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Influence of Weed Management by Allelopathy on Growth, Yield and Nutrient Status of Soil in Pigeonpea (*Cajanus cajan* L.)

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A B S T R A C T

A pot experiment was carried out at Zonal Agriculture Research Station, Kalaburagi (Karnataka), during *kharif* 2018 and 2019 to study the influence of weed management by allelopathy on nutrient status of soil in pigeonpea (*Cajanus cajan* L.). The soil was medium deep black with soil pH (8.13), EC (0.25 dS m^{-1}), available nitrogen (242 kg ha^{-1}), P_2O_5 (34 kg ha^{-1}) and K_2O (347 kg ha^{-1}). The experiment was laid out in completely randomized block design which comprised of 18 treatments with three replications, consisting four plant extracts, *i.e*., Sorghum, Parthenium, Cassia and Eucalyptus and imazythapyre herbicide. All the practices followed were according to package of practice of UAS, Raichur. The data of each crop season were statistically analyzed. Weed management practices significantly influenced the available nutrients in soil (N, P and K) among all the treatments at harvest of pigeonpea. Imazythapyre @ 56.25 g *a.i.*/ha + sorghum plant extract at 20-25 DAS, imazythapyre @ 56.25 g *a.i.*/ha + cassia plant extract at 20-25 DAS, imazythapyre @ 56.25 g *a.i.*/ha + parthenium plant extract at 20-25 DAS, imazythapyre @ 37.5 g *a.i.*/ha + sorghum plant extract at 20-25 DAS, imazythapyre @ 56.25 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS, imazythapyre @ 37.5 g *a.i.*/ha + cassia plant extract at 20-25 DAS, imazythapyre @ 37.5 g *a.i.*/ha + parthenium plant extract at 20-25 DAS and imazythapyre @ 37.5 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS recorded significantly higher number of primary and secondary branches, seed yield per plant, 100 seed weight and grain yield and lower available nitrogen, phosphorus and potassium compared to rest of the treatments. Plant extracts when used with herbicide help to reduce usage of herbicide by 50 %. Soil fertility and productivity can be maintained for longer period through which crop production can become more productive, sustainable and economical both directly and indirectly.

Keywords

Allelopathy, Available nutrients, 100-seed weight, Grain yield

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Introduction

Pulses are an important component of agricultural food crops and the cheapest source of dietary protein. The high content of protein in pulses makes the diet more nutritive for vegetarian when consumed with other cooked food items. Pulses are rich source of protein, dietary fiber, complex carbohydrates and K, Se, Fe and Zn-power house of nutrients. Pulses are also known for increasing productivity of soil through fixation of nitrogen from atmosphere. Pulses are well suited in rainfed condition and require less farm resources; hence farmers prefer to grow them from economic point of view throughout the country that helps to eliminate hunger, food security and malnutrition. India plays a key role in global pulse production and contributes about 25 per cent to the total pulse basket with total production of 3.38 million tonnes from 4.55 million ha area (Anon., 2019). On account of their value as nutritious food, feed and forage, pulses remained an integral component of subsistence cropping system since time immemorial. Weed is one of the important limiting factor in pigeonpea production through competition for environmental resource and can reduce yield by 30-45 % (Talnikar *et al.,* 2008). Today, the most of pigeonpea producers use chemical herbicides for weed control in pigeonpea. Application of high dose of chemical herbicide in agricultural production causes many adverse effects that most of them relating to incorrect use of herbicide. One of the adverse effects of herbicides application is evolution of resistant weed biotypes.

The major challenge for India is that of producing adequate food for the ever growing human population. Traditional method of pigeonpea cultivation is no longer a viable system of crop production because of increasing human population on limited arable land which has reduced the duration of fallow, low soil fertility, declining crop yield and high weed pressure are some of the problems that have been associated with reduced fallow duration and intensification of cropping systems. Pigeonpea being long duration crop, cultivated with wider spacing due to which weed management in these rows plays significant role on yield of the crop. These weeds can cause 20-90 % yield loss in pulse crops (Pooniya *et al.,* 2015). Management of weeds by using herbicide is the commonly followed method. Recent advances in management of weeds through plant water extracts *i.e*., allelopathy is gaining importance due to better control of weeds, cost effective and biodegradability.

