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PHOSPHORUS USE EFFICIENCY OF DIFFERENT VARIETIES OF LENTIL AND GRASS PEA

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ABSTRACT

A pot experiment was conducted in the net house of the Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh during the period from October, 2012 to April, 2013 to compare the phosphorus use efficiency (PUE) as well as the effect of phosphorus (P) on yield and quality of six varieties of lentil and grass pea (three from each crop). The experiment was laid out in a Completely Randomized Design (CRD) with two treatments and three replications. Treatments included optimum phosphorus (P) dose i.e. @ 25 kg P ha^{-1} (P_1) and control (P_0). Among the observed parameters, application of P fertilizer had performed better over control (P0) in all varieties of lentil and grass pea. Among the three varieties of lentil (viz. BARI masur-5, BARI masur-6 and BARI masur-7), the best yield performance was observed in BARI masur-5. Similarly, among the three varieties of grass pea, (viz. BINA khesari-1, BARI khesari-1 and BARI khesari-2), BINA khesari-1 showed the best yield performance. In lentil varieties, BARI Masur-5 produced the highest seed yield (2.78 g pot^{-1}), whereas, BINA kheshari-1 gave the highest yield (3.38 g pot^{-1}) among grass pea varieties. In case of lentil and grass pea varieties, highest seed P contents were observed in BARI masur-5 (1.36%) and BINA khesari-1 (1.22%) varieties, respectively. Maximum PUE (192.5%) for lentil varieties was found in BARI masur-5 and that of (234.0%) for grass pea varieties was in BINA khesari-1. On the other hand, P used per unit seed yield in lentil and grass pea was highest in BARI masur-5 and BINA khesari-1, respectively. Therefore, our farmer can be benefitted by cultivating BARI masur-5 and BINA khesari-1 through maximized yield using less amount of P fertilizers.

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INTRODUCTION

Lentil is one of the most important legume crops grown in Bangladesh. The lentil crop covers 32.70 percent of the total area of pulse in the country (BBS, 2011). It occupies a unique position in the world of agriculture by virtue of its high protein content. In developing countries like Bangladesh, pulse constitutes the major concentrate source of dietary protein. It is considered as poor man's meat as well as cheapest source of protein for under privileged group of people who cannot afford to buy animal proteins (Hariyappa, 2006). Grass pea is also a grain legume crop used for human and animal consumption since ancient times (Hanbury *et al*., 2000). It is also a source of protein of many poor people in Bangladesh. Many people take this grass pea protein despite the risk of lathyrism because of their poor demand. The potential of grass pea for animal feed depends on the achievement of yields that make it competitive with other protein-rich ingredients.

Effect of P application increases grain yield, yield contributing components and grain quality in various legumes (Ahmed *et al.,* 2001*)*. However, P is one of the crucial nutrient elements which are made available to the soil after application for a very limited period. Phosphorus increased the yield of both annual and perennial legume species through increasing the plant available P in soil. Optimum available P for maximum yield differed between species as did PUE. For this reason, species which perform well in low P soils are valuable for this type of production system and environment.

Again the price of P fertilizers is getting higher day by day due to limited reserve of raw materials (e.g. rock phosphate) in the world. Moreover, excessive use of fertilizer not only increases production cost but also detrimental to the environment. Nevertheless, the application of optimal rates of P and the use of genotypes with high PUE (grain yield per unit P added) is one of the strategies that farmers can adopt to improve legume crops in Bangladesh. Providing farmers with genotypes adapted to specific conditions of P availability in the soil and having good PUE should improve yields, without excessively increasing production cost or damaging the environment. Among legumes, lentil and grass pea are the leading grain legumes in Bangladesh in terms of production and consumption. PUE has been studied in many species. Moreover, some studies carried out only P management in legume crops. However, very limited information is available regarding the PUE of the major legume varieties of Bangladesh. Under these circumstances, the present research was carried out to assess the effect of P fertilizer on growth and yield of lentil and grass pea varieties and screen out major lentil and grass pea varieties of Bangladesh having higher PUE.

