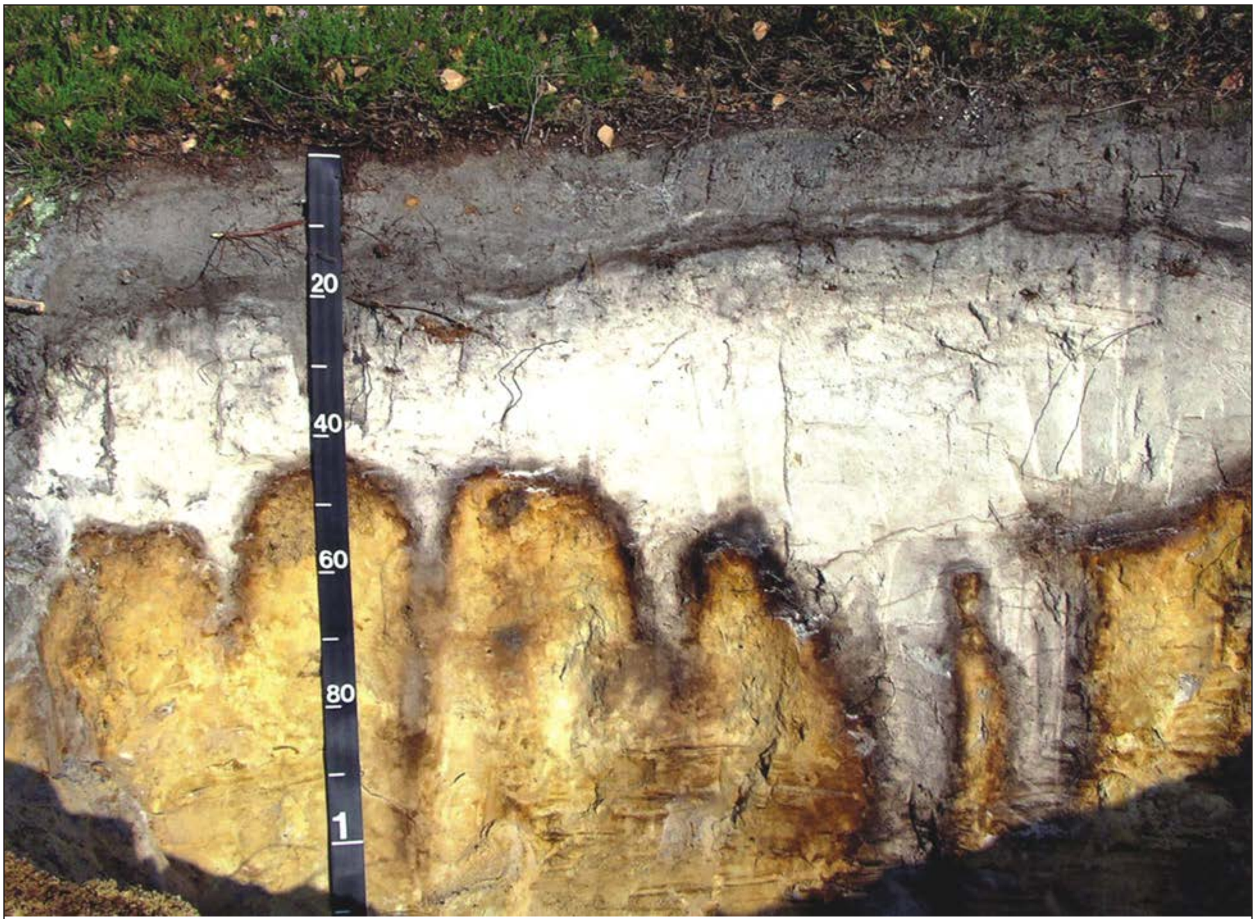

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Use of Uprooted *Parthenium* Before Flowering as Compost: A Way to Reduce its Hazards Worldwide