Materials and Methods

A pot experiment was carried out at Zonal Agriculture Research Station, Kalaburagi (Karnataka), during *kharif* 2018 and 2019; the research was conducted to study the influence of weed management by allelopathy on growth, yield and nutrient status in pigeonpea (*Cajanus cajan* L.). The soil was medium deep black with soil pH (8.13), EC (0.25 dS m^{-1}), available nitrogen (242 kg ha^{-1}), P_2O_5 (34 kg ha^{-1}) and K_2O (347 kg ha^{-1}). The experiment was laid out in completely randomised block design which comprised of 18 treatments in three replications, consisting four plant extracts, *i.e*., Sorghum, Parthenium, Cassia and Eucalyptus and imazythapyre herbicide. All the practices followed were according to package of practice of UAS, Raichur. Treatments as follows; T_1: Imazythapyre @ 18.75 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS, T_2: Imazythapyre @ 37.5 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS, T_3: Imazythapyre @ 56.25 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS, T_4: Only Sorghum plant extract at 20-25 DAS, T_5: Imazythapyre @ 18.75 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS, T_6: Imazythapyre @ 37.5 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS, T_7: Imazythapyre @ 56.25 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS, T_8: Only Parthenium plant extract at 20-25 DAS, T_9: Imazythapyre @ 18.75 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS, T_{10}: Imazythapyre @ 37.5 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS, T_{11}:

Imazythapyre @ 56.25 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS, T_{12}: Only Eucalyptus leaf extract at 20-25 DAS, T_{13}: Imazythapyre @ 18.75 g *a.i.*/ha + Cassia plant extract at 20-25 DAS, T_{14}: Imazythapyre @ 37.5 g *a.i.*/ha + Cassia plant extract at 20-25 DAS, T_{15}: Imazythapyre @ 56.25 g *a.i.*/ha + Cassia plant extract at 20-25 DAS, T_{16}: Only Cassia plant extract at 20-25 DAS, T_{17}: Weed free and T_{18}: Unweeded check were used in the experiment..

Recommended dose of N, P and K (25:50:00 kg N, P_2O_5 K_2O ha^{-1}) were applied to the soil in the form of urea, di-ammonium phosphate and muriate of potash at the time of sowing and subsequent applications were done by following package of practice. At each spot two seeds were dibbled up to 4 to 5 cm deep in the seed lines. The pigeonpea variety, TS-3R was used during both the years and was sown at spacing of 90 x 30 cm. All agronomical package of practices were followed to raise the crop. Available nitrogen was determined by alkaline potassium permanganate method as described by (Subbaiah and Asija, 1956). Available phosphorus was determined by Olsen's method (Jackson, 1973) using Systronics UV visible Spectrophotometer (Model: 117). Available potassium was extracted with neutral ammonium acetate (pH 7.0) and the content of potassium in the solution was estimated by Systronics Flame Photometer (Model: 128) (Jackson, 1973).

The data of each crop season were statistically analyzed. Fisher's method of analysis of variance was applied for analysis and interpretation of the data as given by Panse and Sukhatme, 1967. The level of significance used in 'F' test was at $p = 0.05$. Critical difference values were calculated whenever 'F' was significant. In other cases, values of standard error of means have been provided.

Results and Discussion

Number of primary branches

The weed free treatment remarked significantly more number of primary branches (14.19) at harvest (Table 1) and was on par with imazythapyre @ 56.25 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (14.10), imazythapyre @ 56.25 g *a.i.*/ha + cassia plant extract at 20-25 DAS (14.07), imazythapyre @ 56.25 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (14.02), imazythapyre @ 37.5 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (13.98), imazythapyre @ 56.25 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (13.93), imazythapyre @ 37.5 g *a.i.*/ha + cassia plant extract at 20-25 DAS (13.90), imazythapyre @ 37.5 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (13.83) and imazythapyre @ 37.5 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (13.79), whereas unweeded check recorded significantly less number of primary branches (12.59).

