paraquat 0.6% (September)

T_4: Paraquat 0.6% (July) fb glyphosate 1.26 kg/ha (August) fb paraquat 0.6% (September)
T_5: Glufosinate 375 g/ha (July) fb glufosinate 375 g/ha (August) fb glufosinate 375 g/ha (September)
T_6: Glufosinate 375 g/ha (July) fb glyphosate 1.26 kg/ha (August) fb paraquat 0.6% (September)
T_7: Glufosinate 325 g/ha (July) fb metribuzin 1.0 kg/ha (August) fb glyphosate 1.26 kg/ha (September)
T_8: Glyphosate 1.26 kg/ha (July) fb metribuzin 1.0 kg/ha (August) fb paraquat 0.6% (September)
T_9: Metribuzin 1.0 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb Glufosinate 375 g/ha (September)
T_{10}: Atrazine 1.5 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb Glufosinate 375 g/ha (September)
T_{11}: Glyphosate1.26 kg/ha (July) fb atra1.5 kg/ha (August) fb Glufosinate 375 g/ha (September)
T_{12}: Glufosinate 375 g/ha (July) fb atra 1.5 kg/ha (August) fb glyphosate 1.26 kg/ha (September)
T_{13}: Three times hand weeding
T_{14}: Mulching with black polythene
T_{15}: Weedy check

Observations on soil pH, ECe and available nitrogen, phosphorous, potassium, zinc and iron was recorded. Soil pH was determined in 1:2 soil water suspension using glass electrode pH meter (Richards, 1954) [11]. The method purposed by Subbiah and Asija (1956) [13] *i.e.* alkaline permanganate method was used for the determination of available nitrogen in soil sample. The available phosphorus (ppm) in soil samples was determined by the procedure described by Olsen (1954) [8]. The available potassium (ppm) of the soil samples was determined by neutral normal NH_4OAC solution using Flame Photometer (Hanway and Heidal, 1952) [4]. The DTPA extractable Zn and Fe was estimated by using the method described by Lindsay and Norvell (1978) [6].

Results and Discussion

Soil pH and ECe

The data on soil pH presented in Table 1 clearly showed that different herbicides did not influence the soil pH significantly during both the years *i.e.* 2019 and 2020. The result is confirmation with Shylla *et al.* (1998) [12] who also found that soil pH is not significantly affected by different floor management practices in plum. ECe of soil is significantly influenced by the application of different herbicides. ECe was significantly lower (1.05 and 1.03) in treatment glyphosate 1.26 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glyphosate 1.26 kg/ha (September) being statistically on par with treatment glyphosate 1.26 kg/ha (July) fb paraquat 0.6% (August) fb glyphosate 1.26 kg/ha (September) and mulching with black polythene. Same results were observed by Ponnusamy, *et al.*, (2019) [10] who found that from 2001-08, the ECe of soil decreased and then in 2014 increased this may be due to the variations in water quality of irrigation and heavy rainfall during both the seasons *i.e.* rainy and winter in rice.

Table 1: Effect of sequential application of herbicides on pH and ECe (dSm^{-1}) of soil under canopy of guava cv. L-49 during 2019 and 2020

Treatments	Ph		ECe (dSm^{-1})	
	2019	2020	2019	2020
T_1: Glyphosate 1.26 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glyphosate 1.26 kg/ha (September)	7.8	7.8	1.05	1.03
T_2: Glyphosate 1.26 kg/ha (July) fb paraquat 0.6% (August) fb glyphosate 1.26 kg/ha (September)	7.8	7.8	1.07	1.05
T_3: Paraquat 0.6% (July) fb paraquat 0.6% (August) fb paraquat 0.6% (September)	7.8	7.8	1.25	1.23
T_4: Paraquat 0.6% (July) fb glyphosate 1.26 kg/ha (August) fb paraquat 0.6% (September)	7.8	7.8	1.24	1.21
T_5: Glufosinate 375 g/ha (July) fb glufosinate 375 g/ha (August) fb glufosinate 375 g/ha (September)	7.8	7.8	1.22	1.19
T_6: Glufosinate 375 g/ha (July) fb glyphosate 1.26 kg/ha (August) fb paraquat 0.6% (September)	7.8	7.8	1.15	1.21
T_7: Glufosinate 325 g/ha (July) fb metribuzin 1.0 kg/ha (August) fb glyphosate 1.26 kg/ha (September)	7.8	7.8	1.10	1.08
T_8: Glyphosate 1.26 kg/ha (July) fb metribuzin 1.0 kg/ha (August) fb paraquat 0.6% (September)	7.8	7.8	1.20	1.17
T_9: Metribuzin 1.0 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb Glufosinate 375 g/ha (September)	7.8	7.8	1.12	1.10
T_{10}: Atrazine 1.5 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb Glufosinate 375 g/ha (September)	7.8	7.8	1.14	1.12
T_{11}: Glyphosate1.26 kg/ha (July) fb atra1.5 kg/ha (August) fb Glufosinate 375 g/ha (September)	7.8	7.8	1.18	1.16
T_{12}: Glufosinate 375 g/ha (July) fb atra 1.5 kg/ha (August) fb glyphosate 1.26 kg/ha (September)	7.8	7.8	1.16	1.14
T_{13}: Three times hand weeding	7.8	7.8	1.11	1.09
T_{14}: Mulching with black polythene	7.8	7.8	1.09	1.07
T_{15}: Weedy check	7.9	7.9	1.28	1.28
S.E(m)±	0.03	0.02	0.01	0.01
CD at 5% level of significance	NS	NS	0.04	0.04

