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Effect of different fertilizer doses and bio-inoculants on yield, nutrient content and economics of summer mungbean (*Vigna radiata* L.)

Pooja Goswami, RS Singh and Amita Sharma

Abstract
A field experiment was conducted during summer season of 2011-12 and 2012-13 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (U.P.) to study the effects of fertility levels (25 and 50 kg P_2O_5 ha^{-1}, 25 kg S ha^{-1} and 3 kg Zn ha^{-1}) and bioinoculants (PSB, *Trichoderma* and PSB + *Trichoderma*) on yield, yield attributes, protein content, protein yield and economics of summer mungbean. The results revealed that application of 50 kg P_2O_5 ha^{-1} + 25 kg S ha^{-1} + 3 kg Zn ha^{-1} and seed inoculation with PSB + *Trichoderma* recorded significantly higher grain yield and yield attributes *viz.*, pods plant^{-1}, grains pods^{-1} and 100 seed weight over other fertility levels during both the years. The combined application of PSB and *Trichoderma* out performed PSB and *Trichoderma* alone. Maximum values of yield, yield attributes, protein content and protein yield were obtained with dual seed inoculation with PSB + *Trichoderma* which were found significantly superior to PSB and *Trichoderma* alone. It was also observed that application of 25 and 50 kg P_2O_5ha^{-1}along with 25 kg S ha^{-1} and 3 kg Zn ha^{-1} was found significantly superior over phosphorus alone. Increasing levels of phosphorus upto 50 kg P_2O_5 ha^{-1} increased yield and yield attributes, protein content and protein yield during both the years of study.

Keywords: Fertility levels, P_2O_5, S, Zn, PSB, trichoderma

Introduction
India is the largest producer, consumer and importer of pulses in the world. In India, pulses occupy an area of about 24.78 m ha with the production of 22.95 mt. (Directorate of Economics and Statistics, Department of Agriculture and Cooperation-2012). Pulses are important for existing farm production system as it adds nitrogen in the soil and provides food and nutritional security to large number of vegetarians and weaker section of the society who cannot afford other sources of protein (Kokate *et al*., 2013) [14]. Among pulses, mungbean (*Vigna radiata* L.) is one of the most important pulse crops of India ranking third after chickpea and pigeon pea (Sathymoorthi *et al.*, 2008) [21]. After the harvest of wheat and before the transplanting of rice, the land remains fallow for 65 – 70 days (late March/April to early July). This period could be used to raise a catch crop of summer mungbean to accomplish resources efficiency, resource maximization productivity, profitability and prosperity to the farmers besides sustaining soil health (Anbumani *et al*., 2003) [1].
Phosphorus has novel function of special importance in the process of energy storage and transfer. Some species of phosphorus solubilizing bacteria like *Bacillus polymyxa* and *Pseudomonas striata* are known to have the ability to solubilize phosphorus from insoluble sources (Gupta *et al.*, 2009) [10]. *Trichoderma* spp. is among the most commonly isolated soil fungi due to their ability to protect plants and contain pathogen populations under different soil conditions. *Trichoderma* spp. was found to be most effective organic phosphorus mobilizer as compared to other fungi (Tarafdar *et al*., 2003) [27] and also possess strong antagonistic activity against soil borne plant pathogenic fungi (Bennett and Lane, 1992; Kumar and Mukerji, 1996) [4, 13] apart from promoting vegetative growth in plant.
Sulphur is one of the essential plant nutrients classified as secondary nutrient. Legumes require almost equal amount of phosphorus and sulphur. When phosphorus and sulphur are present below the critical level in the soil, plant growth and quality of produce are affected adversely (Dubey and Mishra 1970) [9]. Sulphur application increased the total chlorophyll content in mungbean (Poorani, 1992) [17]. Sulphur plays a dominant role in improving the quality of pulses (Pasricha and Fox, 1993) [18]. Singh and Yadav (1997) [22] indicated that mung beans quite responsive to sulphur application.