Number of secondary branches

Weed management practices significantly influenced the number of secondary branches at harvest (Table 1). Weed free treatment recorded significantly higher number of secondary branches (12.43) and it was on par with imazythapyre @ 56.25 g a.i./ha + sorghum plant extract at 20-25 DAS (12.35), imazythapyre @ 56.25 g a.i./ha + cassia plant extract at 20-25 DAS (12.33), imazythapyre @ 56.25 g a.i./ha + parthenium plant extract at 20-25 DAS (12.28), imazythapyre @ 37.5 g a.i./ha + sorghum plant extract at 20-25 DAS (12.24), imazythapyre @ 56.25 g a.i./ha + eucalyptus leaf extract at 20-25 DAS (12.20), imazythapyre @ 37.5 g a.i./ha + cassia plant extract at 20-25 DAS (12.17), imazythapyre @ 37.5 g a.i./ha + parthenium plant extract at 20-25 DAS (12.11) and imazythapyre @ 37.5 g a.i./ha + eucalyptus leaf extract at 20-25

DAS (12.08) and significantly lesser number of secondary branches (11.02) was seen in unweeded check, in pooled data.

Above results are in conformity with Arif *et al.,* (2015) and he stated that allelopathy is an eco-friendly and organic weed management approach which may be used as a tool in controlling weeds.

Allelopathic water extracts of sorghum, sunflower and brassica applied at 25, 40 and 55 DAS each at 18 and 20 L ha^{-1}, significantly improved growth and yield parameters of wheat by weed management. Thus it's best to make use of plant extract or combination of herbicide and plant extract to control the weeds and improve the growth of crop.

Seed yield per plant (g)

Table 2 represents data related to seed yield per plant as influenced by plant extracts as weed management practice in Pigeonpea by allelopathy and varied significantly among weed management practices. Weed free treatment recorded significantly higher seed yield per plant (63.2 g) in pooled data, whereas it was on par with imazythapyre @ 56.25 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (58.8 g), imazythapyre @ 56.25 g *a.i.*/ha + cassia plant extract at 20-25 DAS (55.6 g), imazythapyre @ 56.25 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (54.4 g), imazythapyre @ 37.5 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (53.9 g), imazythapyre @ 56.25 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (53.4 g), imazythapyre @ 37.5 g *a.i.*/ha + cassia plant extract at 20-25 DAS (53.1 g), imazythapyre @ 37.5 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (52.8 g) and imazythapyre @ 37.5 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (52.3 g) and unweeded check showed significantly less seed yield per plant (26.2 g).

100 seed weight (g)

The data pertaining to 100 seed weight as influenced by allelopatheic effect of plant extracts as weed management practice in pigeonpea which varied significantly among different weed management practices is presented in Table 2. Significantly higher 100 seed weight was seen in weed free treatment (9.72 g), while imazythapyre @ 56.25 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (9.59 g), imazythapyre @ 56.25 g *a.i.*/ha + cassia plant extract at 20-25 DAS (9.47 g), imazythapyre @ 56.25 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (9.45 g), imazythapyre @ 37.5 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (9.36 g), imazythapyre @ 56.25 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (9.23 g), imazythapyre @ 37.5 g *a.i.*/ha + cassia plant extract at 20-25 DAS (9.13 g), imazythapyre @ 37.5 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (9.09 g) and imazythapyre @ 37.5 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (9.07 g) were on par with it and unweeded check (6.92 g) showed significantly lower 100 seed weight.

Grain yield (kg ha^{-1})

Grain yield as influenced by allelopatheic effect of plant extracts as weed management practice in pigeonpea is presented in the Table 3 and is clear that it varied significantly in different treatments. Significantly higher grain yield was seen in weed free treatment (2336 kg ha^{-1}) and was on par with imazythapyre @ 56.25 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (2175 kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + cassia plant extract at 20-25 DAS (2054 kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (2014 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (1998 kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (1981 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + cassia plant extract at 20-25 DAS (1968 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (1954 kg ha^{-1}) and imazythapyre @ 37.5 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (1933 kg ha^{-1}) and significantly lower grain yield was seen (964 kg ha^{-1}) in unweeded check in pooled data.

