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COMPARATIVE EFFECTIVENESS OF PARTHENIUM WEED COMPOST ON GROWTH AND YIELD OF CHILI CROP

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ABSTRACT

Compost of parthenium weed (PWC) alone (10 t ha^{-1}) and in combination with NPK (½PWC + ½NPK recommended for chili crop) was compared with recommended NPK, FYM (10 t ha^{-1}), ½FYM + ½NPK and along with control for its effect on growth and yield attributes of chili on a farmer's field in District Nowshera, Pakistan during 2014. The study was conducted in Randomized Complete Block Design (RCBD) replicated 3 times. Results indicated significantly ($p<0.05$) higher growth and yield with ½PWC + ½NPK. Increase in plant height (13-48%), plant spread (10-48% at the 80th day after transplanting and 12-43% at maturity), number of leaves plant^{-1} (7-36%), number of branches (18-86%), flower bearing plants at 50th (56%) and 60th day (100%) , fresh biomass per chili plant (27% and 47% higher over the control and FYM, respectively), dry biomass (41, 55 and 11% higher over the control, FYM and ½FYM + ½NPK, respectively) were noted in ½PWC + ½NPK. Root depth was higher in PWC alone (upto 30%), whilst root volume was highest in ½PWC+ ½NPK ranging from 7-110% over the others. Increase in chilies yield plant^{-1} in ½PWC + ½NPK ranged from 14-50% over the rest of the treatments. This study depicted that fresh FYM produced very poor results that were at par or inferior to the control in most of the growth parameters. It was concluded that parthenium weed composting, besides an environment friendly management of the parthenium, possesses as additional advantage of nutrient supplementation of soil that increased yield and yield attributes in chilli crop. Overall results showed that the application ½PWC + ½NPK should be encouraged for higher growth, yield and it biological control.

Key words: Chilies, growth parameters, parthenium weed, weed compost, yield.

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INTRODUCTION

Chili (*Capsicum annum* L) is considered as one of the most important commercial spice crops. There are more than 400 different varieties of chilies found all over the world. Its origin is believed to be South America and is being used as a spice in human diet since about 7500 BC (MacNeish 1964). Recent research reveal that chilies were cultivated as domestic crop about 6000 years ago as one of the first self-pollinating crops cultivated in Mexico, Central and parts of South America. Since then, it has been cultivated as a perennial small shrub under suitable climatic conditions. It has several types classified on the basis of pungency, color, shape, flavor and fruit size, and their use (Smith *et al.,* 1987; Bosland, 1992). Despite of differentiation in one or more characteristics, most chili cultivars cultivated commercially thrughout the world belong to the species, *C. annuum*.

In Pakistan, chilies cultivation on large scale as a cash crop exists in southern Punjab and Sindh provinces covering about 62000 ha and producing annually about 131000 tones (Anonymous, 2000) thereby recording an average of 2.5 t ha^{-1} and contributing about 1.5% to the country's GDP (GoP, 2009). Out of this total area and yield, Khyber Pakhtunkhwa contribution is only 600 t $ha^{-1}$with a total yeild of 700 tones and an average yield of 1.2 t ha^{-1}(GoP, 2009). However chilies yield ha^{-1} circle arroung two varieties namely Capsicum annum and Capsicum frutescens (GOP, 2007) and is quite low in Pakistan compared to other agriculturally advanced countries.

Parthenium hysterophorus L. is aherbaceous plant of neotropical origin (Evans, 1997). It is a noxious and fast growing weed attaining a maximum height of 6 feet under facourable conditions and grow in abundance in fallow or waste lands, road sides, ponds sides, gomal as well in cultivated lands (Tefera, 2002). The plant biomass is mostly succulent with high absorption capacity of N and P and other nutrients (Son, 1995; Biradar *et al.*, 2006)and therefore, can be used to help substantially in soil fertility resotration if composted andmixed into the soil. A laboratory test conducted in India by Channappagoudar *et al.* (2007) revealed that pre-flowering composting of parthenium contribute the maximum N content to the compost (2.95%) compared to the N content in poultry manure (2.02%), vermi compost (1.21%) and farmyard manure (0.54%). In addition to N, the P content in parthenium compost (0.82%) was also higher over FYM (0.26%) and comparable to vermi compost (0.86%) but lower to the poultry manure (1.6%). The K content was also significantly higher in parthenium compost (1.39%) compared to Vermi compost (0.55%) and FYM (0.34%) but it was comparable to the K content in poultry manure (1.42%). Moreover, composting of uprooted parthenium before flowering may reduce its spreading as well as menace to environmental and human health.