MATERIALS AND METHODS

A pot experiment was conducted at the net house of the Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh during *Rabi* season of 2013-2014. The site is situated at 24º 43' 42" N latitude and 90º 26' 6" E longitudes at a height of 18 m above the main sea level. The soil used in this experiment is classified as silt loam, non-calcareous, dark grey type. Before conducting the experiment, initial characteristics of the soil was determined by standard procedures. The soil contained 1.53% organic matter, 0.10% total nitrogen, 0.14 cmol g^{-1} of soil exchangeable K, 12.09 mg kg^{-1} of soil available S, 0.23 mg kg^{-1} of soil available B, 8.3 me $100g^{-1}$ of soil CEC and 12.06 mg kg^{-1} of soil available P (sodium bicarbonate extractable-P, Olsen and Sommers (1982) with a pH of 6.1. Treatments of the three replicated experiment included optimum P dose i.e. @ 25 kg P ha^{-1} (P_1) and control (P_0) and was laid out in Completely Randomized Design. Three varieties of lentil (BARI masur-5, BARI masur-6, BARI masur-7) and grass pea (BINA khesari-1, BARI khesari-1 and BARI khesari-2) were used as test crops. The earthen pot size was 35 cm diameter and 30 cm height. The processed air dry soil samples were placed in the pots @ 10 kg pot^{-1}. A basal dose of N @ 20 Kg ha^{-1} through urea and potassium as K_2O @ 40 Kg ha^{-1} through MoP were applied to all pots at the time of transplanting. Three healthy and uniform sized 10 days old seedlings were transplanted in each pot. Light irrigation was given immediately after transplanting by watering cane. The crop was further irrigated at 40 days after transplanting. All other agronomic practices were kept uniform throughout the experiment. After maturity, harvested plants with pods were taken for measuring plant height, fresh weight, dry weight, number of seed $plant^{-1}$, 1000 seed weight and grain yield. Grain and shoot P contents were measured by stannous chloride reduced spectrophotometric method and PUE was calculated for individual varieties of the two crops.

All experimental data were subjected to analysis of variance (ANOVA) using statistical computer package SPSS. Significant different between treatments were further analyzed using least significant difference test for mean separation.

RESULTS AND DISCUSSION

A). Effect of variety and P on growth and yield attributes of lentil

The plant height, fresh weight, dry weight, number of seeds plant^{-1}, weight of 1000 seeds and seed yield pot^{-1} of lentil were significantly affected by variety. The longest plant, maximum fresh and dry weight, number of seeds plant^{-1}, weight of 1000 seeds and highest seed yield were 45.83 cm, 5.93 g, 1.62 g, 98, 22.02 g and 2.73 g pot^{-1}, respectively (Fig.1), recorded in BARI masur-5. The shortest plant, minimum fresh and dry weight, number of seeds plant^{-1}, weight of 1000 seeds and lowest seed yield were 34.67 cm, 4.03 g, 1.22 g, 49, 20.08 g and 1.81 g pot^{-1}, respectively (Fig.1), obtained in BARI masur-7 at harvest. The highest number of pods plant^{-1} and higher number seeds plant^{-1} contributed to higher seed yield in BARI masur-5 under the present experimental situation and it was probably due to comparatively higher yield potential as well as having higher yield attributes over other varieties. Additionally, crops with suitable root morphology probably modified rhizosphere pH and exudates organic acids into rhizosphere, and thereby increased soil P availability which probably helps its root system to acquire more P (Yan et al. 2001).

Phosphorus application had increased plant height, fresh weight, dry weight, number of seeds plant^{-1}, weight of 1000 seeds and seed yield invariably in all lentil varieties (Fig 1). The higher value of plant height, fresh weight, dry weight, number of seeds plant^{-1}, weight of 1000 seeds and seed yield were 47.56 cm, 6.77 g, 1.96 g, 104, 25.06 g and 2.69 g pot^{-1}, respectively (Fig.1), obtained in application of (P1) treatment, whereas the lower value of plant height, fresh weight, dry weight, number of seeds plant^{-1}, weight of 1000 seeds and seed yield were 33.78cm, 3.07g, 0.90g, 33, 16.03 g and 1.73 g pot^{-1}, respectively (Fig. 1), recorded in control (P0). Similar results were reported by authors in experiments with soybean and common bean. They observed an increase in dry matter and leaf area of soybean (Turuko and Mohammad, 2014; Jennifer, 2000) and common bean (Veeresh, 2003) with an increase in P level. This increment in dry matter yield with application of P fertilizer might be due to the adequate supply of P which attributed to an increase in number of branches per plant and plant height. The increment in number of branches per plant might be resultant from enhanced cell division activity due to increased P supply. Leading to the increase of plant height and number of branches and consequently increased the plant dry weight (Tesfaye, 2007). This in turn increased photosynthetic area and number of pods per plant. The increment of number of pods per plant due to application of P fertilizer confirms with P fertilizer promotes the formation of nodes and pods in legumes (Buttery, 1969). The result of the present study were in agreement with the findings of (Turuko and Mohammed, 2014) who reported that number of seeds per pod increased significantly to levels of P added. The increment of seeds per pod with increasing P fertilizer application up to optimum level might be P fertilizer for nodule formation, protein synthesis, fruiting and seed formation.

