

## DHAINCHA, AN EFFECTIVE AMENDMENT IN IMPROVING SALT AFFECTED SOILS AND ENHANCING P EFFICIENCY IN RICE – WHEAT CROPPING SYSTEM

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### ABSTRACT

*Incorporating green manure in soil increases the bioavailability of phosphate in the succeeding crop. A field experiment was conducted during 2004 – 2006 at Agriculture Research Institute, Dera Ismail Khan (NWFP) to study the effect of green manure with Dhaincha (*Sesbania aculeata*) on phosphate availability in salt affected soil. The green manuring with Dhaincha was compared with the organic and chemical amendments viz. FYM, Pressmud and Gypsum. Results of the study shows that all the treatments significantly ( $P < 0.05$ ) influenced wheat yield. The highest grain yield of  $4525 \text{ Kg ha}^{-1}$  was observed in the treatment of green manuring with Dhaincha and was at par with pressmud at 0.05 level of significance. It was further revealed in the study that level of phosphate in soil increased each year, but the highest P content of  $8.09 \mu\text{g P g}^{-1}$  soil was recorded in green manure treatment. There was a positive correlation between P uptake and extractable phosphate ( $r = 0.99$ ). A close relationship ( $r = 0.98$ ) between P uptake and yield was also observed in wheat crop grown during 2006.*

**Key Words:** *Sesbania aculeata* (Dhaincha), Soil phosphate, Gypsum, Press mud, Salt affected soil

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### INTRODUCTION

Dhaincha (*Sesbania* species) is a valuable crop of the summer season (March - July) with multivarious uses. It finds use in green manuring, soil reclamation, as an animal feed and in agro-forestry. Some species are even known to control weeds and the seeds of still others have valuable properties for gum production. Green manuring is the practice of growing crops, preferably legumes and ploughing them under the soil surface, when they reach the reproductive stage of growth. Green manures can increase the sustainability of the cropping system by protecting the soil from erosion, enhancing fertility and also improving soil properties. Green manures may enhance P nutrition of succeeding crops via a number of mechanisms. Green manure crops may convert relatively unavailable native and residual fertilizer P to chemical forms more available to succeeding crops.

On decomposition, organic P in green manure tissues could provide a relatively labile form of P to succeeding crops, thus providing a larger pool of mineralizable soil organic P to supplement soluble inorganic P pools, Tiessen *et al.*, (1994). Saline soils contain large amount of soluble salts. The soluble salts can be of any cation or combination of cations, i.e.  $\text{Ca}^{++}$ ,  $\text{Mg}^{++}$ , and  $\text{Na}^{+}$  etc. The accumulated salts are present either in dissolved state in a moist soil, or as crystal in dry soil. Sodic soils differ from saline soils, which are occupied by large amount of sodium ions. Soil salinization and sodication affect large areas of agricultural land in the world. Amelioration of these soils to make them suitable for agricultural production depends on understanding sodium dynamics and chemical interactions governing nutrient availability, Vukadinovic and Rengel (2007). In the salt affected soil as the concentrations of salts increase, the P availability to plants declines, Cho-ruk and Morrison (2004). The different organic and inorganic methods are used to reclaim the soil and increase P availability of soil, Chun *et al.* (2007). According to a survey conducted in North West Frontier Province (NWFP) 44 % of the soils are low in available P ( $< 5 \text{ mg Kg}^{-1}$ ) (Bhatti and Afzal 2001), it was further reported that large P deficiency were observed in Dera Ismail Khan and Bannu districts.

Keeping in view the above finding and importance of the P availability and reclamation of salt affected soil in wheat – Rice cropping system, a research project was carried out to (i) investigate the effect of Green manure (*Sesbania aculeata*), (ii) analyse the status of phosphorous and (iii) compare the yield of wheat crop as preceded by the treatments.