The allelopathic content of chemicals (sesquiterpene lactones and phenolics) in parthenium to affect many plant species (Swaminathan *et al.*, 1990) and their ability to inhibit and alter the growth and development of other plants is well eastablished (Kanchan and Jaya, 1980; Tefera, 2002; Singh *et al.*, 2003; Batish *et al.*, 2005a; Batish *et al.*, 2005b; Wakjira *et al.*, 2005; 2009; Marwat et al. 2008; Waris et al. 2016).

The study reported here aimed an environment friendly solution to the problem of parthenium infestation in agriculturally important areas of the Khyber Pakhtunkhwa. Parthenium composting before the onset of flowers on the plant was tested as two face advantageous activity i.e controlling the onset of seeds and their subsequent shredding in the nearby areas to reduce its infestation in future and to harness its nutritional value for soil fertility restoration and yield increase.

MATERIALS AND METHODS

The study site was selected on the basis of heavy infestation problem of parthenium , a farmer's field in District Nowshera during 2014. The site was also selected on the basis of a history of lowest yield of chillies and heavy parthenium weed infestation. Parthenium compost was prepared at Palattoo Research Farm of the University of Agriculture AMK Campus Mardan June to September, 2013 on 25, 25 and 50% fresh weight basis of parthenium, market organic waste and farmyard manure (FYM). Farmyard manure was obtained from local farmers. Characteristics of prepared parthenium weed compost (PWC) and the FYM used in the experiment are given in Table-1.

Experiment was based on the layout of with the procedures for randomized complete block (RCB) split plot (2 m^2) design replicated three times. The treatments were; Control, Recommended $N:P_2O_5:K_2O$ (NPK, 60:60:30 kg ha^{-1}), Farmyard manure (FYM, 10 t ha^{-1}), Parthenium weed compost (PWC, 10 t ha^{-1}), ½PWC + ½NPK , and ½FYM + ½NPK. Chilies nursery was established during February, 2014 and 40 days old chili seedlings were transplanted in March 2014 with recommended plant to plant (30 cm) and row to row (60 cm) distance. All growth Data was measured at three intervals (40, 80 and 120 days after transplanting) upon randomly selected plants per treatment (5 in No) Plant height was recorded through stretching the tap from the base to the top of plant (Yadhalli, 2008). Plant spread was measured from North to South direction (Ganiger, 2010). Number of branches in each treatment was measured as per the procedure followed by Yadhalli (2008). Percentage of flowers bearing plants was noted following Rahman *et al.* (2012) at 40 and 60 days after transplanting and fruits bearing plants percentages were also noted at 50 and 70 days after transplanting. At maturity (120 days after transplanting), rooting depth was measured after the selected plants were uprooted and root depth was measured from soil surface to the end of root. Root volume of the uprooted plants was measured through water displacement method (Kuttimani *et al.,* 2013). Roots were placed in graduated cylinder and increase in water volume was measured to find out root volume. Chillies season after weekly fruit picking. Data was analysed through procedures for RCB split plot design using MSTATC, MS Excel and Statistix software. The variations among the treatments were compared using LSD-test of significance (Steel and Torrie, 1980).

Table-1. Analysi of farmyard manure (FYM) and parthenium weed compost (PWC) for physic-chemical properties.

Parameter	Unit	FYM	PWC
Moisture content	%	47.5	28.4
Total N	g kg^{-1}	10.9	28.8
Total Organic Carbon (O.C)	g kg^{-1}	234.8	351.2
C/N ratio	-	21.54	12.2
Total P	mg kg^{-1}	192.3	699.3
Total K	g kg^{-1}	1.01	2.14
Fe	g kg^{-1}	0.08	0.15
Cu	mg kg^{-1}	18.37	44.12
Zn	mg kg^{-1}	12.40	46.11
Mn	mg kg^{-1}	106.20	394.05

RESULTS AND DISCUSSION

Plant height (cm)

