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Potential use of Parthenium (*Parthenium hysterophorus* L.) in Agriculture

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Abstract: *Parthenium hysterophorus* L., being a declared invasive weed is threatening the biodiversity and human health in several areas of India. Several researchers have documented the allelopathic effect of this weed. Therefore, Parthenium management would remain a great concern of the century. However, several studies proposed that Parthenium can be used as a Green manure, compost, biocontrol, soil ameliorate that may improve physical, chemical and biological properties of the soils and is a source of readily available plant micro- and macro-nutrients. Numerous studies revealed that the integrated use of Parthenium in soil modifies the physico-chemical, biological and nutritional quality of the soil. Parthenium has great potentiality in agriculture due to its efficacy in modification of soil health and crop performance. The high concentration of elements (N, P, K, Fe, Mn, Cu and Zn) in composted Parthenium increases the yield of many agricultural crops. An exhaustive review of numerous studies of last two decades took place in this study, which systematically covers the importance, scope and apprehension regarding utilization of Parthenium in agriculture. *Parthenium hysterophorus* can be used as a bioherbicide. Appreciable quantity of nutrients in Parthenium can be utilized to nourish the crops after composting and a lot of green Parthenium can be destroyed. This suggests that composting of uprooted Parthenium, or use as a green manure and Parthenium extract may reduce its spreading and inhibit the weed growth as well as menace of human health hazards worldwide.

Key words: Parthenium compost, parthenium, compost, biopesticide, soil amended, green manure

INTRODUCTION

Congress grass (*Parthenium hysterophorus* L.) is spreading very fast in grass lands and pastures and now has become an obnoxious weed to human all around the world. It is common in vertisols than an alfisols. It is also observed on road sides and wastelands. It can tolerate drought condition also to a certain extend under favorable conditions. *Parthenium hysterophorus* L. complete about three generation in a year. It is also reported that congress grass has remarkable power of regeneration. The weed left as such in the same area acts as a seed bank because of its higher seed production capacity and extended dormancy period. Parthenium is an exotic weed comes under Asteraceae family. Accidentally introduces in

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India, 1955 in Pune through the imported foodgrains (Dhawan and Dhawan, 1996). Present, it has occupied almost all parts of India and is attracting the attention of all (Dhawan and Dhawan, 1996).

Parthenium extracts nutrients even from nutrient deficient soil and in cropped land can reduce up to 40% in yield (Swaminathan *et al*., 1990). Beneficial effect of organic sources on soil properties and profitable crop yield has been well documented. Huge amount of locally available Parthenium can be utilized as a source of organic matter to prepare its compost. Composting of Parthenium is recommended as the seeds deprive their viability due to the higher temperature during composting. In spite of enough quantity of various essential macro and micro plant nutrients, composting of Parthenium is not practiced by farmers. The decomposition of Parthenium plant is done by composting and the composted product becomes enriched with mineralizable plant nutrients. The *Parthenium hysterophorus* compost contains two times more nitrogen, phosphorus and potassium than Farm Yard Manure (FYM) (Angiras, 2008; Channappagoudar *et al*., 2007). Adoption of composting technology constitutes an essential component of organic farming. In India, nearly 7,000 million tones (Mt) of organic wastes and dairy wastes are produced yearly (Bhaiday, 1994). Composting is a one of the fastest and effective ways to recycle these organic materials in which the organic wastes can be compo-stabilized into compost. Compost is a rich source of macro-and micronutrients, vitamins, enzymes, antibiotics, growth hormones and immobilized micro flora (Bhawalker, 1991).

Allelochemicals or plant derived chemicals offers a great potential for the pesticides because they are comparatively safer for the environment. In the past two decades, much more work has been done on plant derived compounds as environmentally safe alternatives to herbicides for the weed control (Duke *et al*., 2002). These chemicals could be used for weed management directly or their chemistry could be used to develop new herbicides. Some trees have negative effect on the seed germination and thus these trees can contribute to the pesticide industry if explored fully (Khan *et al*., 2005). The inhibitory effects of *P. hysterophorus* L., on germination of many crops have been reported (Narwal, 1994). With the increasing concentration of Parthenium extracts the seed germination and growth of Eragrostis decreased significantly (Tefera, 2002). The current article reviews various attributes of Parthenium for its application in agriculture and deriving agronomic benefits. Hence, effort was also made to search the reason for it to minimize the spread of Parthenium.

Importance of Parthenium

Instead of eradication of Parthenium constituents can be made use of for our purpose. Information is available on the possibility of utilization of Parthenium as a green leaf manure, as a biopesticide and also as a compost and its response on crop.

Use as a Green Manure Value

For the main crop of rice, the effect of Parthenium green leaf manure on plant height was comparatively less as compared to other green manures like leucaena and sunnhemp. Whereas, in the ratoon rice crop Parthenium green leaf manure was superior in influencing the plant height (Sudhakar, 1984). Similarly in the main crop, Parthenium green leaf manure produced less number of filled grains while it produced the highest number of filled grains in the ratoon crop. Among the green leaf manures tried, the residual effect for dry matter production was the highest with Parthenium as green leaf manure.