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Abstract: *Parthenium* can be utilized to nourish the crops after composting. The present investigation was aimed to assess the combined effect of N through *Parthenium* Compost (PCN) and urea (U) along with *Azotobacter chroococcum* on growth and yield of *Triticum aestivum* L. Salient chemical characteristics of *Parthenium* Compost (PC) such as total nutrient content (N, P, K and S) and biological characteristics such as total number of bacteria, fungi, azotobacter and Phosphate Solubilizing Bacteria (PSB) were 3.66×10^6, 9.67×10^4, 2.33×10^6, 7.67×10^5 and 2.67×10^6, respectively. Total N, P, K and S in *Parthenium* compost were 1.58, 0.33, 1.64 and 0.29%, respectively and total micronutrients such as Fe, Mn, Zn and Cu were recorded 7829, 304, 116 and 66 ppm, respectively. Results revealed that 100% N through *Parthenium* compost is detrimental to wheat. Judicious use of 50% N through each of *Parthenium* compost and urea along with *Azotobacter chroococcum* was found to be beneficial for better growth and higher yields of wheat. Increasing temperature of compost pit could not destroy 100% viability of *Parthenium* seeds. Embryo dormancy exists in seeds of *Parthenium hysterophorus* that break down by heat shock. Application of bloomed *Parthenium* compost generated new plants of *Parthenium* in wheat. This suggests that composting of uprooted *Parthenium* before flowering may reduce its spreading as well as menace of human health hazards worldwide.

Key words: *Parthenium* compost, *Parthenium*, compost, integrated nutrient management, organic matter, plant growth response

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 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). While, application of composted biomass to soil may increase soil physical

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quality and plant nutrition (Weber *et al*., 2007), it may also reduce mineralization of bio-labile compounds, thereby enhancing the role of Soil Organic Matter (SOM) as a sink of Organic Carbon (OC) (Piccolo *et al*., 2004). Compost amendments enhance SOM quality and quantity by an increased accumulation of various classes of organic compounds. Research on SOM following compost amendments has been mainly focused on changes of bulk OC (Pedra *et al*., 2007; Sebastia *et al*., 2007), microbial biomass, macro and micronutrients availability (Kowaljow and Mazzarino, 2007) and organic matter pools such as Dissolved Organic Matter (DOM) and humic substances (Adani *et al*., 2007). *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 such as FYM, crop residues and compost 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 resulting we can control its exotic weed and sustain the soil health. Kumar *et al*. (2007) also recorded higher yield of rice-wheat with the use of organic manures. They also reported that bio-fertilizers have added advantage in wheat production. Integration of FYM and *Azotobacter* with N, productivity and monetary returns of wheat can be increased by maintaining or improving soil fertility (Sarma *et al*., 2007). Composting cannot be considered a new technology, but amongst the waste management strategies it is gaining interest as a suitable option for manures with economic and environmental profits, since, this process eliminates or reduces the risk of spreading of pathogens, parasites and weed seeds associated with direct land application of manure and leads to a final stabilized product which can be used to improve and maintain soil quality and fertility (Larney and Hao, 2007; Pullicinoa *et al*., 2009). 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. 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). The present investigation was aimed to assess the combined effect of N through *Parthenium* compost and urea along with *Azotobacter chroococcum* on growth and yield of wheat (*Triticum aestivum* L.). *Parthenium* compost provided N after mineralization, it is a slow process and takes more time. So, N requirement of wheat plants is fulfill by addition of nitrogen through urea for better growth and development of plants.

MATERIALS AND METHODS

Prepared *Parthenium* Compost

Flowered and unflowered plants of *Parthenium hysterophorus* were uprooted, chopped together and composted under tree shade at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University Varanasi in a pit of size 4'×3'×2' during rainy season (August, 2006) 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 mud plaster was removed and content of pit was turned and mixed with water, then again plastered. *Parthenium* compost was ready in 14 weeks (10 November, 2006).

Sampling and Analysis of *Parthenium* Compost

Compost was sampled from ten points in the pile and mixed well (approximately 20 kg-wet weight). Samples for analysis were collected from this compost mixture in three replications and analyzed in Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, B.H.U. Varanasi. The *Parthenium* compost was digested with nitric-perchloric acid (9:1), di-acid mixture for the other elements except nitrogen. Nitrogen was determined by colorimetric method using Nessler's reagent and phosphorus was estimated by vanadomolybdate yellow colour method (Jackson, 1973). Potassium was estimated flame photometrically. Sulphur was determined by turbidimetric method of Chesnin and Yein (1951). The pH and EC of composted *Parthenium* were measured in soil and water suspension in ratio of (1:2.5) by pocket pH meter and pocket EC meter (Jackson, 1973). The population of total bacteria, fungi *Azotobacter*, actinomycetes and phosphate solubilizing bacteria in compost was determined by dilution plate counting technique using Thornton (1922), Thom and Raper (1945), Jenson's medium, Kneknight and Munaier's medium and Pikovskaya's medium, respectively.