Initially (40 days after transplant), plant height was non-significant amongst the treatments but at the middle of the growth stage and at maturity, plant height was significantly ($P<0.05$) higher (37, 48, 16, 16 and 13%, respectively) in treatment receiving parthenium weed compost (PWC) co-applied with NPK over the control, FYM alone, FYM plus NPK, NPK alone and PWC alone treatments, respectively (Table-2). At maturity (after 120 days of transplant), the maximum plant height (87 cm) was recorded in PWC plot which was 50, 53, 21, 16 and 10% higher over the control, FYM, FYM+NPK, NPK alone and PWC+NPK treatments, respectively. The increased plant height in PWC and PWC+NPK plots might be due to better availability of nutrients from well decomposed parthenium weed composts throughout growth stages and the allelopathic effect of the parthenium component on weed density and soil borne diseases. Suge *et al.* (2011) reported higher plant height with combined organic and inorganic fertilizer than organic and inorganic fertilizer used separately but our results further clarified that the organic component of the soil amendment should be well decomposed so that as opposite to fresh farmyard manure, no or minimum weed seeds or plant pathogens exist in it. Additionally, parthenin released in soil during prathenium leaves decomposition is phytotoxic (Belz *et al.*, 2007) thereby suppressing weed germination and emergence and resulting in reduced pressure on established chili plants. These results are supportive to the previous findings of Rahman *et al.* (2010). Rehman (2012) also reported that co-application of NPK and bio compost resulted in higher yield and yield components along with improved soil fertility.

Table-2: Effect of nutrient sources on phenological of characteristics of chillies

Treatment	Plants bearing flowers (%)			Plants bearing fruits (%)		
	40	80	120	40	80	120
	……………………………….Days……………………………					
CONTROL	21	43 c	60 c	13	35 cd	40 c
NPK	23	52 b	67 b	14	37 bc	51 b
PWC	23	53 b	67 b	14	39 ab	49 b
FYM	21	40 c	65 bc	13	29 d	44 c
½ PWC + ½ NPK	25	59 a	68 b	16	43 a	57 a
½ FYM + ½ NPK	22	51 b	73 a	13	36 bc	50 b
LSD ($p<0.05$)	ns	4.65	5.25	ns	5.08	3.74

Plant spread (cm)

Likewise the plant height, difference in plant spread was also non-significant ($p<0.05$) amongst the treatments at the initial growth stage (40 days) but it differed significantly ($p<0.05$) at the mid of vegetative growth (80 days) and at maturity (120 days) (Table-2). The maximum plant spread (61 cm) was recoded in treatment that received ½PWC+ ½NPK which was 23, 48, 19, 16 and 10% higher at the middle of growth stages (80 days) and 43, 30, 14, 12 and 16% higher at maturity (120 days of transplanting) over the control, FYM, ½FYM+½NPK, NPK alone and PWC alone treatments, respectively. Vasant (2010) reported maximum plant spread (60 cm) with application of inorganic fertilizer (DAP) in chilies but our results indicated that 50% NPK provide primary macro nutrients abruptly at the initial and middle growth stages whilst the ½PWC applied ensure nutrient availability at the latter growth stages resulting in luxurious plant growth in ½PWC + ½NPK treatments and therefore, resulted in maximum plant spread. The weaker plants with lower plant spread in FYM alone plot might be attributed to the immobilization of available nutrients at the initial stages and middle stages of growth resulting in lower nutrient availability to chili plants. Secondly, the profuse weed growth in FYM and the control plots might have scavenged the available nutrients from soil resulting in poor availability of nutrients for chili crop. The performance of PWC alone is superior after the combined PWC+NPK plots which might be due better nutrient release from well decomposed PWC and might also be due to the suppression of weed due to parthenium allelopathy. Khan *et al.* (2012) reported that all growth and yield parameters were lower in plots where weed density m^{-2} was higher but in plots where weeds were controlled through hand weeding, the highest number of fruits $plant^{-1}$, chili fruit length and and total fruit yield was observed

Leaves and branches $plant^{-1}$

Leaves $plant^{-1}$ were found significant at all three intervals (40, 80 and 120 days), While branches $plant^{-1}$ were significant at the 120 days interval only (Table-3). Number of leaves $plant^{-1}$ were higher by 17, 30, 25, 25 and 21% at the 40^{th} day, 29, 21, 17, 8 and 13% at the 80^{th} day and 31, 36, 13, 7 and 9% at the 120^{th} day after transplanting over the control, FYM, NPK, PWC and ½FYM + ½NPK treatments, respectively. Although, the number of branches after 40 and 80 days of transplanting was also the highest in ½PWC + ½NPK, yet the difference over the control was non-significant. After 120 days of seedlings transplantation, the maximum number of branches was recorded in ½PWC + ½NPK which was 86% higher over the control, 63% higher over the FYM, 30% higher over the NPK alone and ½FYM + ½NPK and 18% higher over the control. The higher rate in number of branches in combined application of organic and inorganic fertilizers may be due to the efficient availability of nutrients to the plant as reported by malawadi (2003) but our research showed that this statement was not true for fresh FYM applied in combination with NPK and that might be due to profuse germination and growth of weeds in the same treatment that scavenged nutrients plus due to the immobilization of available nutrients during the early stage decomposition of fresh FYM. Likewise, PWC co-application with NPK provided nutrients to the crop for the whole plant life along with reduced weed infestation in the crop and the improved physical conditions due to organic matter augmentation in the form of composts. Ahmad (2009) also reported higher biological yield for the sites having higher organic matter and improved physical conditions.