**MATERIALS AND METHODS**

The experiment was carried out in two consecutive years 2004 – 2006 at Agriculture Research Institute, Ratta Kulachi, Dera Ismail Khan, located 30° 52’ 15.39’’ N and 70° 53’ 07.63’’ E on the saline sodic soils following rice – wheat cropping sequence. Farmyard Manure (FYM) @ 10 ton/ha, Gypsum @ 5 ton/ha, press mud @ 10 ton/ha were applied. The dosages of fertilizer N-P-K were applied @ 120-90-60 kg ha<sup>-1</sup> as recommended dose in all plots. The experiment consists of four replications with five treatments i) Farm Yard Manure + Wheat – Rice – Wheat (T1) , (ii) Gypsum + Wheat – Rice – Wheat (T2), (iii) Press Mud + Wheat – Rice – Wheat (T3), (iv) Fallow – Dhaincha – Wheat (Green Manure) (T4) and a control treatment of Wheat – Rice – Wheat (T5). The experiment was laid out in Randomized Complete Block Design. The Wheat variety Raj 2000 was grown in this experiment. Soil samples from each treatment were collected after the harvest of each crop and were analysed for P content (Watanabe and Olsen, 1965) and different soil properties like Electrical conductivity (EC), pH, Sodium Adsorption Ratio (SAR) Ryan *et al.* (2001), Organic matter (Nelson and Sommer, 1982) and Bulk density (Blake and Hartage, 1986). The plant samples of wheat flag leaf at heading stage were collected and analysed for the P – uptake (Bhargava and Raghupathi, 1993). The yield of crops in different treatments was recorded on each season and the data was subjected to the statistical analysis by the procedure given by Steel and Torrie, (1980). The economics of each treatment was calculated.

**RESULT AND DISCUSSION**

*Grain yield of Wheat and Rice in three Seasons*

After premixing of the amendments in specified plots wheat was grown in all the plots except fallow plots (T4). In the following Kharif season (2005) rice was grown in all treatments except T4 in which Dhaincha (*Sesbania aculeata*) was grown. After the rice harvest and green manuring of Dhaincha, wheat was grown in all the plots to compare the yield.

The results pertaining to wheat and rice yield showed a significant difference (P< 0.05) among the treatments (Table I). In the first season the highest yield of 3772 kg ha<sup>-1</sup> was obtained from press mud treatment, followed by Gypsum and FYM treatments. Similar trend was observed in the yield of rice during 2005. The highest yield of 3293 Kg ha<sup>-1</sup> was obtained from press mud and was at par with FYM. In the final year the results were significantly different (P < 0.05) in term of wheat yield. The yield of green manuring treatment (Dhaincha) was the highest with 4525 Kg ha<sup>-1</sup> and was statistically at par with Press mud amended treatment. The lowest yield of 3005 Kg ha<sup>-1</sup> was recorded in control. Bhatti *et al.*, (2005) have reported the increased yield of wheat in the treatment with Dhaincha as amendment in salt affected soil of D.I.Khan. Similarly Rao and Gill (2000) reported that the productivity of wheat was enhanced in consecutive two years experiment after Dhaincha was ploughed in to saline soils. The enhancement of yield by the green manure incorporation may be due to the increase efficiency of the fertilizer especially P, with the increase in organic matter content and improving the physical properties of soil as reported by Sultani *et al.*, (2007).

**Table I** *Effect of different treatments on the yield of wheat and rice*

S. No.	Treatments	Wheat 2004 - 05	Rice 2005 Kg ha <sup>-1</sup>	Wheat 2005 – 06
T1	Farm Yard Manure + Wheat – Rice – Wheat	2920 b	3118 ab	3735b
T2	Gypsum + Wheat – Rice – Wheat	3100 b	2816b	3770b
T3	Press Mud + Wheat – Rice – Wheat	3772 a	3293a	4178ab
T4	Fallow – Dhaincha – Wheat	-	-	4525a
T5	Wheat – Rice – Wheat (control)	2612 c	1977c	3005c

**Table II** Economics of the different treatment during three seasons

S. No.	Treatments	Total income	Total Cost	Net Return	Benefit :
					Cost
Pak Rs.					
T1	Farm Yard Manure + Wheat – Rice – Wheat	1,31931	40,166	91,765	2.28
T2	Gypsum + Wheat – Rice – Wheat	1,32476	32,816	99,660	3.0
T3	Press Mud + Wheat – Rice – Wheat	1,53619	38,766	1,14853	2.9
T4	Fallow – Dhaincha – Wheat	70,137	12,262	57,875	4.7
T5	Wheat – Rice – Wheat (control)	1,05310	30,266	75044	2.47

**Economics of different Treatments Compared with Dhaincha**

Economics of various treatments showing the cost incurred (including seed, fertilizers, gypsum, FYM and press mud) and the benefits obtained in the Table II. The highest net return in a season was observed in Dhaincha treated plot. Similarly the Benefit Cost ratio was observed the highest in the Dhaincha treated plot which gave the highest benefit Cost ratio of 4.7 followed by gypsum and press mud.

