International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
DOI: 10.22192/ijarbs Coden: IJARQG(USA) Volume 4, Issue 5 - 2017

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2017.04.05.016

Demonstration and evaluation of the effect of different doses of phosphorus with gypsum on the grain yield of wheat in ecological zone of Sahiwal

Muhsammad Akram[1], Laila Khalid[2], Mueen-u-Din[3] and Mushtaq Ali[4]
[1]Research Officer Sahiwal
[2]Research Officer Bahawalnagar
[3]Senior Subject Matter Specialist (Agronomy) Department of Adaptive Research Farm, Vehari
[4]Director (Farms and Trainings) Adaptive Research Vehari

Abstract

A field experiment was conducted during winter seasons 2013-14 and 2014-15 at farmer's field of Adaptive Research Station Sahiwal. Five different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha) were evaluated in a three replicated RCBD method. Results revealed that all the yield and yield parameters were significantly affected by the doses of phosphorus with gypsum. The average of two years result revealed that significant maximum plant population i.e 237.66, tillers 308.5, height 104.63, 1000 grain weight 35.99 and grain yield of 4251.5 kg ha^{-1} was obtained when recommended P_2O_5 + 10 bags of gypsum@ /ha was used.

Keywords: wheat, phosphorus with gypsum, RCBD method

Introduction

Wheat (*Triticum aestivum* L.) as cereal crop plays a vital role in Pakistan economy and cultivated for food and feed (Iqbal et al. 2001). Many factors responsible for low yield of wheat such as cultivation of old varieties, sowing date, low seed rate, low fertilizer rates etc. As cultivars differ significantly regarding fertile tillers m^{-2}, spike length, number of grains per spike, grain and straw yield (Naeem, 2001; Ali et al. 2010). The unavailability and inadequate supply of essential plant nutrients is another factor responsible for low yield in the region. For instance, 90% soils are deficient in nitrogen (N) and phosphorus (P) and 40% in potassium in Pakistan (Ahmad & Rashid, 2004). Among all the nutrient elements required by a plant, P has prime importance for crop production and emphasis is being given on the efficient use of P fertilizers for sustainable crop production (Ryan, 2002). In Pakistan, over 90% soils are low in available P, suffering from moderate to severe P deficiency due to alkaline calcareous nature of soil (Iqbal et al.,2003); as P fixation is a severe dilemma in alkaline (PH>7) and calcareous ($CaCO_3$>3%) soils (Sharif et al.,2000). Major portion (over 80%) of added P gets fixed and only a minute portion of it goes to soil solution which may be either taken up by crops or precipitates (Leytem & Mikkelsen, 2005). Additionally, the adsorbed P becomes firm to release in soil solutions, resulting in decline in efficiency of P

fertilizer with time (Delgado et al.2002). To grasp the full yield potential of modern wheat cultivars, optimum P supply is vital (Clark, 1990). Plants require a balanced supply of nutrients throughout their development. Mostly they have accumulated most of their nutrients during flowering and ripening stages. Approximately 50 to 90 percent of N and P in the plant at flowering moves from the leaves and stem to the developing seed (Chapin, et al. 1988). Various amendments like gypsum, sulphur, acids, press mud and farm yard manure (FYM) may be used for reclamation of these soils (Muhammad 1990, Sharma et al. 1996, Biggar 1996, Haq et al., 2001). The use of gypsum as a source of Ca^{+2} is a well-established practice for the amelioration and management of sodium saturated water/soils (Bresleret al., 1982). Wheat roots absorb P only from the soil solution (Johnston et al., 1999); thus, external soil solution P requirement may be a plant characteristic (Fox, 1981). Verma and Abrol (1980) while comparing gypsum and pyrite at requirement rates of 25, 50, 75 and 100% gypsum requirement (G.R.) for rice-wheat rotation on sodic loam soil showed gypsum to be far better than pyrite at all rates of application. Singh et al. (1981) reported that surface application of gypsum @ 25 or 50% gave higher grain yield. Chhabra (1999) reported that in rice-wheat cropping sequence gypsum application to alkaline soil increased the yield of rice and wheat up to significant level. Gypsum besides Sand Ca supply causes micro-acidification of soils which slightly lower down the pH of soil and increases the nutrient availability (Alcordo and Rechcigl 1993). The use of gypsum ($CaSO_4.2\ H_2\ O$) for fertilization has a long history dating back to the ancient Greece and Rome. In Europe gypsum treatment of soils was still a widely used practice in the 18^{TH} century (Tisdale and Nelson 1975). Gypsum treatment of salinised, alkaline soils in arid areas is an old amelioration measure to displace an excessive proportion of sodium in the sorption complex. The impact of the gypsum treatment of soils in relation to the indication of the nutrient status of soils by multi-nutrient soil tests (Mehlich 3, extraction with 0.5M ammonium acetate with addition of NH4 F, and extraction with water) was studied by Matula and Pechová (2005).

