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Changes in soil properties after amendments with ash of *Parthenium hysterophorus* L.

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ABSTRACT

To know the effect of different concentrations of ash of *Parthenium hysterophorus* L. in the soil properties, the experiment was conducted. The treatments were control condition and amendment of soil with 1%, 5%, 10%, 15% and 20% ash of Parthenium. Seeds of *Cajanus cajan* were used to evaluate the effect of ash concentrations on germination and growth. The data collected on some selected properties of soil indicated that pH values in 1% and 5% treatments decreased whereas in higher concentrations increased compared to control condition. The values for organic matter (%), organic carbon (%), N (%) and K (%) increased in all treatments. However, values for P (%) and EC (%) decreased in 1% and 5% treatments; and increased in higher concentrations. Micronutrients, such as Zn (%), Mn (%) and Cu (%) increased in all treatments however, Fe (%) decreased in 1%, 5% and 10% treatments. The most striking feature was maximum increase in K, Zn and Mn contents compared to control condition.

Keywords: Ash Amendment, *Cajanus cajan*, *Parthenium hysterophorus*, Soil Properties.

INTRODUCTION

Parthenium hysterophorus L. starts its growth before the rainy season and covers whole area of the University campus of J.P.University Chapra and the adjacent agricultural fields which suppresses the growth of other herbaceous vegetation and crops. It remains covered with its peak growth in agricultural lands. Farmers through ploughing in agricultural field uproot *Parthenium* or harvest, collect and burn in the agricultural fields. Literature on effects of *Parthenium* ash on seed germination and growth of crops are only a few.

Cajanus cajan an important pulse of the region is grown by farmers on large scale. The large amount of burnt ash of *Parthenium* remains with *Cajanus cajan* sown or other crops sown by farmers in the agricultural fields.

Thus before starting the experiments on the effect of ash of *Parthenium* on seed germination and growth of seedlings of *C.cajan* in pot culture experiments following hypothesis was developed: Ash of *Parthenium* changes the properties of soil. Therefore, the present experiments in pot culture experiment was conducted.

METHODOLOGY

Parthenium plants were uprooted from the University campus of J.P.University Chapra during their peak growth period in 2017. They were collected and stored adjacent to the Department of Botany and air-dried in open place. After drying of the plants collected, they were burnt and ashes were collected to conduct the experiments.

For conducting the experiment composite soil sampling was done in the University campus. Soil samples were collected from ten different locations from upper 0 – 15cm soil depth and were mixed together. Composite soil samples were thus prepared.

Following were the treatments:

(i) Control condition i.e. without mixing of ash of *Parthenium*
(ii) Soil + 1% ash of *Parthenium*
(iii) Soil + 5% ash of *Parthenium*
(iv) Soil + 10% ash of *Parthenium*
(v) Soil + 15% ash of *Parthenium*
(vi) Soil + 20% ash of *Parthenium*

500g composite soil sample was taken. For each treatment six replicates were maintained. In each polyethylene bag ten viable seeds of *C.cajan* were dibbed at 2cm soil depth and were watered regularly as required.

After twenty one days of setting up of the experiments in each polyethylene bag the germinated seeds were counted and the seedlings grown in each bag were removed separately and the rate of seed germination and growth of seedlings were determined.

To know the effect of different concentrations of ash on soil properties following ten parameters of soil were analysed with the help of Bihar State Soil Testing Laboratory Chapra: pH of soil, Organic carbon, Total nitrogen, Available phosphorus, Available potassium, Total soluble salts, Zinc, Copper, Mangnese and Iron contents.

RESULTS

SOIL PROPERTIES:

The data collected for properties of soil after completion of the experiment are presented in Tables 1 to 4.

(a) Soil pH:

pH value for control condition was recorded 9.21; and 8.28 to 10.31 in different treatments in which different doses of ash was added (Table 1). In 1% and 5% ash amendments the pH value decreased by 10.10% and 7.49%, respectively whereas in 10%, 15% and 20% ash amendments pH value increased by 3.47%, 6.95% and 11.94%, respectively, compared to control condition**.**

(b) Electric conductivity (mimho/cm) or Total soluble salt contents:

EC value for control condition was 1.39 mimho/cm; and for other treatments these values ranged from 0.79 for 1% ash treatment to 3.62 for 20% ash treatment soil. In 1% and 5% treatments EC value decreased by 43.17% and 31.65%, respectively compared to control condition whereas in 10, 15 and 20% treatments EC value increased by 10.07%, 80.58% and 160.43%, respectively.