**Status of Soil Phosphate as Influenced by Dhaincha**

The results on status of soil phosphate at various crop harvest show that all the treatment were significantly different from each other (Table III). After the harvest of wheat during 2004 – 05, the highest P concentration of 7.46  $\mu\text{g g}^{-1}$  was recorded in Press mud treated plots, which was at par with FYM and Gypsum. Singh *et al.*, 2007 also reported that Press mud cakes used in soil increased P content of the soil upto 60% over the unamended control. The high P recovery was also observed by Delgado *et al.*, (2002) in the Gypsum amended reclaimed soils. Memon (2001) reports that addition of organic matter in various forms, including Farmyard manure (FYM) to mineral soil has been shown to increase phosphorous availability.

During 2005 after harvesting of rice and Dhaincha, P concentration was the highest observed in Green manure with Dhaincha and was at par with press mud treated plots and the lowest was observed in control. Similarly in third season, the P content after harvesting of wheat crop (2006) showed that the highest P concentration 8.09  $\mu\text{g g}^{-1}$  was observed in plot with green manure, which was at par with the treatment of Press mud and FYM. However the lowest P concentration was observed in control.

**Table III** Soil Phosphate influenced in different treatments

S. No.	Treatments	Phosphate in Soil ( $\mu\text{g/g}$ )		
		Wheat 2004 – 05	Rice 2005	Wheat 2005 –06
T1	Farm Yard Manure + Wheat – Rice – Wheat	7.20a	7.25bc	7.17ab
T2	Gypsum + Wheat – Rice – Wheat	6.83ab	6.23d	7.03bc
T3	Press Mud + Wheat – Rice – Wheat	7.46a	8.01ab	7.61ab
T4	Fallow – Dhaincha – Wheat	5.00 c	8.53a	8.09a
T5	Wheat – Rice – Wheat (control)	6.08b	6.70cd	6.12c

**Table IV** Effect of various treatments on P uptake of wheat leaves

S.No.	Treatments	P Uptake by Wheat leaves (%)
T1	Farm Yard Manure + Wheat – Rice – Wheat	0.247 b
T2	Gypsum + Wheat – Rice – Wheat	0.240 b
T3	Press Mud + Wheat – Rice – Wheat	0.272 ab
T4	Fallow – Dhaincha – Wheat	0.302 a
T5	Wheat – Rice – Wheat (control)	0.145 c

The highest amount of extracted P in green manured crops may be due to the improved physical condition of the soil, by providing aeration and enhancing the microbial activity. The increase in P availability had been described due to mineralization of green manuring material, chelation of Ca in alkaline soil and Al in acid soils (Hundal *et al.* 1988).

**Phosphorous Uptake by Wheat**

The P uptake was significantly influenced by the different treatments. The results of different treatment showed that the highest P uptake by the wheat leaf was observed in the green manured treatment, which was 0.302 % and was at par with press mud treated soil. The lowest P uptake was measured in the control (Table IV).

The enhanced P uptake by wheat in the treatment of Dhaincha was highest due to the availability of P through the Organic and inorganic sources (commercial fertilizes), Sultani *et al.*,(2004) showed a good response of P uptake by the wheat crop with application of P fertilizer @ 60 Kg ha<sup>-1</sup>. Highest positive correlation was shown between the extractable P and the P uptake, with r = 0.98 (Fig. 1). Mattingly *et al.*, (1963) recorded the correlation (r = 0.92) between soil P and P uptake by rye grass in a group of soil. Correlating the P uptake with the yield of wheat showed that with increase in P content of the plant the yield was increased (Fig 2).