The climate of Sahiwal Division is extremely hot, reaching 45-50 degrees Celsius max in summers, and cold in winter down to 5-10 degree Celsius. The soil of the division is very fertile. The average rainfall is about 2000 mm. Sahiwal Division is in the southeast of Punjab. From Multan Division it lies between 30-40 north latitude and 73-06 longitude. It is 500 ft (150 m) above sea level**.** Keeping in view the importance of wheat crop, the present study was conducted to see the effect of different doses of phosphorus with gypsum on the grain yield of wheat in ecological zone of Sahiwal.

Materials and Methods

The experiment was conducted at farmer's field of Adaptive Research Station Sahiwal during two consecutive years 2013-14 and 2014-15. The objective of this study was to evaluate the effect of different doses of phosphorus with gypsum under the ecological zone of Sahiwal. The experiment was laid out in Randomized Complete Block design (RCBD) with three replications. Five different doses of phosphorus with gypsum i.e (recommended $P_2\ O_5$ @114kg/ha, 75% $P_2\ O_5$ + 10 bags of gypsum@ /ha, 50% $P_2\ O_5$+ 10 bags of gypsum@ /ha, 25% $P_2\ O_5$ + 10 bags of gypsum@ /ha and recommended $P_2\ O_5$ + 10 bags of gypsum@ /ha) as mention in table 1 were checked out for yield and yield parameters case. Recommended seed rate of wheat variety Punjab-2011 was used. The previous crop was cotton in this field which was sown on 2^{nd} fortnight of May. Cotton picking was done from the month of October to December. The fertilizer application and all other agronomic practices were same during both years. Weedicides were used for the control of narrow and broad leaved weeds during mid January and February. Harvesting was done during 1^{st} week of May.

Following growth and yield parameters were recorded.

1. Germination count/m^2
2. Tillers/m^2
3. Plant height (cm)
4. 1000 grain weight(g)
5. Yield kg/ha

Data were analyzed statistically with M-stat package and means were compared by DMR test at 5 percent probability level (Duncan, 1955).

Table 1- Different doses of phosphorus with gypsum

Treatments	Different doses of phosphorus with gypsum
T_1	Recommended P_2O_5 @ 114Kg ha^{-1}
T_2	75% P_2O_5 + 10 Bags of gypsum @ ha^{-1}
T_3	50% P_2O_5 + 10 Bags of gypsum @ ha^{-1}
T_4	25% P_2O_5 + 10 Bags of gypsum @ ha^{-1}
T_5	Recommended P_2O_5 + 10 Bags of gypsum ha^{-1}

Results and Discussion

Germination count (m^{-2})