fb: followed by

Table 2: Effect of sequential application of herbicides on available N (Kg/ha), P (Kg/ha), K (Kg/ha), Zn (mg/kg) and Fe (mg/kg) in soil in guava cv. L-49 during 2019 and 2020

Treatments	N (Kg/ha)		P (Kg/ha)		K (Kg/ha)		Zn (mg/kg)		Fe (mg/kg)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
T_1: Glypho 1.26 kg/ha (July) fb glypho 1.26 kg/ha (August) fb glypho 1.26 kg/ha (September)	266.32	269.55	13.95	14.93	298.59	299.65	2.41	2.46	6.89	6.98
T_2: Glypho 1.26 kg/ha (July) fb para 0.6% (August) fb glypho 1.26 kg/ha (September)	265.34	267.54	13.92	14.92	292.96	296.14	2.39	2.41	6.88	6.96
T_3: Para 0.6% (July) fb para 0.6% (August) fb para 0.6% (September)	253.19	255.54	11.26	12.22	273.28	275.41	2.17	2.20	6.70	6.75
T_4: Para 0.6% (July) fb glypho1.26 kg/ha (August) fb para 0.6% (September)	254.27	256.35	11.56	12.53	274.64	276.59	2.19	2.21	6.72	6.77
T_5: Glufo 375 g/ha (July) fb glufo 375 g/ha (August) fb glufo 375 g/ha	258.65	260.66	12.41	13.41	277.48	279.11	2.23	2.25	6.73	6.82

(September)										
T_6: Glufo 375 g/ha (July) fb glypho 1.26 kg/ha (August) fb para 0.6% (September)	256.41	259.21	12.06	13.20	276.55	277.44	2.21	2.23	6.71	6.81
T_7: Glufo 375 g/ha (July) fb metri1.0 kg/ha (August) fb glypho 1.26 kg/ha (September)	264.11	266.55	13.74	14.73	290.33	292.34	2.36	2.38	6.86	6.94
T_8: Glypho 1.26 kg/ha (July) fb metri 1.0 kg/ha (August) fb para 0.6% (September)	259.27	261.34	12.72	13.71	284.18	287.36	2.24	2.26	6.74	6.83
T_9: Metri 1.0 kg/ha (July) fb glypho1.26 kg/ha (August) fb glufo 375 g/ha (September)	263.41	265.54	13.46	14.45	287.36	289.41	2.33	2.36	6.82	6.93
T_{10}: Atra1.5 kg/ha (July) fb glypho1.26 kg/ha (August) fb glufo 375 g/ha (September)	262.54	263.33	13.27	14.33	286.21	288.33	2.28	2.30	6.77	6.87
T_{11}: Glypho1.26 kg/ha (July) fb atra1.5 kg/ha (August) fb glufo 375 g/ha (September)	260.56	262.28	12.94	13.91	279.42	281.54	2.26	2.29	6.75	6.84
T_{12}: Glufo 375 g/ha (July) fb atra 1.5 kg/ha (August) fb glypho1.26 kg/ha (September)	261.17	262.28	13.25	14.26	284.24	286.21	2.27	2.29	6.76	6.86
T_{13}: Three times hand weeding	255.22	257.53	12.21	13.04	281.04	283.41	2.29	2.31	6.79	6.88
T_{14}: Mulching with black polythene	267.15	269.55	13.75	14.84	296.14	298.59	2.31	2.33	6.84	6.90
T_{15}: Weedy check	238.12	231.21	10.63	10.93	268.87	269.80	2.18	2.20	6.63	6.66
S.E(m)±	4.83	6.06	0.45	0.48	4.01	5.79	0.06	0.03	0.04	0.07
CD at 5% level of significance	12.00	13.01	1.30	1.39	11.67	12.63	0.07	0.10	0.11	0.09

*fb: followed by; Glypho: glyphosate; Para: paraquat; Glufo: glufosinate; Metri: metribuzin; Atra: atrazine

Available Nitrogen (Kg/ha)