B). Effect of variety and P on growth and yield attributes of grass pea

Different levels of P and varieties of grass pea had distinct effect on plant height, fresh weight, dry weight, number of seeds plant^{-1}, weight of 1000 seeds and seed yield of grass pea. The longest plant, maximum fresh and dry weight, number of seeds plant^{-1}, weight of 1000 seeds and highest seed yield were 73.67 cm, 7.88 g, 2.55 g, 41, 53.70 g and 3.03 g pot^{-1}, respectively (Fig. 2), found in BINA khesari-1 (Fig. 2). While lowest value were 49.83 cm, 4.03 g, 1.10 g, 19, 50.7 g and 1.49 g pot^{-1}, respectively (Fig. 2), obtained in BARI khesari-2 at harvest. Application of P was found to be highly effective in enhancing growth, yield and yield attributing characters as compared to control treatments (Fig. 2). It might be due to the beneficial effect of these treatments in physiological process which increased the growth and yield of grass pea crop. These results are in conformity with the findings of (Pramanik and Singh, 2003) who reported that the application of P_2O_5 at 60 kg ha^{-1} significantly increased yield attributes and yield over control in chickpea. The lowest growth, yield and yield attributing characters of grass pea crop were recorded under control (P0) treatment.

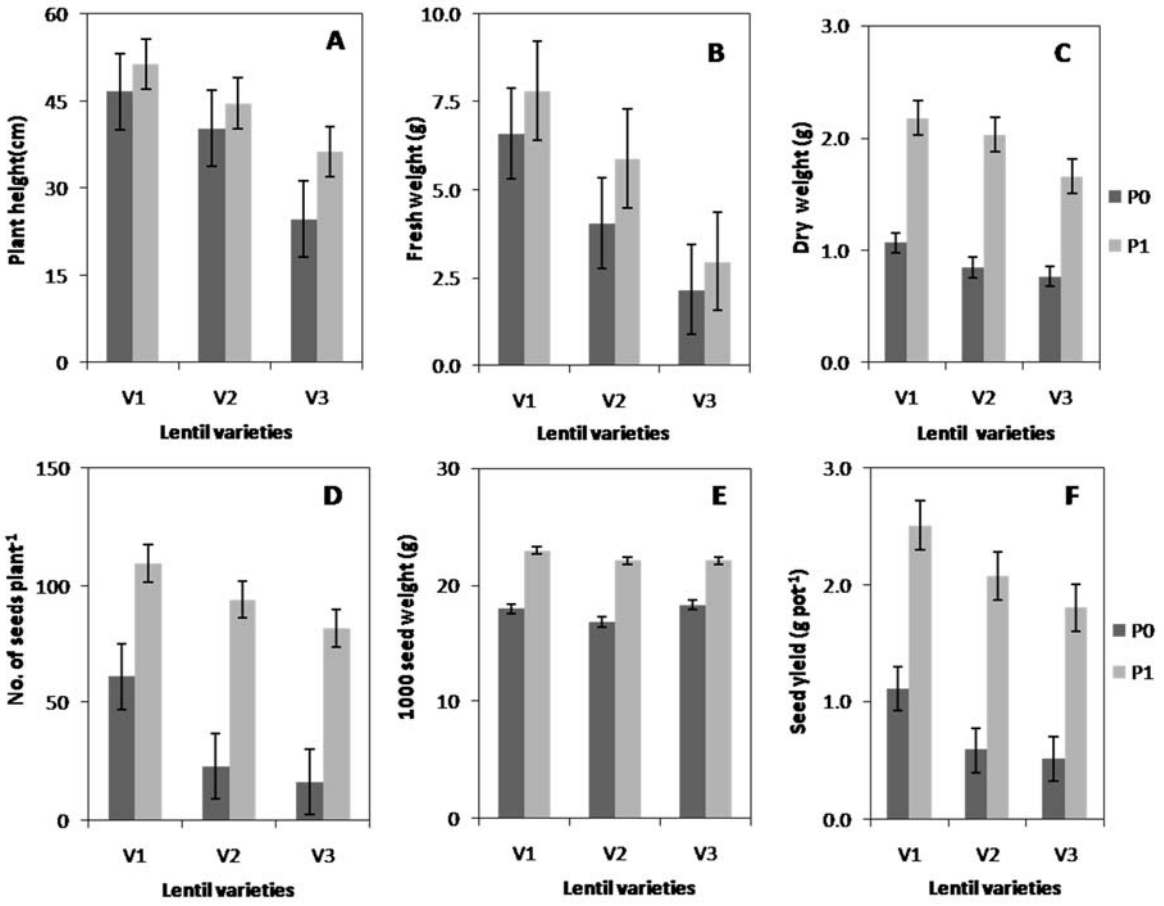

Figure 1. Effects of P on plant height (A), fresh weight (B), dry weight (C), no. of seed plant^{-1} (D), 1000 seed weight (E) and seed yield (F) of lentil varieties, where, V1= BARI masur-5, V2= BARI masur-6 and V3= BARI masur-7.

C). Effect of phosphorous and varieties on P content in shoot and grain of lentil

Distinct effect of variety and P application on P content in shoot and grain were observed in the study (Fig. 3). The highest P content of shoot was found in BARI masur-5 in P1 treatment and lowest P content observed in BARI masur-7 in P0 treatment (Fig. 3). The interaction effect of variety and P level had significant influence on P content of shoot however it was non-significant in grain.