Data concerning germination counts m^{-2} is shown in Table 2. Statistical analysis of the data revealed that the different doses of phosphorus with gypsum shows significant results on germination counts for the growing seasons. Average values for germination counts m^{-2} of different doses of phosphorus with gypsum ranged from 235 to 250 m^{-2}. During the year (2013-14) average germination counts m^{-2} observed from different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha was 241.33, 237.33, 241.33 235.00 and 250.00 m^{-2} respectively. The maximum germination counts m^{-2} was observed as 250.00 m^{-2} for recommended dose of P_2O_5 + 10 bags of gypsum@ /ha and minimum for the dose of 25% P_2O_5 + 10 bags of gypsum@ /ha as 235 m^{-2}. During the year (2014-15) average germination counts m^{-2} of different doses of phosphorus with gypsum ranged from 223 to 225 m^{-2}. During the year (2014-15) average germination counts m^{-2} observed from different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha was 223.33, 224.00, 224.66 223.33 and 225.33 m^{-2} respectively. The maximum germination counts m^{-2} was observed as 225.00 m^{-2} for recommended dose of P_2O_5 + 10 bags of gypsum@ /ha and minimum for the dose of 25% P_2O_5 + 10 bags of gypsum@ /ha as 223 m^{-2} was observed. An adequate moisture supply was continued for facilitating seed germination and seedling establishment (Zhang, 2007). The variation for the germination counts m^{-2} due to many biotic, abiotic and fertilizer amounts Sorour et al. (1995) reported significant differences in the emergence.m^{-2} of wheat seeds.

Number of tiller (m^{-2})

Different wheat varieties have a significant effect on tillering counts m^{-2}. Data regarding number of tillers m^{-2} is presented in table 2. Average values for tillers m^{-2} of different doses of phosphorus with gypsum ranged from 306 to 331 m^{-2}. During the year (2013-14) average tillers m^{-2} observed from different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha was 311.33, 315.66, 306.00 327.00 and 331.00 m^{-2} respectively. The maximum tillers counts m^{-2} was observed as 331.00 m^{-2} for recommended dose of P_2O_5 + 10 bags of gypsum@ /ha and minimum for the dose of 50 % P_2O_5 + 10 bags of gypsum@ /ha as 306 m^{-2}. During the year (2014-15) average tillers counts m^{-2} of different doses of phosphorus with gypsum ranged from 282 to 301 m^{-2}. During the year (2014-15) average tillers counts m^{-2} observed from different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha was 295.00, 282.66, 282.00 295.00 and 301.00 m^{-2} respectively. The maximum tillers counts m^{-2} was observed as 301.00 m^{-2} for recommended dose of P_2O_5 + 10 bags of gypsum@ /ha and minimum for the dose of 75 and 50% P_2O_5 + 10 bags of gypsum@ /ha as 282.00 m^{-2}.

Plant height (cm)

Data concerning plant height is shown in Table 2. Statistical analysis of the data showed that plant height has non-significantly ($P \leq 0.05$) affect by the different doses of phosphorus with gypsum. Average values for plant height of different doses of phosphorus with gypsum ranged from 102 to 111.26 cm. During the year (2013-14) average plant height observed from different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags

of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha was 102.93, 102.60, 106.73, 107.66 and 111.26 cm respectively. The maximum plant height cm was observed as 111.26 cm for recommended dose of P_2O_5 + 10 bags of gypsum@ /ha and minimum for the dose of recommended dose @114kg/ha and 75 % P_2O_5 + 10 bags of gypsum@ /ha as 102cm. During the year (2014-15) average plant height cm of different doses of phosphorus with gypsum ranged from 95 to 98 cm. During the year (2014-15) average plant height cm observed from different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha was 97.60, 97.20, 95.93 95.46 and 98.80 cm respectively. The maximum plant height cm was observed as 98.80 cm for recommended dose of P_2O_5 + 10 bags of gypsum@ /ha and minimum for the dose of 25 and 50% P_2O_5 + 10 bags of gypsum@ /ha as 95cm. The possible reason for this variation could be the availability of more space, light and nutrients to wheat plants and water applied. The results are similar with Javadi et al. (2004) that reported that there was no significant difference in plant height.