Pot Trial and Treatments

In a pot culture experiment, integration impact of *Parthenium* Composted Nitrogen (PCN), urea N (U) and *Azotobacter chroococcum* was studied on growth attributes and yields of wheat (*Triticum aestivum* L.). A glass house experiment was conducted in Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, B.H.U. Varanasi with wheat during Rabi, 2006-2007 comprising eight treatments in complete randomized design with eight replications. Bulk soil collected from Indo-Gangetic alluvial plain of Varanasi had pH 7.5, EC 0.33 dS m^{-1} and organic C 0.45%. Available N, P_2O_5 and K_2O were 251, 22 and 160 kg ha^{-1}, respectively. Based on soil test, recommended dose of fertilizer N for wheat was 120 Kg ha^{-1}. Required quantity of *Parthenium* compost for substituting a specific amount of N, basal dose of 60 kg N, 26 kg P and 33 kg K ha^{-1} through urea, single superphosphate and muriate of potash, respectively were mixed to soil as per the treatment before 10 days of sowing of wheat. Treatments included in the present study are T1 {100% N through Urea (U)}, {100% N through *Parthenium* compost (PCN)}, T3{75%N(U)+25%N (PCN)}, T4{50%N(U)+50%N (PCN)}, T5{25%N(U)+75%N(PCN)}, T6{T3+*Azotobacter*}, T7{T4+*Azotobacter*}, T8 {T5+*Azotobacter*}. Each pot was lined with polythene and filled with 5 kg of above soil. Wheat seeds (HUW 510) were treated with 10 days old *Azotobacter chroococcum* suspension (10^9 cells mL^{-1}) with sticker (5% sugar and 2% gum acacia in water) and sown as per the treatments. Moisture of each pot was maintained as and when required. Five healthy and uniform plants in each pot were maintained after seedlings establishment. Remaining 60 kg N ha^{-1} was applied in two equal splits at tillering and flag leaf initiation. The recommended agronomic practices were adopted for raising the crop. At 60 DAS, four pots under each treatment were used to study tillers, plant height and root volume. Grain and straw yields of remaining four pots were recorded at crop harvest. Researchers have seen emergence of *Parthenium* in pots to which its compost was applied. Hence, effort was also made to search the reason for it to minimize the spread of *Parthenium.* Researchers have seen emergence of *Parthenium* in pots to which its compost was applied. Hence, effort was also made to search the reason for it to minimize the spread of *Parthenium.*

Viability of *Parthenium* Seed

Laboratory experiments were conducted in Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, BHU Varanasi. Researchers was observed that *Parthenium* seed germinate in pots, where application of *Parthenium* compost. So, researchers know the reasons for germination of *Parthenium* in wheat pots that had received the *Parthenium* compost in above experiment because generally during composting increased the temperature of compost resulting, destroy the seed viability. Flowers of *Parthenium* were incubated at the temperature of 40, 45, 50, 55 and 60°C for 72 h. Unheated flowers were considered as control. Multilocational trials were carried out with *Parthenium* free permanent soil as well as compost pots to confirm the germination of heat shocked *Parthenium* seeds. Germination percentage of seeds separated from randomly selected heated flowers was determined in growth chamber at 25±0.5°C with 60% humidity. Viability of the seeds was studied by using Triphenyle Tetrazolium Choride (TTC).

Plant Sampling and their Analyses

Wheat grains and straw were harvested at maturity and air-dried for further processing. The dried grains were stored at room temperature for 3 months prior to analysis. The samples were analyzed in the laboratory for chemical parameters after tri-acid digestion. Protein content was determined from the formula: Nx 5.83 (AOAC, 1990). Phosphorus content was estimated photometrically via the development of a phospho-molybdate complex, as described by Taussky and Shorr (1953). Potassium content was determined by flame photometry. Micronutrients (Fe, Mn, Zn and Cu) were determined by atomic absorption spectrophotometer.

Statistical Analysis

All of the plant data were analyzed by complete randomized design, using Microsoft Excel and SPSS packages. Least Significance Difference (LSD) at p = 0:05 were tested to determine the significant difference (Gomez and Gomez, 1984). Statistical analysis of *Parthenium* seed Viability were computed for F-test.