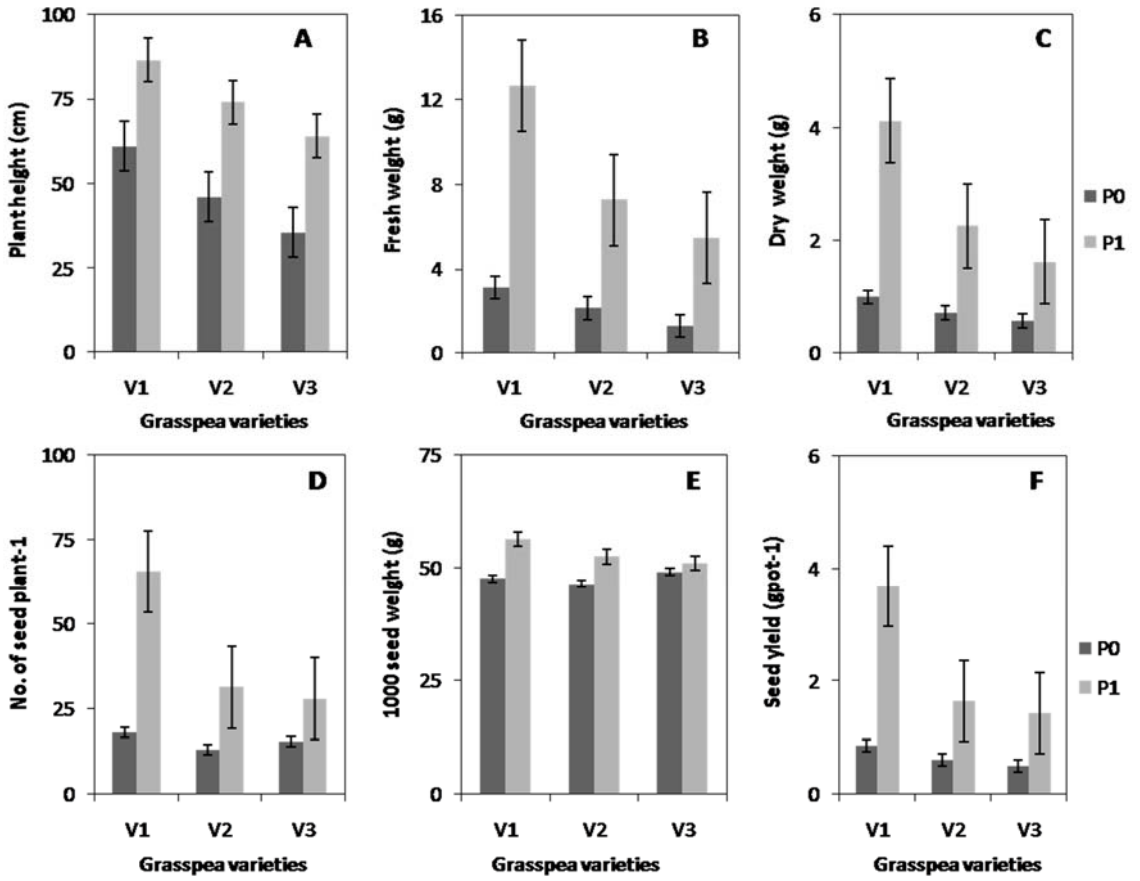

Figure 2. Effects of P on plant height (A), fresh weight (B), dry weight (C), no. of seeds plant^{-1} (D), 1000 seed weight (E) and seed yield (F) of grass pea varieties; where, V1= BINA khesari-1, V2= BARI khesari-1and V3= BARI khesari-2.

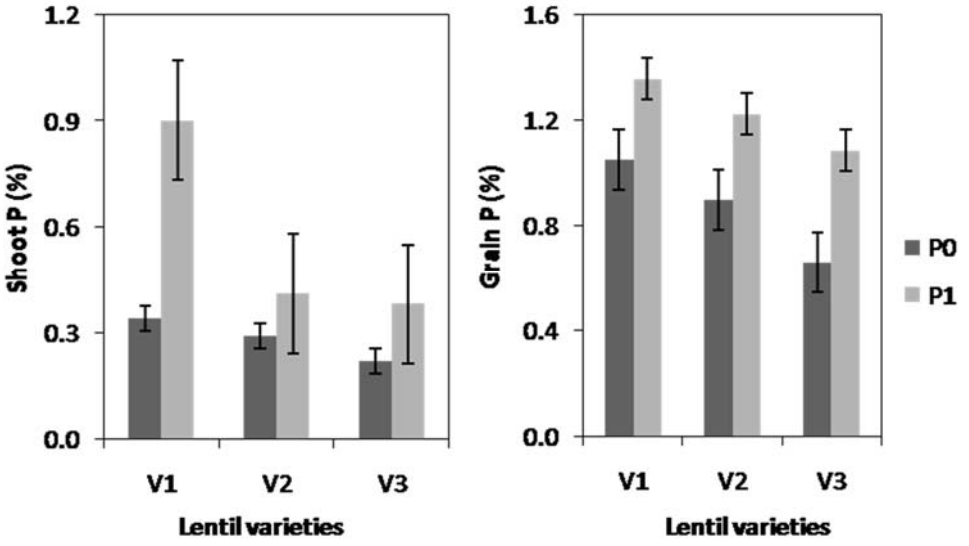

Figure 3. Shoot and grain P content (%) as affected by P fertilizer in lentil varieties; where, V1= BARI masur-5, V2= BARI masur-6 and V3= BARI masur-7.

D). Effect of phosphorous and varieties on P content in shoot and grain of grass pea

The effects of P and varieties on shoot and grain of grass pea crop were observed. The highest P content of shoot and grain were obtained in BINA khesari-1 with P1 treatment and lowest P content were found in BARI khesari-2 with control treatment (Fig. 4). Analysis of variance data showed that interaction of variety and P also had significant effect on the P content in shoot and non-significant in grain.