Use as a Biopesticide

Parthenium hysterophorus extracts significantly inhibited the seed germination of Eragrostis tef (Tefera, 2002) due to released of phytotoxins from Parthenium leaves (Stephen

and Sowerby, 1996). Seed germination of Lepidium pinnatifidum was more prone to higher concentration of Parthenium extracts where there was no germination at Parthenium concentration of 30 g L^{-1}. Species-specific differences in the sensitivity to aqueous extracts of fresh or dry leaf material of Parthenium hysterophorus were reported by Kohli *et al.* (1996), Mersie and Singh (1987). This might be due to the fact that broadleaf are more susceptible to Parthenium extracts as compared to grasses. However this needs to be confirmed. In a similar study it was noted that species varied considerably in their sensitivity to aqueous extracts of Parthenium hysterophorus for both root growth and germination (Belz *et al.*, 2007; Rashid *et al.*, 2008). Marwat *et al.* (2008) reported that pre-emergence application of Parthenium extracts was more effective compared to post-emergence application. These results suggested that higher concentration of Parthenium retard the growth of plants which might be due to inhibition of cell division as allelopathic chemicals have been found to inhibit gibberellin and indole acetic acid function (Tomaszewski and Thimann, 1966). Parthenin is among other inhibitors relevant for residue allelopathy as simulated under laboratory conditions by delaying germination and reducing plant growth (Belz *et al.*, 2007). It is concluded that *Parthenium hysterophorus* can be used as a bioherbicide but still needs extensive study to fully explore its potential against different summer and winter weeds. The weed population in rice field was found to be influenced by the incorporation of composted organic wastes. Among the treatments the composted coir pith and Parthenium recorded lower weed population. The application of organic waste composts reduced the weed count from 30.5 to 39.8% over NPK at 60 DAT. This could be attributed to the role of allelopathic compounds such as phenol present in these two plant debris even after composting (Son, 1995). Similar reduction in weed population due to Parthenium as green leaf manure for rice was reported earlier by Sudhakar (1984). Among the different composts, coir pith and Parthenium compost recorded lower weed population in maize. The beneficial effect of organic wastes in reducing the incidence of pests such as stem borer and leaf roller was observed due to the application of organic waste composts. Generally under incorporation of organic wastes, the reduction in pest incidence was to the extent of 43.4 to 50% at 60 DAT as compared to NPK alone (Son, 1995). Incidence of leaf roller in rice crop was the highest with urea application, whereas it was the lowest with Parthenium as green leaf manure application (Sudhakar, 1984).

Use as a Compost

To assess the manurial value of Parthenium and its composting value, a composting experiment was conducted by Kishor *et al.* (2010). Flowered and unflowered plants of *Parthenium hysterophorus* were uprooted, chopped together and composted under tree shade in a pit of size 4'×3'×2'during rainy season and finally plastered with mud layer. Temperature of compost was recorded from different places of pit after a week of plastering using 1 m long probe thermometer. In a month's time the material was turned over and manure was ready in 14 weeks. The manurial value of composted Parthenium is shown in Table 1.

Soil Amendment Value

Any organic waste application aids in moisture conservation which is utilised for better root penetration and crop growth. In general, incorporation of organic wastes enhanced the moisture content of the soil to the tune of 45.5 to 77.4% as compared to application of NPK alone to maize crop (Son, 1995). This enhancement could be attributed to the higher water holding capacity of the soil due to the influence of organic waste application. The moisture

Table 1: Chemical and biological characteristics of composted *Parthenium*

Characteristics	Value
Macronutrients (%)	
Total N	1.58
Total P	0.33
Total K	1.64
Total S	0.29
Micronutrients (ppm)	
Fe	7829
Mn	304
Zn	116
Cu	66
Electrochemical	
pH	7.8
EC (dS m^{-1})	1
Biological (g $compost^{-1}$)	
Total bacteria	13.66×10^{6}
Fungi	9.67×10^{4}
Azotobacter	2.33×10^{6}
Actinomycetes	7.67×10^{5}
Phosphate Solubilizing Bacteria (PSB)	2.67×10^{6}

in soil due to application of Parthenium compost was 14.5 and 16.5% at 0-15 and 15-30 cm depths as compared to 10.7 and 11.6% at 0-15 and 15-30 cm depths of soil due to application of NPK alone. This may be due to building up of organic carbon status in soil. This behaviour can be well utilised for moisture conservation practices. Allelopathic effect Allelopathy is an expression of a general phenomenon of chemical interaction and are known to inhibit seed germination by inhibiting hydrolysation of reserve food, cell division and several other factors (Rice, 1974). An experiment conducted on allelopathic effect of Parthenium leaf extract on sunflower and sorghum revealed that the germination percentage, shoot and root length, dry weight and vigour index decreased with an increase in the concentration of Parthenium leaf extract from one to 10% (Murthy *et al*., 1995).