Extracts and residues of tested species might have the potential to be used for pre-emergence and post-emergence weed control (Nekonam *et al.*, 2013). Application of reduced dose of herbicides mixed with allelopathic water extracts produced higher grain yield compared with the application of reduced dose of herbicides (Khan and Khan, 2012). Gilbert *et al.*, (1999) reported that allelochemical facilitate nutrient solubilization and release nutrients from complex forms. Under low phosphorus (P) levels, plant release phosphatases which improve P availability through hydrolysis. Phenolics improve release and uptake of P, Iron (Fe) and other nutrients under their less availability. The basic function is the solublization of nutrients. They make nutrients more mobile and thus improve their uptake in plant body.

Available soil nitrogen (kg ha^{-1})

Available soil nitrogen data as influenced by plant extracts as weed management practice in pigeonpea by allelopathy that varied significantly among different weed management practices is presented in Table 4 and Fig. 1. Significantly lower available soil nitrogen was seen in weed free treatment (221.95 kg ha^{-1}) and was on par with imazythapyre @ 56.25 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (224.93 kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + cassia plant extract at 20-25 DAS (227.71 kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (228.30 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (229.20 kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (229.73 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + cassia plant extract at 20-25 DAS (231.46 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (232.29 kg ha^{-1}) and imazythapyre @ 37.5 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (232.98 kg ha^{-1}) in pooled data and significantly higher available soil nitrogen was observed (59.09 kg ha^{-1}) in unweeded check.

Available soil phosphorous (kg ha^{-1})

Available soil phosphorous data was influenced by allelopatheic effect of plant extracts as weed management practice in pigeonpea and showed that it varied significantly among different weed management practices (Table 5 and Fig. 1). Weed free treatment recorded significantly lower available soil phosphorous (26.46 kg ha^{-1}) in pooled data and was found to be on par with imazythapyre @ 56.25 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (27.05 kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + cassia plant extract at 20-25 DAS (27.69 kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (28.15 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (28.21 kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (28.53 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + cassia plant extract at 20-25 DAS (28.72 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (28.91 kg ha^{-1}) and imazythapyre @ 37.5 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (30.04 kg ha^{-1}) and significantly higher available soil phosphorous was witnessed in unweeded check (45.09 kg ha^{-1}).

Table.1 Primary branches and secondary branches as influenced by weed management in pigeonpea by allelopathy in pot culture experiment at harvest

Treatment	Primary branches			Secondary branches		
	2018	2019	Pooled	2018	2019	Pooled
T_1: Imazythapyre @ 18.75 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	13.02	13.88	13.45	11.41	12.16	11.78
T_2: Imazythapyre @ 37.5 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	13.59	14.37	13.98	11.90	12.59	12.24
T_3: Imazythapyre @ 56.25 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	13.70	14.50	14.10	12.00	12.70	12.35
T_4: Only Sorghum plant extract at 20-25 DAS	12.61	13.43	13.02	11.05	11.76	11.41
T_5: Imazythapyre @ 18.75 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	12.77	13.58	13.18	11.18	11.90	11.54
T_6: Imazythapyre @ 37.5 g *a.i.*/ha + Parthenium plant extract at20-25 DAS	13.44	14.22	13.83	11.77	12.46	12.11
T_7: Imazythapyre @ 56.25 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	13.62	14.42	14.02	11.93	12.63	12.28
T_8: Only Parthenium plant extract at 20-25 DAS	12.40	13.19	12.79	10.86	11.55	11.21
T_9: Imazythapyre @ 18.75 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	12.67	13.48	13.08	11.10	11.81	11.45
T_{10}: Imazythapyre @ 37.5 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	13.40	14.18	13.79	11.74	12.42	12.08
T_{11}: Imazythapyre @ 56.25 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	13.54	14.32	13.93	11.85	12.54	12.20
T_{12}: Only Eucalyptus leaf extract at 20-25 DAS	12.52	13.32	12.92	10.97	11.67	11.32
T_{13}: Imazythapyre @ 18.75 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	12.90	13.72	13.31	11.30	12.02	11.66
T_{14}: Imazythapyre @ 37.5 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	13.51	14.29	13.90	11.83	12.52	12.17
T_{15}: Imazythapyre @ 56.25 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	13.68	14.47	14.07	11.98	12.68	12.33
T_{16}: Only Cassia plant extract at 20-25 DAS	12.46	13.25	12.85	10.91	11.61	11.26
T_{17}: Weed free	13.79	14.59	14.19	12.08	12.78	12.43
T_{18}: Unweeded check	12.20	12.98	12.59	10.68	11.37	11.02
S.Em±	0.20	0.17	0.19	0.19	0.17	0.18
C.D. at 5 %	0.79	0.67	0.72	0.73	0.67	0.69