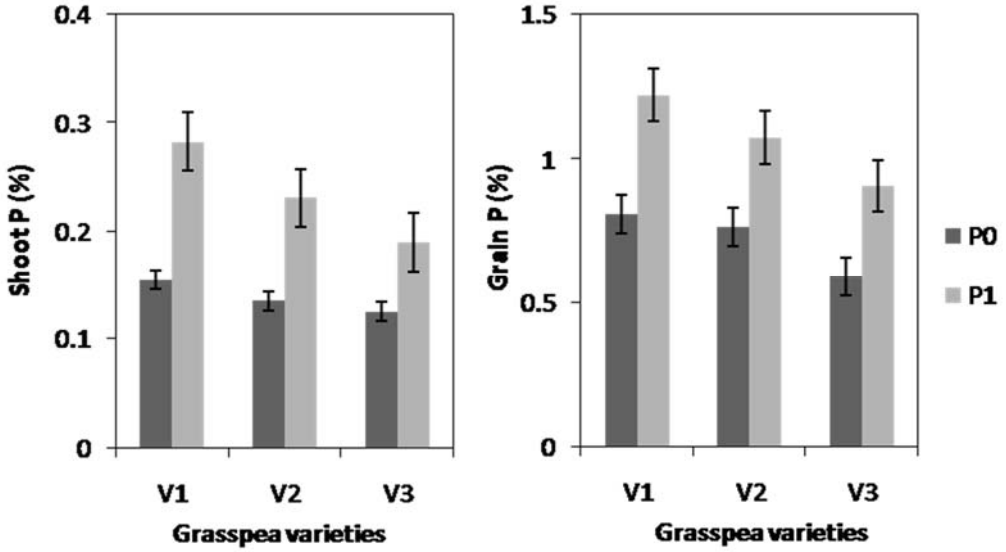

Figure 4. Shoot and grain P content (%) as affected by phosphorus fertilizer in lentil varieties where, V1= BINA khesari-1, V2= BARI khesari-1and V3= BARI khesari-2.

E). Phosphorus use efficiency in lentil and grass pea

PUE was calculated in terms of P uptake per unit of fertilizer P application. The results revealed that maximum PUE of 192.5% and 234.4% were observed at BARI masur-5 and BINA khesari-1, respectively, with P1 treatment. Similarly, the minimum PUE of 104.1 % and 62.5 % were obtained in the variety of BARI masur-7 and BARI khesari-2, respectively, with control (P0) treatment (Fig.5).

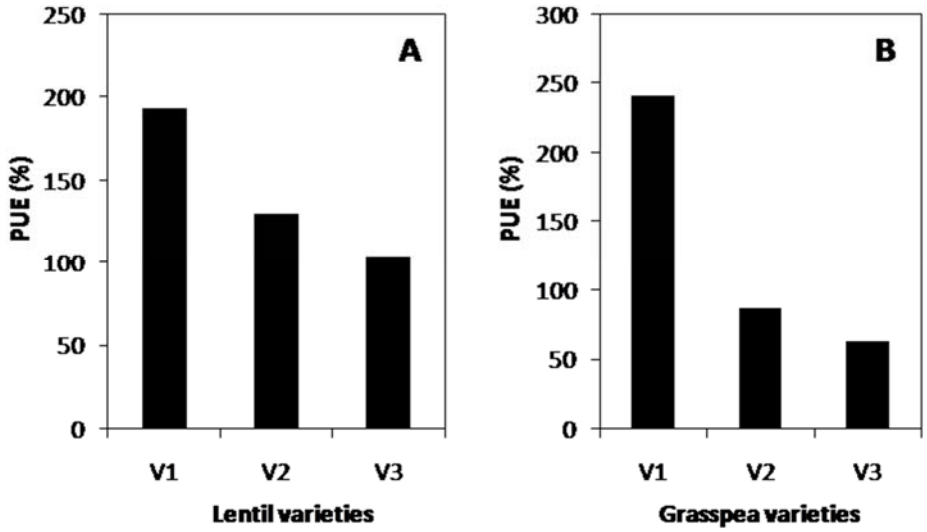

Figure 5. Phosphorus use efficiency of lentil (A) and grass pea (B) varieties. Here, in (A) V1= BARI masur-5, V2= BARI masur-6 and V3= BARI masur-7; and in (B) V1= BINA khesari-1, V2= BARI khesari-1and V3= BARI khesari-2.

CONCLUSION

From this study it can be concluded that BARI masur-5 and BINA khesari-1 could both be sown with 25 kg P ha^{-1} to obtain reasonable yield. The overall results thus indicate that the farmers may be advised for application of P which are necessary to ensure optimum yield and maximum PUE of lentil and grass pea.

COMPETING INTEREST

The authors declare that they have no competing interests.

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