RESULTS

Manurial Value of *Parthenium* Compost

Table 1 shows the manorial value of *Parthenium* compost. The electrical conductivity and pH of *Parthenium* compost was found to be higher 1 dS m^{-1} and 7.8, respectively. Total N, P, K, S, Fe, Mn, Zn and Cu content in *Parthenium* compost was 1.58, 0.33, 1.64, 0.29, 7829, 306, 116 and 66, respectively. Viable number of total bacteria, fungi, *Azotobacter*, Actinomycetes and Phosphate solubilizing bacteria were observed 3.66×10^6, 6.67×10^4, 2.33×10^6, 7.67×10^5 and 2.67×10^6, respectively in per g compost.

Effect of Temperature on Viability of *Parthenium* Seed

At maturity of compost, seed bearing flowers of *Parthenium* were observed as brown and hard. Though, it has been reported that seeds of *Parthenium* don't have dormancy period and are capable to germinate anytime when moisture is available viability and generation of seed were recorded up to 60°C. Germination of seeds separated from different batches of unheated flowers were tested several times in growth chamber without much delay showed zero percent of germination though seeds showed an average of 75-80% cell viability (Table 2).

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

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}

Table 2: Effect of heat shocking on germination and viability of *P. histerophorous* seeds

Temperature°C	*Germination in pots	**Germination (%)	Viability (%)
Control (No heat shock)	+	0	75-80
40	+	60	60
45	+	40	45
50	+	30	40
55	+	10	25
60	+	10	15

* Soil and compost pots in two locations. **In growth chamber

Table 3: Effect of integrated use of composted *P. hysterophorous* on growth and yields of wheat

				Yield (g pot^{-1})	
Treatments	Plant height (cm)	Tillers (pot^{-1})	Root volume (cc pot^{-1})	Grain	Straw
T1 (100% urea N)	50.43	18.00	35.00	28.82	36.02
T2 (100% PCN)	43.00	14.50	25.00	21.44	26.80
T3 (75% urea N+25% PCN)	55.00	18.50	37.50	30.91	38.05
T4 (50% urea N+50% PCN)	55.50	20.50	40.00	32.00	40.00
T5 (25% ureaN+75% PCN)	45.50	17.00	30.00	23.52	29.40
T6 (75% urea N+25% PCN+ *Azotobacter chroococcum*)	63.50	20.50	51.50	32.89	40.74
T7 (50% urea N+50% PCN+ *Azotobacter chroococcum)*	67.00	23.50	58.40	34.87	43.59
T8 (25%urea N + 75% PCN+ *Azotobacter chroococcum*)	65.50	21.00	53.20	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

*N: Nitrogen through Urea. **PCN: Nitrogen through *Parthenium* compost, CD: Critical difference at 5%

Effect of Integrated Use of Composted *P. hysterophorous* on Growth and Yields of Wheat

The mean plant height (cm), total number of tillers, root volume (cc pot^{-1}) and root length (cm) pertaining to different treatments recorded at 60 days of wheat plant has been shown in Table 3. Scanning of data revealed that the mean plant height ranged from 43 to 67 cm. Treatment T7gave significantly greater plant height than T_4 where recommended dose of nitrogen was applied in the ration 1/2:1/2 through urea and *Parthenium* compost (PCN) with inoculation of *Azotobacter chroococcum.* Treatment T_6, T_7 and T_8 were superior to T_3, T_4 and T_5. Application of 100% N through composted *Parthenium* (PCN) resulted in significant reduction in plant height, tillers and root volume of plant and ultimately grain and

Table 4: Effect of integrated use of *Parthenium* compost, urea and *Azotobacter* on macro and micro nutrients acquisition of wheat

Treatment	Total macro nutrient acquisition (g pot^{-1})				Total micro nutrient acquisition (mg pot^{-1})			
	N	P	K	S	Fe	Mn	Zn	Cu
T1 (100% urea N)	0.43	0.10	0.49	0.12	2.79	0.98	3.02	0.31
T2 (100% PCN)	0.29	0.07	0.34	0.07	1.95	0.60	1.80	0.12
T3 (75% urea N+25% PCN)	0.48	0.13	0.53	0.14	3.33	2.07	2.25	0.46
T4 (50% urea N+50% PCN)	0.54	0.14	0.56	0.17	4.28	0.75	2.86	0.50
T5 (25% ureaN+75% PCN)	0.34	0.09	0.39	0.08	4.73	2.20	1.96	0.60
T6 (75% urea N+25% PCN+ *Azotobacter chroococcum)*	0.58	0.14	0.58	0.18	3.38	1.80	2.88	0.54
T7 (50% urea N+50% PCN+ *Azotobacter chroococcum)*	0.67	0.16	0.68	0.22	3.76	3.31	3.15	0.70
T8 (25% urea N + 75%PCN+ *Azotobacter 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