Table.2 Seed yield per plant (g) and 100 seed weight (g) as influenced by weed management in pigeonpea by allelopathy in pot culture experiment

Treatment	Seed yield per plant (g)			100 seed weight (g)		
	2018	2019	Pooled	2018	2019	Pooled
T_1: Imazythapyre @ 18.75 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	41.3	47.4	44.4	7.89	8.17	8.03
T_2: Imazythapyre @ 37.5 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	50.3	57.5	53.9	9.20	9.52	9.36
T_3: Imazythapyre @ 56.25 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	55.5	62.0	58.8	9.43	9.76	9.59
T_4: Only Sorghum plant extract at 20-25 DAS	27.1	38.0	32.6	7.39	7.65	7.52
T_5: Imazythapyre @ 18.75 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	36.6	46.0	41.3	7.36	7.62	7.49
T_6: Imazythapyre @ 37.5 g *a.i.*/ha + Parthenium plant extract at20-25 DAS	49.3	56.3	52.8	8.93	9.25	9.09
T_7: Imazythapyre @ 56.25 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	50.7	58.1	54.4	9.29	9.61	9.45
T_8: Only Parthenium plant extract at 20-25 DAS	24.8	36.1	30.5	6.90	7.14	7.02
T_9: Imazythapyre @ 18.75 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	35.4	45.1	40.3	7.62	7.89	7.75
T_{10}: Imazythapyre @ 37.5 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	48.4	56.2	52.3	8.90	9.24	9.07
T_{11}: Imazythapyre @ 56.25 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	49.6	57.2	53.4	9.07	9.39	9.23
T_{12}: Only Eucalyptus leaf extract at 20-25 DAS	27.1	37.9	32.5	7.19	7.44	7.32
T_{13}: Imazythapyre @ 18.75 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	37.8	47.0	42.4	7.80	8.07	7.94
T_{14}: Imazythapyre @ 37.5 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	49.5	56.7	53.1	8.97	9.28	9.13
T_{15}: Imazythapyre @ 56.25 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	51.9	59.2	55.6	9.30	9.63	9.47
T_{16}: Only Cassia plant extract at 20-25 DAS	26.0	37.2	31.6	7.10	7.35	7.22
T_{17}: Weed free	60.2	66.2	63.2	9.56	9.89	9.72
T_{18}: Unweeded check	20.1	32.2	26.2	6.80	7.04	6.92
S.Em±	3.5	4.1	3.0	0.17	0.17	0.17
C.D. at 5 %	13.4	15.6	11.5	0.65	0.65	0.65

Table.3 Grain yield (kg ha^{-1}) as influenced by weed management in pigeonpea by allelopathy in pot culture experiment