Table-3. Effect of Parthenium weed compost in comparison with other nutrient sources on leaves and branches plant^{-1}

Treatment	Number of leaves (cm)			Number of branches		
	40	80	120	40	80	120
	……………………………………Days………………………………					
CONTROL	30 b	146 e	156 d	2	6	7 bc
NPK	28 bc	161 cd	180 c	3	8	10 ab
PWC	28 bc	174 b	191 b	3	8	11 ab
FYM	27 c	155 de	150 d	2	7	8 b
½ PWC + ½ NPK	35 a	188 a	204 a	4	9	13 a
½ FYM + ½ NPK	29 b	166 bc	187 bc	2	7	10 ab
LSD (p<0.05)	3.66	8.74	11.07	ns	Ns	3.28

Flowers and fruits bearing plants (%)

Results showed that flowers (50 and 60 days after transplant) and fruits (60 and 70 days after transplant) percentage per chili plant was different significantly ($p<0.05$) amongst the treatments with the highest flowers and fruits percentage in the combined PWC+NPK treatment followed by the PWC alone and the combined FYM+NPK treatments (Table-4). After 50 days of transplant, the ½PWC + ½NPK recorded 56% more flowers over the control and 100% more flowers over the FYM whilst its superiority over the ½FYM + ½NPK, NPK alone and PWC alone was 19, 21 and 3% respectively. Similar trend of flower bearing percentage was observed after 60 days of transplant where the superiority of ½ PWC + ½NPK over the control, FYM, ½FYM + ½NPK, NPK alone and Compost alone was 33, 35, 8, 19 and 10%, respectively. Fruits bearing percentage recorded after 10 days of flowering showed that number of fruits per plant in the ½PWC + ½NPK was 74% higher over the control, 111% higher over the FYM, 26% higher over the NPK alone, 20% higher over the ½FYM + ½NPK and 13% higher over the PWC alone treatments at the 60th day after transplant. At the 70th day after transplant, similar trend of fruits bearing percentage was recorded with 39, 35, 16, 11 and 5% more fruits in the ½PWC + ½NPK over the control, FYM alone, NPK alone, ½FYM + ½NPK and the PWC alone treatments, respectively. Results were in line with previous research reporting that nutrient application to soil can improve the performance of the crop (Haefele *et al.*, 2006) and repeated application of recommended doses of NPK from fertilizer sources ensured constantly greater crop yields (Yadav *et al.*, 2000). Farmyard manure is reported to have slow release of nutrients for an annual crop during the first year of its application (Gitari and Friesen, 2001), and the fresh FYM is expected to immobilize the available nutrients thus resulting the deficiency of nutrients for the crop plant to produce flowers and fruits. Therefore, the use of well decomposed compost with some additional quality of suppressing weed infestation are expected to perform better under such circumstances as was evident from the current research. Results reported by Rahman *et al.* (2012) support these findings by stating that the application biocompost plus NPK has exhibited to significantly affect the number of days required for the initiation of flowering. The number of days were lower in the case of biocompost+NPK whilst it was the highest for the control and the treatemtn received bacterial suspension. Similar findings were also reported by Rahman *et al.* (2010).

Table-4. Effect of Parthenium weed compost in comparison with other nutrient sources on flower and fruit bearing plants percentage of chilies

Treatment	Plants bearing flowers (%)		Plant bearing fruits (%)	
	50 days	60 days	60 days	70 days
CONTROL	41 d	75 d	34 c	66 d
NPK	53 c	84 c	47 b	79 c
PWC	62 ab	91 bc	52 ab	88 ab
FYM	32 e	74 d	28 c	68 d
½ PWC + ½ NPK	64 a	100 a	59 a	92 a
½ FYM + ½ NPK	54 bc	93 ab	49 b	83 bc
LSD (p<0.05)	8.20	8.31	7.92	6.71

Fresh and dry biomass (g plant^{-1})