Zinc plays an important role in biological system, such as maintenance of structural integrity of biological membranes and direct contributions to protein synthesis.

Zinc deficiency is common throughout the world. Mungbean also exhibits response to Zn application. This could reflect an increase in enzymatic activity within the nodule and the possibility of increased translocation of nitrogen substances from the nodules to other parts of the plant which require them.

Materials and Methods

The experiment was conducted during the summer season of 2011-12 and 2012-13 at the Agricultural Research Farm, Banaras Hindu University, Varanasi. The initial soil was sandy clay loamin texture, having pH of 7.46 and 7.53, respectively. It was moderately fertile being low in organic carbon (0.34 and 0.39%). The available N, P, K, S, and Zn was 180.70, 19.56, 205.38, 17.21and 1.01 kg ha^{-1}in first year and 186.20, 21.34, 210.12, 21.33 and 1.16 kg ha^{-1}in second year, respectively. The treatment comprising nine fertility levels (levels of 25 and 50 kg P_2O_5 ha^{-1} along with 25 kg S and 3 kg Zn ha^{-1}) and bioinoculants (PSB, *Trichoderma* and PSB + *Trichoderma*) replicated thrice in split plot design (overall area 72 m × 50 m).

Mungbean seed was treated with carrier based phosphate solubilizing bacteria (*Paenibacillus Polymyxa*), *Trichoderma viride* and dual seed inoculation of PSB + *Trichoderma* (*Paenibacillus Polymyxa* + *Trichoderma viride*) and mixed well to ensure the inoculum to stick on the surface of seeds at the rate of 2.5g per kg of seeds. The treated seeds were dried in shade for an hour and used for sowing. The crop variety HUM-16 was sown at the rate of 25 kg ha^{-1}on 15thApril (2011-12) and 8thApril (2012-13). The recommended dose of nitrogen and potassium at the rate of 15 and 20 kg ha^{-1}followed by phosphorus, sulphur and zinc as per treatment were applied through urea, Murate of potash, Diammonium phosphate (DAP), elemental sulphur and zinc oxide (ZnO) respectively at the time of sowing.

Sulphur concentration in soil and plant was analyzed as per standard turbido metric method (Chesin and Yien, 1950) [5] and zinc was determined with an atomic absorption spectrophotometer (Perkin Elmer Model, 5000) (AOAC, 1990) [2]. Protein content in seed was determined by multiplying the total nitrogen determined by Kjeldhal's method with a factor of 6.25 (AOAC, 1965). The required plant population (30 cm row to row and 5 cm plant to plant) was maintained by thinning plant after two weeks of sowing. The data were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Cochran and Cox (1967) [6]. Barlett's test was applied to test the homogeneity of variance and was found homogenous for both the years.

Results and Discussion

Effect of fertility levels and bioinoculants on yield attributes and yield

Application of 50 kg P_2O_5 ha^{-1} + 25 kg S ha^{-1} + 3 kg Zn ha^{-1} recorded significant increases in yield attributes and grain yield over other fertility levels (Table1). Application of 25 and 50 kg P_2O_5 ha^{-1} along with 25 kg S ha^{-1} or 3 kg Zn ha^{-1} recorded significantly higher yield and yield attributes over phosphorus alone but higher levels of phosphorus *viz.*, 50 kg P_2O_5 ha^{-1}along with 25 kg S ha^{-1} or 3 kg Zn ha^{-1}gave higher yield and yield attributes as compared to lower levels. It was also observed from Table 1 that yield attributes and grain yield also increased with increasing phosphorus levels up to 50 kg P_2O_5 ha^{-1}as compared to 25 kg P_2O_5 $ha^{-1}$and control during both the years of experimentation. These results are in conformity with Kushwaha and Singh (1992), Rao *et al*., (1993) [19], Thakur *et al*., (1996) with 50 kg P_2O_5 ha^{-1}, Shukla and Dixit (1996) [26] with 40 kg P_2O_5 ha^{-1} in mungbean. Favourable effects of 50 kg P_2O_5 ha^{-1} along with 40 kg S ha^{-1} have been also reported by Paricha (1993) [18] and Shivakumar (2001) [25] in mungbean.