Effect of Parthenium Compost on Crop

Kishor *et al*. (2010) reported that application of 100% N through composted Parthenium resulted in significant reduction in plant height, tillers and root volume of plant and ultimately grain and straw yield of wheat. This may be due to the allelopathic potential of Parthenium (Oudhia *et al*., 1997, 2000) and Integrated use of 50% recommended dose of N through each of urea and composted Parthenium along with *Azotobacter chroococcum* is beneficial to target higher yield of wheat (Table 2). Inoculation of *Azotobacter chroococcum* produced 33-130 % more volume of roots as compared to its corresponding uninoculated treatment indicating synergistic effect of composted Parthenium on activity of organophilic *Azotobacter chroococcum*. Table 3 clearly showed that integrated use of Parthenium compost and Azotobacter increased nitrogen phosphorus, potassium and sulphur acquisition in wheat than urea and Parthenium compost. The maximum uptake N (0.67 g pot^{-1}), P (0.16 g pot^{-1}), K (0.68 g pot^{-1}) and S (0.22 g pot^{-1}) were recorded with treatments T7, where 50% N through each of urea and composted Parthenium were applied with Azotobacter. This may be due to increasing availability of nitrogen, phosphorus, potassium and sulphur in soil when integrated application composted Parthenium (Gupta *et al*., 1986). Application of nitrogen through Parthenium compost exhibited lowest value of nutrients acquisition because application of full dose of nitrogen through composted Parthenium adversely affected the plant growth and lower supply of nutrients. Composted Parthenium probably had allelopathic effect and affected metabolic processes of

Table 2: Effect of integrated use of composted *P. hysterophorous* on growth and yields of wheat

Treatments	Plant height (cm)	Tillers (pot^{-1})	Root volume (cc pot^{-1})	Yield (g pot^{-1})	
				Grain	Straw
100% urea N	50.43	18.0	35.0	28.82	36.02
100% PCN	43.00	14.5	25.0	21.44	26.80
75% urea N+25% PCN	55.00	18.5	37.5	30.91	38.05
50% urea N+50% PCN	55.50	20.5	40.0	32.00	40.00
25% ureaN+75% PCN	45.50	17.0	30.0	23.52	29.40
75% urea N+25% PCN+ *Az. chroococcum*	63.50	20.5	51.5	32.89	40.74
50% urea N+50% PCN + *Az. chroococcum*	67.00	23.5	58.4	34.87	43.59
25%urea N + 755PCN + *Az. chroococcum*	65.50	21.0	53.2	32.66	40.83
SEM+	0.57	0.72	1.83	0.19	0.99
CD (p = 0.05)	1.40	1.77	4.54	1.97	2.45

Table 3: Effect of integrated use of Parthenium compost, urea and Azotobacter on macro and micro nutrients acquisition of wheat

Treatments	Total macro nutrient acquisition (g pot^{-1})				Total micro nutrient acquisition (mg pot^{-1})			
	N	P	K	S	Fe	Mn	Zn	Cu
100% urea N	0.43	0.10	0.49	0.12	2.79	0.98	3.02	0.31
100% PCN	0.29	0.07	0.34	0.07	1.95	0.60	1.80	0.12
75% urea N + 25%PCN	0.48	0.13	0.53	0.14	3.33	2.07	2.25	0.46
50% urea N + 50%PCN	0.54	0.14	0.56	0.17	4.28	0.75	2.86	0.50
25% urea N + 75%PCN	0.34	0.09	0.39	0.08	4.73	2.20	1.96	0.60
75% urea N + 25%PCN + *Az.chroococcum*	0.58	0.14	0.58	0.18	3.38	1.80	2.88	0.54
50% urea N + 50%PCN + *Azotobacte chroococcum*	0.67	0.16	0.68	0.22	3.76	3.31	3.15	0.70
25% urea N + 75%PCN + *Azotobacte chroococcum*	0.60	0.15	0.61	0.19	5.20	1.43	2.37	0.60
SEM+	0.014	0.005	0.016	0.006	0.351	0.239	0.108	0.06
CD (p = 0.05)	0.035	0.013	0.041	0.012	0.868	0.519	0.267	NS

wheat plant. A similar trend was recorded for acquisition of Mn and Zn also. Copper uptake was affected non significantly by the application of composted Parthenium (Kishor *et al*., 2010).

CONCLUSION

The nutrient composition of composted *Parthenium* was higher than FYM. Hence recycling of Parthenium plants by composting and Parthenium extract seems to be an efficient way for utilizing the tremendous agricultural weeds. Composting is a resource for low external input sustainable agriculture and is also a good method for solving control weeds and pollution problems.

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