1000-grain weight (g)

Data recorded on 1000 grain weight is shown in Table 2 for the two growing seasons. Analysis of the data revealed that 1000-grain weight has a significantly ($P \leq 0.05$) affect by the different doses of phosphorus with gypsum. Average values for 1000 grain weight (g) of different doses of phosphorus with gypsum during 2013-14 ranged from 35 to 37g. During the year (2013-14) average 1000 grain weight observed from different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha was 36.68, 36.00, 35.33, 35.66 and 36.66g respectively. The maximum grain weight was observed as 37g for recommended dose of P_2O_5 + 10 bags of gypsum@ /ha and minimum for the dose of recommended dose 50 and 25 % P_2O_5 + 10 bags of gypsum@ /ha as 35g. During the year (2014-15) average 1000 grain weight of different doses of phosphorus with gypsum ranged from 34 to 35 g. During the year (2014-15) average 1000 grain weight observed from different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha was 34.66, 35.00, 34.66, 34.33 and 35.33g respectively. The maximum grain weight was observed as 35.00 g for recommended dose of P_2O_5 + 10 bags of gypsum@ /ha and minimum for the dose of 25 and 50% P_2O_5 + 10 bags of gypsum@ /ha as 34g. The possible reason for this variation could be the availability of more space, light and nutrients to wheat plants and water applied Javadi et al. (2004).

Grain yield (kg ha^{-1})

Data recorded on grain yield kg ha^{-1} is shown in Table 2 for the two growing seasons. Analysis of the data revealed that grain yield kg ha^{-1} has a significantly ($P \leq 0.05$) affect by the different doses of phosphorus with gypsum. Average values of grain yield kg/ha of different doses of phosphorus with gypsum during 2013-14 ranged from 3633.30 to 4653.30kg/ha. During the year (2013-14) average grain yield kg/ha observed from different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha was 4416.60, 4320.00, 4186.60, 3633.30 and 4653.30 kg/ha respectively. The maximum grain yield kg/ha was observed as 4653.30 for recommended dose of P_2O_5 + 10 bags of gypsum@ /ha and minimum for the dose of recommended dose 25 % P_2O_5 + 10 bags of gypsum@ /ha as 3633.30kg/ha. During the year (2014-15) average grain yield kg/ha of different doses of phosphorus with gypsum ranged from 2930 to 3850kg/ha. During the year (2014-15) average grain yield kg/ha weight observed from different doses of phosphorus with gypsum i.e (recommended P_2O_5 @114kg/ha, 75% P_2O_5 + 10 bags of gypsum@ /ha, 50% P_2O_5+ 10 bags of gypsum@ /ha, 25% P_2O_5 + 10 bags of gypsum@ /ha and recommended P_2O_5 + 10 bags of gypsum@ /ha was 3670, 3520, 3220, 2930 and 3850 kg/ha respectively. The maximum grain yield kg/ha was observed as 3850 kg/ha for recommended dose of P_2O_5 + 10 bags of gypsum@ /ha and minimum for the dose of 25% P_2O_5 + 10 bags of gypsum@ /ha as 2930 kg/ha. Verma and Abrol (1980) observed that gypsum at requirement rates of 25, 50, 75 and 100% gypsum requirement for rice-wheat rotation on sodic loam soil showed gypsum to be far better than pyrite at all rates of application.

Table 2: The effect of different doses of phosphorus with gypsum on the grain yield of wheat during Rabi season 2013-14 and 2014-15.