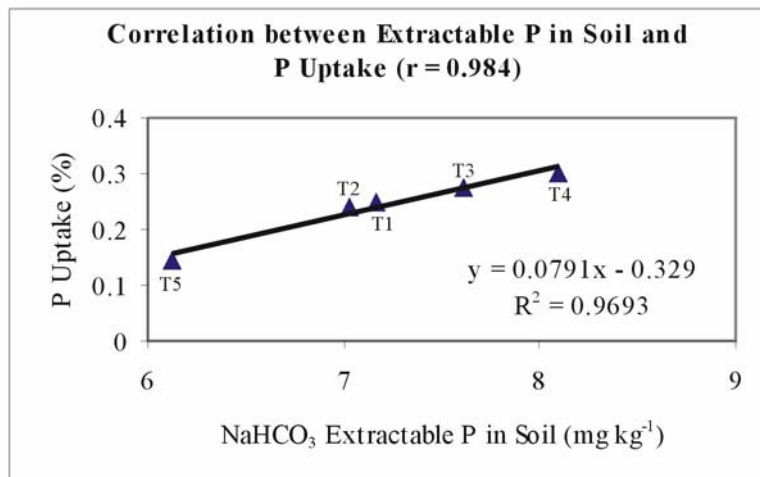


Fig: 1 Correlation of NaHCO<sub>3</sub> extractable P with P uptake by leaves

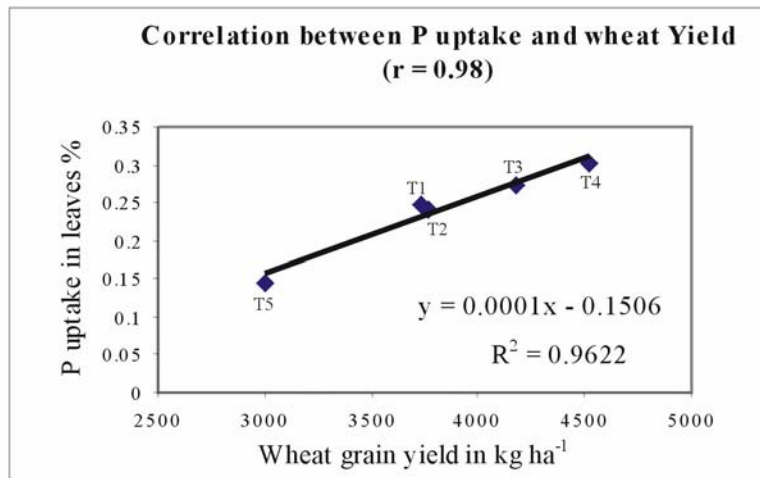


Fig: 2 Correlation between P uptake and wheat grain Yield

**Effect of Dhaincha on Soil Properties and Salinity Level**

Considerable influence of the green manuring crop was observed in reducing the level of salinity and sodicity in soil as compared with the untreated original soil (Table V). By applying t – test of significance it was observed that all the treatments were effective in reducing the pH, ECe, SAR and Bulk density, while enhancing the

organic matter content and soil phosphate (Table VI). Similar results of Dhaincha in rice – wheat cropping sequence were also reported by Bhatti *et al.*, (2005). Sultani *et al.*, (2007) reported that green manuring on the average reduced soil bulk density by 5% and enhanced total porosity by 8%.

**Table V** Different soil physico – chemical properties of untreated soil

Soil Properties	Value
Texture	Clay Loam
pH	8.41
ECe (dSm <sup>-1</sup> )	20.22
SAR	17.7
Bulk Density (g cm <sup>-3</sup> )	1.42
Organic matter (%)	0.75
Phosphorus (mg kg <sup>-1</sup> )	5.01

**Table VI** t value for different physico – chemical properties as influenced by different treatments

Soil Properties	t - value		
	After Wheat harvest 04 - 05	After Rice harvest 05	After Wheat harvest 05 - 06
pHe	3.618*	10.588**	9.315**
ECe	5.418**	41.599**	67.749**
SAR	4.349*	14.524**	25.273**
Bulk Density	2.8167*	3.457*	4.273*
Organic matter (%)	- 3.325*	- 7.705**	- 5.869*
Soil phosphate	- 3.4581*	- 5.5721**	- 6.6241**

\* Significant

\*\* Highly significant

## CONCLUSION

It may be concluded from the finding of this study that the soil properties were influenced by all treatment, but a very promptly effect of Dhaincha was observed as the physical and chemical properties of soil were improved and phosphate content, yield of wheat and rice and P uptake were enhanced. Green manuring with dhaincha was found to be the most effective and economical treatment.

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