Treatment	Grain yield (kg ha^{-1})		
	2018	2019	Pooled
T_1: Imazythapyre @ 18.75 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	1529	1752	1641
T_2: Imazythapyre @ 37.5 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	1869	2126	1998
T_3: Imazythapyre @ 56.25 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	2054	2296	2175
T_4: Only Sorghum plant extract at 20-25 DAS	1005	1407	1206
T_5: Imazythapyre @ 18.75 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	1355	1703	1529
T_6: Imazythapyre @ 37.5 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	1827	2081	1954
T_7: Imazythapyre @ 56.25 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	1879	2148	2014
T_8: Only Parthenium plant extract at 20-25 DAS	918	1333	1126
T_9: Imazythapyre @ 18.75 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	1311	1666	1489
T_{10}: Imazythapyre @ 37.5 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	1792	2074	1933
T_{11}: Imazythapyre @ 56.25 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	1850	2111	1981
T_{12}: Only Eucalyptus leaf extract at 20-25 DAS	1005	1400	1203
T_{13}: Imazythapyre @ 18.75 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	1398	1740	1569
T_{14}: Imazythapyre @ 37.5 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	1835	2100	1968
T_{15}: Imazythapyre @ 56.25 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	1923	2185	2054
T_{16}: Only Cassia plant extract at 20-25 DAS	961	1370	1166
T_{17}: Weed free	2228	2444	2336
T_{18}: Unweeded check	743	1185	964
S.Em±	129	150	111
C.D. at 5 %	494	577	428

Table.4 Available soil nitrogen (kg ha^{-1}) status after harvest as influenced by weed management in pigeonpea by allelopathy in pot culture experiment

Treatment	Nitrogen (kg ha^{-1})		
	2018	2019	Pooled
T_1: Imazythapyre @ 18.75 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	237.80	234.70	236.25
T_2: Imazythapyre @ 37.5 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	230.70	227.70	229.20
T_3: Imazythapyre @ 56.25 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	226.40	223.46	224.93
T_4: Only Sorghum plant extract at 20-25 DAS	252.30	249.02	250.66
T_5: Imazythapyre @ 18.75 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	242.88	239.72	241.30
T_6: Imazythapyre @ 37.5 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	233.80	230.79	232.29
T_7: Imazythapyre @ 56.25 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	229.80	226.80	228.30
T_8: Only Parthenium plant extract at 20-25 DAS	255.40	252.08	253.74
T_9: Imazythapyre @ 18.75 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	247.50	244.28	245.89
T_{10}: Imazythapyre @ 37.5 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	234.50	231.45	232.98
T_{11}: Imazythapyre @ 56.25 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	231.23	228.22	229.73
T_{12}: Only Eucalyptus leaf extract at 20-25 DAS	251.10	247.84	249.47
T_{13}: Imazythapyre @ 18.75 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	240.72	237.59	239.16
T_{14}: Imazythapyre @ 37.5 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	232.97	229.94	231.46
T_{15}: Imazythapyre @ 56.25 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	229.20	226.22	227.71
T_{16}: Only Cassia plant extract at 20-25 DAS	253.50	250.20	251.85
T_{17}: Weed free	223.40	220.50	221.95
T_{18}: Unweeded check	257.88	254.53	256.20
S.Em±	3.45	3.00	2.99
C.D. at 5 %	13.28	11.53	11.48

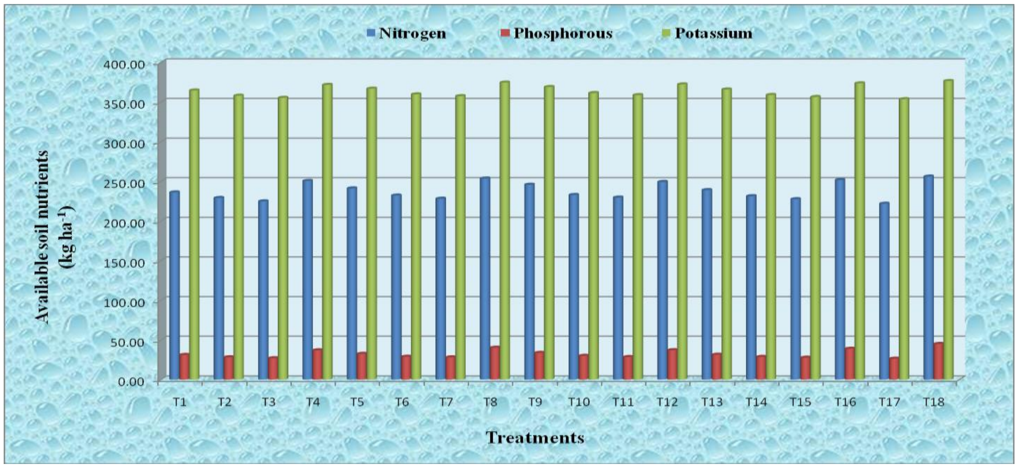
Table.5 Available soil phosphorous (kg ha^{-1}) status after harvest as influenced by weed management in pigeonpea by allelopathy in pot culture experiment