Results (Table-5) depicted that differences in fresh and dry biomass per chili plant were significant ($p<0.05$) amongst the treatments with the maximum values observed in the combined PWC + NPK treated plots. Fresh biomass per chili plant in the same treatment was 27 and 47% higher over the control and FYM treated plots, respectively, whilst with rest of the treatments, it was statistically at par. Dry biomass showed similar trend which was 41, 55 and 11% higher over the control, FYM and ½FYM + ½NPK plots, respectively, whilst with rest of the treatments, it was statistically at par. Both fresh and dry biomass per plant depends upon the extent of available nutrients in soil and the extent of competition for these available nutrients amongst the sinks. The inferior performance of fresh FYM might be due to more competition of amongst weeds and crop plants and the immobilizing micro-organisms resulting in lower crop growth. The lower fresh and dry biomass in the control might be due deficiency of available nutrients and higher weed population. On the contrary, higher fresh and dry biomass per chili plant in the ½PWC + ½NPK might be due to the availability of nutrient throughout growth stages of the crop and reduced weed competition with the crop. This might be possible due to the different kinds of compounds with phytotoxicity viz. phelolics, sesquiterpenes and lactones released during decomposition of parthenium components of the compost (Belz *et al.*, 2007)

Root depth (cm) and volume (cm^3)

Data showed that nutrients application through variable sources significantly ($P<0.05$) affected root depth determined at maturity (120 days). The maximum root depth was recorded in PWC alone plot that was 24, 4, 30, 4 and 24 higher over the control, NPK, FYM, ½PWC+ ½NPK and ½FYM + ½NPK, respectively. Root volume was highest in ½PWC+ ½NPK and that was 83, 19, 7, 110 and 22% higher over the control, NPK, PWC, FYM, and ½FYM + ½NPK, respectively. Yang *et al.* (2004) reported the co-application of mineral fertilizer and FYM increased the root length. Kuttimani *et al.* (2013) reported that nutrient application significantly increased the root volume and Martinez *et al.* (1999) reported that increase in radical volume, leaf area, shoot dry matter were noted with application of varmi compost.

Chilies yield (g) plant^{-1}

Chili yield per plant amongst the treatments was significantly ($p<0.05$) different and the highest yield per chili plant was recorded by the ½PWC + ½NPK which was 50% higher over the control, 45% higher over the FYM alone, 26% higher over the NPK alone, 20% higher over the ½FYM + ½NPK and 14% higher over the PWC alone plots (Table-5). The additional contribution of both macro and micro nutrients by PWC treatment applied in combination with NPK may explain the improved growth and yield found in plants receiving fertilization through PWC+NPK as compared to the NPK, FYM and PWC alone treatments. Chavan *et al.* (1997) results for the combined N and FYM application was more rewarding than fertilizer alone with respect to yield and quality of chilies. Yet they further suggested that the inorganic fertilizer in combination with biocompost is more suitable or better for production of chilies that build up soil fertility as well as contribute to improved production. According to subbaih *et al.* (1982), the co-application of nutrients from organic and inorganic sources was highly beneficial for increasing the yield level of chilies as compared to fertilizer alone explaining the solublization effect of plant nutrients from FYM as evident from more uptake of N,P,K, Ca and Mg by the crop compared to sole inorganic fertilizer . Dhamke *et al.* (1988) observed the highest yield of chilies with FYM addition at the rate of nine tons ha^{-1} alone and with 50 kg ha^{-1} each of N,P_2O_5 and K_2O. Similarly, surlekov and rankov (1989) reported significantly higher yield of chilies with application of FYM along with 100:80:100 kg ha^{-1} NPK when compared to control. Additionally, the growth enhancement with the use of PWC might be due to its contribution in increasing the soil organic matter and increased microbial activity that may have improved bio-physical parametersof the soil (Diaz-Perez *et al.*, 2008).

Table-5. Effect of Parthenium weed compost in comparison with other nutrient sources on plant fresh and dry weight, rooting depth, root volume and yield of chilies per plant

Treatment	Fresh weight $plant^{-1}$	Dry weight $plant^{-1}$	Rooting Depth	Root volume	Chili Yield $plant^{-1}$
	………….. (g)	…………….	(cm)	(cm^3)	(g)
CONTROL	74 b	58 c	20 c	24 c	223 c
NPK	90 a	78 ab	23 b	37 b	266 b
PWC	93 a	77 ab	25 a	41 ab	293 b
FYM	64 c	53 c	19 c	21 c	231 c
½ PWC + ½ NPK	94 a	82 a	24 ab	44 a	335 a
½ FYM + ½ NPK	92 a	74 b	20 c	36 b	279 b
LSD ($p<0.05$)	9.59	5.94	1.91	6.11	32.04

CONCLUSION

This study concluded that parthenium weed composting, besides an environment friendly management of the parthenium, possesses as additional advantage of increased yield and yield attributes in chilli crop. For better crop nutrition and higher yield, parthenium weed compost should be applied in combination with 50% of the recommended NPK. Moreover, fresh FYM application either alone or in combination with NPK should be avoided due to its negative effect on nutrient availability and profuse weed growth.

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