Year	Treatments	Average germination counts (m^{-2})	Avg. Tiller counts (m^{-2})	Average plant height (cm)	Average 1000-grain weight (g)	Average grain yield (kg/ ha)
2013-14	T_1	241.33b	311.33d	102.93d	36.68a	4416.60b
	T_2	237.33c	315.66c	102.60d	36.00b	4320.00c
	T_3	241.33b	306.00e	106.73c	35.33bc	4186.60d
	T_4	235.00d	327.00b	107.66b	35.66b	3633.30e
	T_5	250.00a	331.00a	111.26a	36.66a	4653.30a
LSD		Non-significant	3.221	Non-significant	0.519	13.99
2014-15	T_1	223.33c	295.00b	97.60b	34.66c	3670b
	T_2	224.00b	282.66c	97.20b	35.00b	3520c
	T_3	224.66b	282.00c	95.93c	34.66c	3220d
	T_4	223.33c	295.00b	95.46c	34.33d	2930e
	T_5	225.33a	301.00a	98.80a	35.33a	3850a
LSD		Non-significant	1.101	Non-significant	0.321	11.05

Table 3: Average values of all parameters from 2013-2015.

Treatments	Average germination counts (m^{-2})	Avg. Tiller counts (m^{-2})	Average plant height (cm)	Average 1000-grain weight (g)	Average grain yield (kg/ ha)
T_1	232.33b	303.16c	100.26c	35.66a	4043.3b
T_2	230.65c	299.16d	99.90d	35.50c	3920.0c
T_3	232.99b	294.00e	101.33b	34.99d	3703.3d
T_4	229.16d	311.00a	101.56b	34.99d	3281.6e
T_5	237.66a	308.50b	104.63a	35.99a	4251.5a

Table.3 shows the average values of all yield parameters during both years. In which all the treatments produced better yield, while in case of comparison in most of the yield parameters the recommended dose of P_2 O_5 + 10 bags of gypsum@ /ha on wheat variety Punjab-2011 performs better and produced highest germination counts m^{-2} (237.66), tillers m^{-2} (308.5), plant height cm (104.63), 1000 grain weight g (35.99) and grain yield kg ha^{-1} (4251.5).

References

1. Ahmad, N. and M. Rashid, 2004. Fertilizer and their use in Pakistan. Government of Pakistan, Planning and Development Division, NFDC, Islamabad, Pakistan.
2. Ali MA, Ali M, Sattar M and Ali L, 2010. Sowing date effect on yield of different wheat varieties. J. Agri. Res. 48: 157-162.
3. Alcordo, 1. S. and Recheigl, J. E. (1993). Phosphogypsum in agriculture: A review Advances in Agronomy 49, 55-118,
4. Biggar, J.W. 1996. Regional salinity/sodicity issue in Punjab, Pakistan. Report IWMI, Lahore, Pakistan. pp. 1-26.
5. Bresler, E.B., B.L. McNeal and D.L. Carter. 1982. Saline and Sodic soils, Principles-dynamic modeling. Springer-Verlag, NY, USA. 236 p.
6. Chapin, F.S. III and I.F. Wardlaw. 1988. Effects of phosphorus deficiency on source sink interactions between the flag leaf and developing grain in barley. Journal of Experimental Botany. 39:165–177.