*N: Nitrogen through Urea, **PCN: Nitrogen through *Parthenium* compost, CD: Critical difference at 5%, NS: Not significant

straw yield of wheat as compared to 100% N through urea (Table 2). This may be due to the allelopathic potential of *Parthenium* (Oudhia *et al*., 1997; Oudhia, 2000). Higher growth and yields of wheat was recorded with 50% N through urea +50% N through composted *Parthenium*. However, use of 25% N through urea +75% N through composted *Parthenium* caused significantly inferior growth attributes and yield of wheat as compared to 50% N through each of composted *Parthenium*+urea. Thus, maximum 50% of N can be supplemented through composted *Parthenium* beyond which it exhibits harmful effect on crop (Singh *et al*., 1999; Rakesh and Bajpai, 2001).

Effect of *Parthenium* Compost on Nutrients Acquisition of Wheat Crop

Table 4 clearly show 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 (0.67g 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*. A similar trend was recorded for acquisition of Mn and Zn also. Copper uptake was affected non significantly by the application of composted *Parthenium*.

DISCUSSION

A good quantity of inorganic nutrients in *Parthenium* plants exhibited significance of its utilization as compost in agriculture. Rivero *et al*. (2004) suggested that compost increases the quality of the soil organic matter by contributing to a higher level in the soil of the most beneficial humic substances, which may change the balance between beneficial and detrimental micro-organisms. The total N, P, K and Fe content of *Parthenium* compost was higher than FYM. *Parthenium* seeds may have embryo dormancy (Ramamoorthy *et al*., 2003) which probably is broken down by high temperature. Viability as well as germination percentage of seeds decreased with increase in temperature. However, all viable seeds could not show normal germination. Since, vegetative generation of *Parthenium* occurs from the root crown of the plant. This indicates that *Parthenium* seeds have heat acclimation potential to save their viability against heat shock. White thin scale which envelops the *Parthenium* seed probably acts as semi-insulator may protects the seed viability against the heat shock. Further, germination of heat shocked *Parthenium* seeds may be due to synthesis of Heat Shock Proteins (HSPs) which has been implicated in improved thermal tolerance in seeds by stabilizing other proteins which easily get denatured by heat (Vierling, 1991; Hurkman, 1998). Therefore, cutting of *Parthenium* either pre or post flowering for composting is not a solution to reduce its hazards until they are uprooted. Singh and Singh (2005) also reported 29.9, 18.8, 35.5 and 15.2% increase in yield owing to FYM application at 15 t ha^{-1} and vermin-compost at 7.5, 10 and 15 t ha^{-1}, respectively over no organic manure. Yadav (2005) also reported similar results. Inoculation of *Azotobacter chroococcum* significantly enhanced growth and yield of *Triticum aestivum* as compared to their respective uninoculated treatment combinations. 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*. Treatment T7 gave significantly higher plant height (cm), number of tillers, root volume (cc) and yield of grain and straw compare to all other treatments, where integrated use of 50% recommended dose of N through each of urea and (PCN)composted *Parthenium* (T7) along with *Azotobacter chroococcum was* beneficial to target higher yield of wheat. It was due to *Azotobacter chroococcum* reduces contents of auxin and gibberellin inhibitors and which causes increase the multiplication of cell and thus help in elongation of plants (Qureshi, 1985). As similar result was found in case of total number of tillers, root volume and root length. The increase in tillers was probably because of greater supply of nitrogen with efficient utilization for cell and formation of nucleic acids. As similar results was observed in case of acquisition N, P, K, S, Mn and Zn (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 wheat plant.

CONCLUSION

The nutrient composition of composted *Parthenium* (PCN) was higher than FYM. Application of recommended dose of nitrogen (120 kg ha^{-1}) through PCN caused lower values of growth, yield and uptake of nutrients by wheat. Inoculation of *Azotobacter chroococcum* along with 50% of nitrogen through each of the urea and PCN gave greater values of growth, yield and nutrient acquisition of wheat. On the basis of these finding it was concluded that integrated nutrient supply approach inclusion of Azotobacter certainly will be useful in improving the growth and yield of wheat. Hence, recycling of *Parthenium* plants by composting 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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