(c) Organic carbon (%):

In control condition organic C was only 0.73% whereas in different treatments these values ranged from 0.74% in 1% ash treatment to 0.91% in 15% and 20% ash treated soil. After amendment with ash of *Parthenium* in different treatments the organic C value increased from 1.37% in 1% treatment to 24.66% in 15% and 20% treatments compared to control condition.

(d) Organic matter (%):

In control condition the organic matter value was 1.26% whereas in other treatments these values ranged from 1.31% in 1% treatment to 1.735% in 15% treatment conditions. Similarly to organic carbon the organic matter value increased from 3.97% in 1% treatment to 37.70% in 15% treatment compared to control condition.

(e) Total Nitrogen (kg/ha):

In control condition total nitrogen was 223 kg/ha whereas in different treatments these values ranged from 225 (kg/ha) in 1% ash treatment to 270.7kg/ha in 20% ash treatment. In comparison to control condition total N value increased from 0.90% in 1% treatment to 21.39% in 20% treatment.

Table 1: Soil properties after amendment with different concentrations of ash of *Parthenium*.

Sl. no.	Treatments	pH	Organic C (%)	Organic Matter (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	EC (mimho/cm)
1	Control	9.21	0.73	1.26	223	93.37	2114	1.39
2	1%	8.28	0.74	1.31	225	56.18	4148	0.79
3	5%	8.52	0.82	1.419	239	71.29	4223	0.95
4	10%	9.53	0.83	1.42	239.7	80.66	4470	1.53
5	15%	9.85	0.91	1.735	253.7	113.0	4546	2.51
6	20%	10.31	0.91	1.569	270.7	180.0	6012	3.62

Table 2: Micro-nutrients contents (ppm) after amendment with different concentrations of ash of *P.hysterophorus*.

Sl. No	Treatments	Zn (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)
1	Control	1.494	7.645	0.70	1.86
2	1%	2.535	7.348	2.60	2.29
3	5%	2.877	7.640	2.87	2.46
4	10%	3.823	7.644	3.92	2.65
5	15%	4.032	10.90	4.00	2.83
6	20%	5.241	12.39	5.36	3.80

Table 3: Per cent Increase (+) or Decrease (-) in soil properties after amendment with different concentrations of ash of *P.hysterophorus*.

Sl. No	Treatments	pH	Organic Carbon (%)	Organic Matter (%)	N (%)	P (%)	K (%)	EC (%)
1	1%	-10.10	+1.37	+3.97	+0.90	-39.83	+96.22	-43.17
2	5%	-7.49	+12.33	+12.62	+7.17	-23.65	+99.76	-31.65
3	10%	+3.47	+13.70	+12.70	+7.49	-13.61	+111.45	+10.07
4	15%	+6.95	+24.66	+37.70	+13.77	+21.02	+116.93	+80.58
5	20%	+11.94	+24.66	+24.52	+21.39	+93.37	+184.39	+160.43

Table 4: Per cent Increase (+) or Decrease (-) in Micro-nutrients contents compared to control condition.

Sl. No	Treatments	Zn (%)	Fe (%)	Mn (%)	Cu (%)
1	1%	+69.68	-3.88	+271.43	+23.12
2	5%	+92.57	-0.065	+310.0	+32.23
3	10%	+155.89	-0.013	+460.0	+42.47
4	15%	+169.88	+42.57	+471.43	+52.15
5	20%	+250.80	+62.07	+665.71	+104.30

(f) Available - P (kg/ha):

In control condition available P value was 93.27 kg/ha; and in different treatments these values ranged from 56.18 in 1% treatment to 180 kg/ha in 20% treatment. In 1%, 5% and 10% treatments the P values decreased by 39.83%, 23.65% and 13.61%, respectively compared to control condition whereas in 15% and 20% treatments P values increased by 21.02% and 93.37%, respectively.

(g) Total K (kg/ha):

In control condition total K was 2114 kg/ha whereas in different treatments these values ranged from 4148 kg/ha in 1% ash treatment to 6012 kg/ha in 20% ash treatment. In comparison to control condition K value increased from 96.22% in 1% treatment to 184.39% in 20% treatment.