Treatment	Phosphorous (kg ha^{-1})		
	2018	2019	Pooled
T_1: Imazythapyre @ 18.75 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	31.80	30.51	31.15
T_2: Imazythapyre @ 37.5 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	28.80	27.62	28.21
T_3: Imazythapyre @ 56.25 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	27.60	26.50	27.05
T_4: Only Sorghum plant extract at 20-25 DAS	37.84	36.33	37.08
T_5: Imazythapyre @ 18.75 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	33.21	31.90	32.56
T_6: Imazythapyre @ 37.5 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	29.50	28.32	28.91
T_7: Imazythapyre @ 56.25 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	28.72	27.57	28.15
T_8: Only Parthenium plant extract at 20-25 DAS	41.18	39.50	40.34
T_9: Imazythapyre @ 18.75 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	34.50	33.12	33.81
T_{10}: Imazythapyre @ 37.5 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	30.65	29.42	30.04
T_{11}: Imazythapyre @ 56.25 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	29.11	27.95	28.53
T_{12}: Only Eucalyptus leaf extract at 20-25 DAS	37.93	36.41	37.17
T_{13}: Imazythapyre @ 18.75 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	32.10	30.82	31.46
T_{14}: Imazythapyre @ 37.5 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	29.31	28.14	28.72
T_{15}: Imazythapyre @ 56.25 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	28.25	27.12	27.69
T_{16}: Only Cassia plant extract at 20-25 DAS	39.80	38.21	39.00
T_{17}: Weed free	27.00	25.92	26.46
T_{18}: Unweeded check	42.30	47.88	45.09
S.Em±	1.08	1.18	0.97
C.D. at 5 %	4.16	4.53	3.71

Table.6 Available soil potassium (kg ha^{-1}) status after harvest as influenced by weed management in pigeonpea by allelopathy in pot culture experiment

Treatment	Potassium (kg ha^{-1})		
	2018	2019	Pooled
T_1: Imazythapyre @ 18.75 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	368.50	361.11	364.81
T_2: Imazythapyre @ 37.5 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	361.80	354.56	358.18
T_3: Imazythapyre @ 56.25 g *a.i.*/ha + Sorghum plant extract at 20-25 DAS	359.11	351.94	355.52
T_4: Only Sorghum plant extract at 20-25 DAS	375.66	368.15	371.90
T_5: Imazythapyre @ 18.75 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	370.80	363.38	367.09
T_6: Imazythapyre @ 37.5 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	363.50	356.23	359.87
T_7: Imazythapyre @ 56.25 g *a.i.*/ha + Parthenium plant extract at 20-25 DAS	361.30	354.07	357.69
T_8: Only Parthenium plant extract at 20-25 DAS	378.50	370.93	374.72
T_9: Imazythapyre @ 18.75 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	372.88	365.42	369.15
T_{10}: Imazythapyre @ 37.5 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	365.20	357.90	361.55
T_{11}: Imazythapyre @ 56.25 g *a.i.*/ha + Eucalyptus leaf extract at 20-25 DAS	362.58	355.33	358.95
T_{12}: Only Eucalyptus leaf extract at 20-25 DAS	376.23	368.71	372.47
T_{13}: Imazythapyre @ 18.75 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	369.80	362.40	366.10
T_{14}: Imazythapyre @ 37.5 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	362.77	355.51	359.14
T_{15}: Imazythapyre @ 56.25 g *a.i.*/ha + Cassia plant extract at 20-25 DAS	360.20	353.00	356.60
T_{16}: Only Cassia plant extract at 20-25 DAS	377.60	370.05	373.82
T_{17}: Weed free	357.40	350.25	353.83
T_{18}: Unweeded check	380.50	372.89	376.70
S.Em±	2.30	2.16	2.11
C.D. at 5 %	8.84	8.32	8.12