It is apparent from the data presented in Table 2 that available Nitrogen influenced significantly due to different sequential application of herbicide mixtures during both the years 2019 and 2020, respectively. The available Nitrogen was observed highest (266.32 and 269.55) under glyphosate 1.26 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glyphosate 1.26 kg/ha (September) being at par with treatment glyphosate 1.26 kg/ha (July) fb paraquat 0.6% (August) fb glyphosate 1.26 kg/ha (September), glufosinate 375 g/ha (July) fb glufosinate 375 g/ha (August) fb glufosinate 375 g/ha (September), glufosinate 375 g/ha (July) fb glyphosate 1.26 kg/ha (August) fb paraquat 0.6% (September), glufosinate 375 g/ha (July) fb metribuzin 1.0 kg/ha (August) fb glyphosate 1.26 kg/ha (September), glyphosate 1.26 kg/ha (July) fb metribuzin 1.0 kg/ha (August) fb paraquat 0.6% (September), metribuzin 1.0 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glufosinate 375 g/ha (September), Atrazine 1.5 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glufosinate 375 g/ha (September), glyphosate 1.26 kg/ha (July) fb atrazine 1.5 kg/ha (August) fb glufosinate 375 g/ha (September), glufosinate 375 g/ha (July) fb atrazine 1.5 kg/ha (August) fb glyphosate 1.26 kg/ha (September), three times hand weeding and mulching with black polythene and lowest (238.12 and 231.21) in weedy check.

Available Phosphorous (kg/ha)

It is amply clear from the data presented in Table 2 that different sequential application of herbicide mixtures affected the available phosphorous significantly. Maximum available phosphorous (13.95 and 14.93) was noticed in under glyphosate 1.26 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glyphosate 1.26 kg/ha (September) being at par with treatment glyphosate 1.26 kg/ha (July) fb paraquat 0.6% (August) fb glyphosate 1.26 kg/ha (September), glufosinate 375 g/ha (July) fb metribuzine 1.0 kg/ha (August) fb glyphosate 1.26 kg/ha (September), glyphosate 1.26 kg/ha (July) fb metribuzin 1.0 kg/ha (August) fb paraquat 0.6% (September), metribuzin 1.0 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glufosinate 375 g/ha (September), atrazine 1.5 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glufosinate 375 g/ha (September), glyphosate 1.26 kg/ha (July) fb atrazine 1.5 kg/ha (August) fb glufosinate 375 g/ha (September), glufosinate 375 g/ha (July) fb atrazine 1.5 kg/ha (August) fb glyphosate 1.26 kg/ha (September), three times hand weeding and mulching with black polythene and minimum (10.63 and 10.93) in weedy check.

Available Potassium

The data pertaining to available potassium presented in Table 2. The available potassium significantly affected due to different sequential application of herbicide mixtures and found more (298.59 and 299.65) in glyphosate 1.26 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glyphosate 1.26 kg/ha (September) being at par with treatment glyphosate 1.26 kg/ha (July) fb paraquat 0.6% (August) fb glyphosate 1.26 kg/ha (September), glufosinate 375 g/ha (July) fb metribuzin 1.0 kg/ha (August) fb glyphosate 1.26 kg/ha (September), Metribuzin 1.0 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glufosinate 375 g/ha (September), Atrazine 1.5 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glufosinate 375 g/ha (September) and mulching with black polythene and least (268.87 and 269.80) in weedy check.

Available Zinc (mg/kg)

The data indicating available zinc is presented in Table 2 showed that different sequential application of herbicide mixtures had significant effect on available zinc. The minimum available zinc (2.18 and 2.20) was noticed in weedy check and maximum (2.41 and 2.46) under glyphosate 1.26 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glyphosate 1.26 kg/ha (September) being at par with treatment glyphosate 1.26 kg/ha (July) fb paraquat 0.6% (August) fb glyphosate 1.26 kg/ha (September) and glufosinate 375 g/ha (July) fb metribuzin 1.0 kg/ha (August) fb glyphosate 1.26 kg/ha (September).

Available Iron (mg/kg)

It is amply clear from the data presented in Table 2 that available iron is influenced by different sequential application of herbicide mixtures significantly. The lowest available iron (6.63 and 6.66) was observed in weedy check and highest (6.89 and 6.98) in glyphosate 1.26 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glyphosate 1.26 kg/ha (September) being at par with treatment glyphosate 1.26 kg/ha (July) fb paraquat 0.6% (August) fb glyphosate 1.26 kg/ha

(September), glufosinate 375 g/ha (July) fb metribuzine 1.0 kg/ha (August) fb glyphosate 1.26 kg/ha (September), metribuzine 1.0 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glufosinate 375 g/ha (September), three times hand weeding and mulching with black polythene.

As root density of fruit trees is lower than that of weeds so the competition between weed and crop plants for uptake of nutrients from soil may not be favorable for fruit orchard. Weed crop competition may negatively influence the tree performance on nutrition uptake with a permanent ground cover all year round (Merwin, 2003 and Webster, 2005) [7, 14]. Paslwar *et al.* (2003) [9] also found that with the application of glyphosate 1% + urea 2%, nutrients uptake was minimum *i.e.*, Nitrogen, phosphorus and potassium after 25 days of weed germination in rainy season while maximum in control followed by sod mulch in Nagpur mandarin.

From this study it was clear that the sequential application of glyphosate 1.26 kg/ha (July) fb glyphosate 1.26 kg/ha (August) fb glyphosate 1.26 kg/ha (September) proved better to improve the soil Ece and soil nutrients *i.e.* Nitrogen, Potassium, Phosphorous, Zinc and Iron.

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