7. Chhabra, R. 1999. Phosphorus requirement of rice and wheat cropping sequence in gypsum amended alkali soil. Annual Report, Central Soil Salinity Res. Inst. Karnal, India. 14 p.
8. Clark, R.B., 1990. Physiology of cereals for mineral nutrient uptake, use and efficiency. In: Baligar, V.C. and R.R. Dunean (eds.), Crops as Enhancers of Nutrient Use, pp: 131−183. Academic Press Inc. USA
9. Delgado, A., I. Uceda, L. Andreu and S. Kassem, 2002. Fertilizer phosphorus recovery from gypsum-amended reclaimed calcareous marsh soils. Arid Land Res. Manage., 16: 319−334
10. Duncan, D.B. 1955. Multiple Ranges and Multiple F. Test Biomet. 11:1-2.
11. Fox, R.L. 1981. External phosphorus requirement of crops. In: Chemistry in the soil environment. (Ed.): M. Shelly et al., American Soc. of Agron. Madison, WI, USA. pp. 223-239.
12. Haq, I., S.G. Khattak, H. Rahman, A. Ali and M. Salim. 2001. Effect of various amendments on yield of rice crop under saline-sodic conditions in Mardan/Swabi districts. Int'l. J. Agric. Biol. 3: 289-291.
13. Iqbal, M. S., Yar, A., Ali, A., Anser, M. R., Iqbal, J. & Akram, H. M., 2001. Effect of sowing dates ad seed rate on grain yield of wheat. J. Agric. Res., 39(3&4): 217-221.
14. Iqbal, Z., A. Latif, S. Ali and M.M. Iqbal, 2003. Effect of fertigated phosphorus on P use efficiency and yield of wheat and maize. Songklanakarin J. Sci. Technol., 25: 697−702
15. Javadi A, Rahimzada R, Yavari A. 2004. Comparison of traditional and mechanized planting methods at different levels and their impact on the performance of dryland seeding. Journal of Agricultural Engineering Research 59(5), 18-78.
16. Johnston, A.M., S.S. Malhi, J.J. Schoenau and S.W. Exner. 1999. Nutrient and biomass accumulation of major crops. Res. Rept. Canadian. Fert. Inst., Ottawa.
17. Leytem, A.B. and R.L. Mikkelsen, 2005. The nature of phosphorus in calcareous soils. Better Crops, 89: 11−13
18. Matula J., Pechová M. (2005): Influence of gypsum treatment on extractability of nutrients from soils. Plant Soil Environ., 51: 368–375
19. Muhammad, S. 1990. Salt affected and water logged soils in Pakistan. An overview. Soil Salinity and Water Management vol. (1). Proc. of Indo- Pak Workshop on Soil salinity and Water Management, Feb. 10-14, 1990, Islamabad, Pakistan pp. 21-37.
20. Naeem M, 2001. Growth, radiation use efficiency and yield of new wheat cultivars under variable nitrogen rates. M. Sc. Thesis, Dept. Agron, Univ. Agric., Faisalabad.
21. Ryan, I., 2002. Efficient Use of Phosphate Fertilizer for Sustainable Crop Production in WANA, pp: 2−5. Phosphate Newsletter, IMPHOS.
22. Sharma, R.D., S. Ali and G.B. Part. 1996. Effect of soil amendments on rice yield. IRRI Notes, 21: 72-73.
23. Sharif, M., M.S. Sarir and F. Rabi, 2000. Biological and chemical transformation of phosphorus in some important soil series of NWFP. Sarhad J. Agric., 16: 587−592
24. Singh. N.T., G.S. Hira and M.S. Bajwa. 1981. Use of amendments in reclamation of alkali soils in India. Supplement, 158-177.
25. Sorour, F.A., M. A. Al-Sharkawy, M. S. Osman. 1995. Influence of tillage methods on the growth and yield of corn. Libyan j.Agric.4:47-50.
26. Tisdale S.L., Nelson W.L. (1975): Soil fertility and fertilizers. Macmillan Publ. Co., Inc. New York, Collier Macmillan Publ., London
27. Verma, K.S. and I.P. Abrol. Agro. Kemia ES, Talajtan Tom 1980. Effects of gypsum and pyrites on soil properties in a highly sodic soil. Indian J. Agric. Sci. 50: 844-851
28. Zhang L., 2007. Productivity and resource use in cotton and wheat relay intercropping. PhD thesis, Wageningen University, Wageningen, The Netherlands. 188 pp. ISBN: 978 90-8504-759-9.

.

Access this Article in Online	
	Website: www.ijarbs.com
Quick Response Code	Subject: Agricultural Sciences
DOI:10.22192/ijarbs.2017.04.05.016	

How to cite this article: Muhsammad Akram, Laila Khalid, Mueen-u-Din and Mushtaq Ali. (2017). Demonstration and evaluation of the effect of different doses of phosphorus with gypsum on the grain yield of wheat in ecological zone of Sahiwal. Int. J. Adv. Res. Biol. Sci. 4(5): 148-153.
DOI: http://dx.doi.org/10.22192/ijarbs.2017.04.05.016