Fig.1 Available soil nutrient status (kg ha^{-1}) after harvest as influenced by weed management in pigeonpea by allelopathy in pot culture experiment



Available soil potassium (kg ha^{-1})

Available soil potassium data was influenced by allelopatheic effect of plant extracts as weed management practice in Pigeonpea and showed that it varied significantly among different weed management practices (Table 6 and Fig. 1). In pooled data, imazythapyre @ 56.25 g *a.i.*/ha + cassia plant extract at 20-25 DAS (355.52 Kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (356.60 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (357.69 kg ha^{-1}), imazythapyre @ 56.25 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (358.18 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + cassia plant extract at 20-25 DAS (358.95 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + parthenium plant extract at 20-25 DAS (359.14 kg ha^{-1}), imazythapyre @ 37.5 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS (359.87 kg ha^{-1}) and imazythapyre @ 56.25 g *a.i.*/ha + sorghum plant extract at 20-25 DAS (361.55 kg ha^{-1}) were found on par with weed free treatment (353.83 kg ha^{-1}) that recorded significantly lower available soil potassium and unweeded check treatment remarked significantly higher available soil potassium (376.70 kg ha^{-1}).

Weed management practices significantly influenced the available nutrients in soil (N, P and K) among all the treatments after harvest of pigeonpea. Imazythapyre @ 56.25 g *a.i.*/ha + sorghum plant extract at 20-25 DAS, imazythapyre @ 56.25 g *a.i.*/ha + cassia plant extract at 20-25 DAS, imazythapyre @ 56.25 g *a.i.*/ha + parthenium plant extract at 20-25 DAS, imazythapyre @ 37.5 g *a.i.*/ha + sorghum plant extract at 20-25 DAS, imazythapyre @ 56.25 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS, imazythapyre @ 37.5 g *a.i.*/ha + cassia plant extract at 20-25 DAS, imazythapyre @ 37.5 g *a.i.*/ha + parthenium plant extract at 20-25 DAS and imazythapyre @ 37.5 g *a.i.*/ha + eucalyptus leaf extract at 20-25 DAS recorded significantly lower available nitrogen, phosphorus and potassium compared to rest of the treatments which might be due better growth of crop in these treatments and therefore good vegetative and reproductive growth helped crop to use available nutrients in the soil.

Allelochemicals, upon release into the rhizosphere may influence nutrient movement, availability and uptake by plants. Changes in microbial activities and nutrient dynamics on addition of allelochemicals to the soil have been reported (Karmarkar and Tabatabai 1991). Usually, allelochemicals are first perceived by the receiver plant's roots which may then affect nutrient uptake and these compounds may restrict or improve the nutrients mobility to plants (Yu and Matsui 1997). Gilbert *et al.,* (1999) reported that allelochemical facilitate nutrient solublization and release from complex forms. Under low phosphorus (P) levels plant release phosphatases which improve P availability through hydrolysis. Phenolics improve release and uptake of P, Iron (Fe) and other nutrients under their less availability. The basic function is the solublization of nutrients. They make nutrients more mobile and thus improve their uptake in plant body. Dalipu (2001) studied the effect of different weed species on leaf total chlorophyll content and leaf nitrate reductase (NR) activity of rice plant. They reported that both the weeds *Cynadon dactylon* and *Cyperus rotundus* at low concentration (1:20) increased the total chlorophyll content, nitrate reductase (NR) activity of rice plant and soil available N, P and K were low at 25 and 50 DAS which might be due to growth promotion property of allelopathic water extracts of these weeds at low concentration.

Plant extracts of Sorghum, Parthenium, Cassia and Eucalyptus with imazythapyre herbicide at 50 % and 75 % help to get good control of weeds in pigeonpea. Thereby help to improve the growth of pigeonpea indirectly and through releasing allelochemicals directly into crop rhizosphere. Hence allelochemicals can be used with herbicide which will help to reduce usage of herbicide by 50 % and dependency on herbicides can be reduced, through which ill effects of herbicides on soil can be avoided. Soil fertility and productivity can be maintained for longer period through which crop production can become more productive, sustainable and economical both directly and indirectly.

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