(h) Zn (ppm):
In control condition Zn value was 1.494 ppm whereas in different treatments these values ranged from 2.535 ppm in 1% ash treatment to 5.241 ppm in 20% ash treated soil. Zn value increased by 69.68% in 1% treatment to 250.80% in 20% treatment compared to control condition.

(i) Fe (ppm):
In control condition Fe value was recorded 7.645 ppm whereas in different ash treated soil these values ranged from 7.348 ppm in 1% ash treated soil to 12.39 ppm in 20% ash treated soil. In 1%, 5% and 10% treatments Fe values decreased by 3.88%, 0.065% and 0.013%, respectively whereas in 15% and 20% treatments Zn values increased by 42.57% and 62.07%, respectively, compared to control condition.

(j) Mn (ppm):
In control condition this value was 0.70 ppm whereas in different ash treatment soils this value ranged from 2.60 ppm in 1% ash treatment to 5.36 ppm in 20% ash treatment soil. In comparison to control condition Mn value increased by 271.43, 310, 460, 471.43 and 665.71%, respectively, in 1%, 5%, 10%, 15% and 20% treatments.

(k) Cu (ppm):
In control condition Cu value was 1.86 ppm recorded whereas in different doses of ash treatment soils this value ranged from 2.29 ppm for 1% ash treated soil to 3.80 ppm for 20% ash treated soils. In comparison to control condition Cu value increased by 23.12, 32.26, 42.47, 52.15 and 104.30%, respectively, in 1%, 5%, 10%, 15% and 20% treatments.

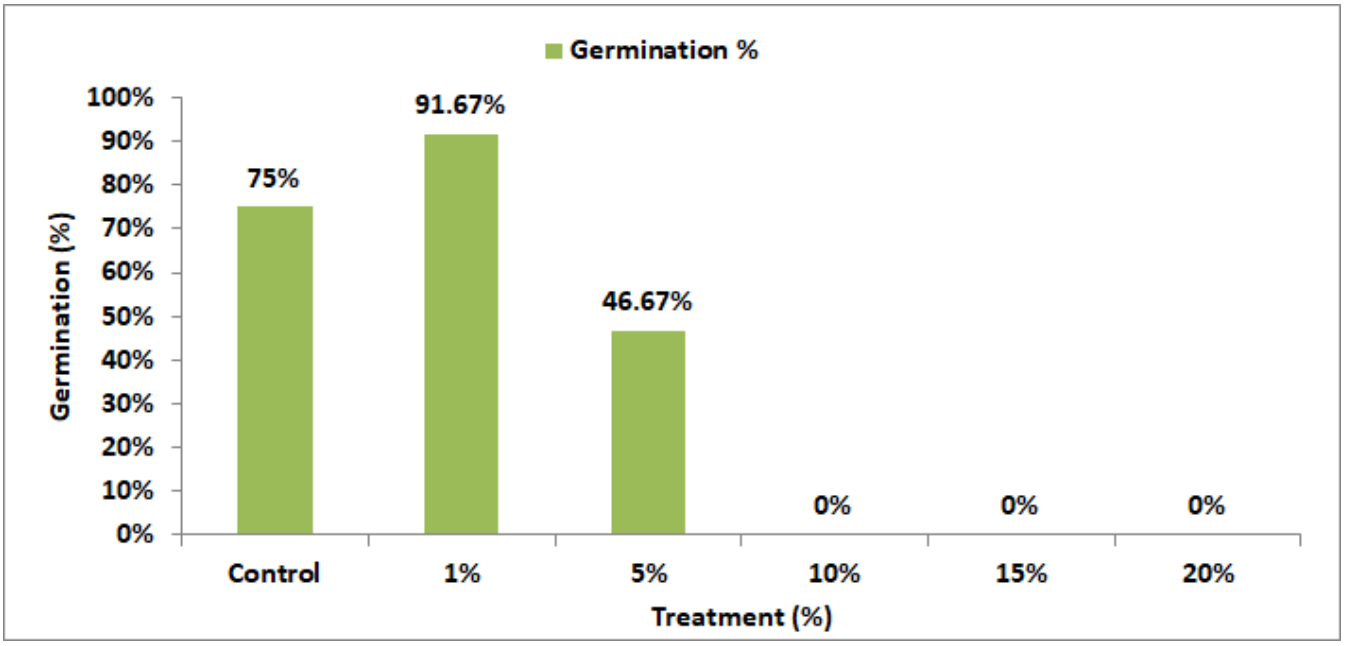

Fig 1: Rate of seed germination in control condition and different concentrations of ash of *Parthenium* in *C.cajan*.

DISCUSSION

Water soluble phenolic and sesquiterpene lactones, parthenin, caffic acid, P-coumaric acid, ferulic acid, vanicillic acid, anisic acid, fumaric acid etc have been reported from roots, stem, leaves, inflorescence, pollens, seeds and even from air–dried root and leaf materials. Thus, it is evident that with increase in the concentration of ash in laboratory condition the rate of seed germination and other growth parameters studied decreased compared to the control condition.

The chemicals isolated from *Parthenium* inhibit the growth of other plants through the contamination of soil (Batish *et al*. 2005; Belz *et al*. 2007; Kanchan 1975; Picman and Picman 1984; Rajan 1973; Rashid *et al*. 2008; Singh *et al*. 2002, 2005).

In the present study after amendment of low concentrations of ash of *Parthenium* (1% and 5%) the pH value, electrical conductivity, Phosphorus and Iron content values decreased. However due to 1% and 5% ash amendments the organic carbon values, total

organic matter, total N, total K, Zn, Mn and Cu contents increased compared to control condition.

After amendments with higher concentrations of ash of *Parthenium* (10, 15 and 20%) the pH value increased from 3.47 to 11.94%; organic carbon from 13.70 to 24.66%; organic matter 12.70% to 37.70%; total N 7.49% to 21.39%; phosphorus 21.02% to 93.37%; K from 111.45% to 184.39%; Zn from 155.89% to 250.80%; Fe from 42.57 to 62.07%; Mn from 460% to 665.71%; Cu 42.47% to 104.30% and electrical conductivity 10.07% to 160.43% compared to control condition.

Thus increase in pH values, potassium contents, micronutrients such as Zn, Mn, Fe, Cu and electrical conductivity values (total soluble salt contents) inhibited the germination of seeds of *C.cajan* in the present study. Further investigation regarding the toxicity of micronutrients and total soluble salt contents and higher pH on seed germination and seedling growth of crops is recommended.

Shikha (2018) has reported that the rate of seed germination in *C.cajan* was 75% in control condition whereas it increased by 22.22% in 1% treatment, decreased by 37.78% in 5% treatment and no seed germination occurred in 10%, 15% and 20% treatments. (Fig 1).

Parthenium infestation changes the chemical properties of soil and avaibility of nutrients. The Soil pH changes from acidic to neutral due to invasion of *Parthenium* as reported by Timsina *et al*. (2011), Karki (2009), Bhowmik *et al*. (2007), and Joshi (2005). Batish *et al*. (2002) have reported that pH of soil decreased due to addition of *Parthenium* residues in soil. Timsina *et al*. (2011) have reported higher amount of carbon content and nitrogen avaibility in *Parthenium* invaded areas. However, Karki (2009) has reported no significant changes in nitrogen and organic carbon in *Parthenium* invaded areas. Batish *et al*. (2002) have reported increase in conductivity, organic carbon, Na, K and decrease in N and Zn contents. Dogra and Sood (2012) have reported 18.21% increase in electrical conductivity in soil invaded with *Parthenium* compared to control condition. Singh *et al*. (2003) have reported the effect of unburnt (UR) and burnt residues of *Parthenium* on the growth of winter crops, radish and chickpeas. Burnt extract was more toxic due to its highly alkaline nature. Further they have reported increase in N, P, k, Ca, Mg and chloride contents by 47.7%, 51.31%, 39.89%, 16.51%, 12.99% and 26.57% in the *Parthenium* invaded soil. Thus due to changes in above-ground vegetation and below-ground nutrients, *Parthenium* invasion has negative effect on functioning of the ecosystem.

CONCLUSION

Current findings provide evidence that the ash of *P.hysterophorus* of lower concentrations (1 to 5%) decreased the soil pH, EC, P and Fe contents however other nutrients increased. But higher concentrations of ash (10, 15 and 20%) increased the values for pH, EC, organic carbon, organic matter, N, P, K, Zn, Fe, Mn and Cu. Thus ash of *Parthenium* changes the soil physio-chemical properties. For *Cajanus cajan* seed germination 1% ash was stimulatory and > 1% ash were toxic. Thus, burning of *Parthenium* in crop field is harmful for agroecosystem.

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Competing interests:
None of the authors have an association that poses any conflict of interest. The funders had no part in the decision to publish the manuscript.

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