Amongst bioinoculants, the combination of PSB + *Trichoderma* out yielded over PSB and *Trichoderma* alone. Seed inoculation with PSB was found significantly superior over *Trichoderma* alone in respect of yield attributes and grain yield. Similar results were also reported by Rudresh *et al*. (2005) [20] for increasing fertile pods $plant^{-1}$ under combined application of PSB and *Trichoderma* spp. in chickpea.

Interaction effects between fertility levels and bioinoculants were also found significantly superior for grain yield during both the years of experimentation. Application of 50 kg P_2O_5 ha^{-1} + 25 kg S ha^{-1} + 3 kg Zn ha^{-1} along with PSB + *Trichoderma* gave higher grain yield (981.01 kgs/ha) over other fertility levels along with PSB (878.36 kgs/ha) and *Trichoderma* (930.79 kgs/ha) alone during both the years of the study (Table 2 and 3). Thus, higher levels of phosphorus upto 50 kg P_2O_5 ha^{-1} along with secondary and micronutrients (25 kg S ha^{-1} and 3 kg Zn ha^{-1}) with bioinoculants recorded higher yield and yield attributes because of the addition of fertilizers in soil enhanced the availability of nutrients to plants. This might have resulted in higher root and shoot growth and yield parameters *viz.*, number of pods $plant^{-1}$, number of grains $pods^{-1}$ may be the result of enhanced photosynthetic activity followed by efficient transfer of these metabolites in seed with the resultant of increase in size and weight of individual seed (Goud *et al*., 2010) [11]. PSB solubilizes native phosphorus to soil solution whereas; *Trichoderma* prevents plants from soil borne pathogens and help in nodulation (Windhman *et al*., 1986; Vinale *et al*.,2008) [29, 28].

Effect of fertility levels and bioinoculants on nutrient content

Fertilization of mungbean with application of nutrients *viz.*, phosphorus, sulphur, zinc and bioinoculants increased N, P, K, S, and Zn content in grain as well as in stalk in mungbean (Table4). Significantly higher N, P, K, S and Zn content was recorded with 50 kg P_2O_5 ha^{-1} + 25 kg S ha^{-1} + 3 kg Zn ha^{-1}. Application of 25 and 50 kg P_2O_5 ha^{-1} along with 25 kg S $ha^{-1}$and 3 kg Zn ha^{-1}recorded higher nutrient content over phosphorus alone. It was also observed that increasing levels of phosphorus upto 50 kg P_2O_5 ha^{-1} increased N, P, K, S and Zn content and was found significantly superior over 25 kg P_2O_5 $ha^{-1}$and control treatment. Similar results were reported by Bairwa *et al*. (2012) [3] with combined application of 30 kg S ha^{-1} and 5 kg Zn ha^{-1} along with *Rhizobium* inoculation. This could be attributed to better supply of nitrogen, phosphorus and potassium, sulphur and zinc leading to higher branch and pods $plant^{-1}$ resulting in higher yield. It regulates the photosynthesis and carbohydrate metabolism which can be considered as one of the major factors limiting growth particularly during the reproductive phase.

Dual seed inoculation with PSB +*Trichoderma* recorded more nutrient content than PSB and *Trichoderma* alone. PSB are reported to facilitate phosphorus supply to plant by solubilizing insoluble soil phosphorus. Similar results were reported by Mohammadi *et al*. (2011) [15] with the dual seed inoculation of PSB + *Trichoderma* spp. in chickpea.

Effect of fertility levels on protein content and yield

Highest protein content in grain was associated with the application of 50 kg P_2O_5 ha^{-1} + 25 kg S ha^{-1} + 3 kg Zn ha^{-1} which was found significantly superior over 25 kg P_2O_5 ha^{-1} along with 25 kg S ha^{-1} or 3 kg Zn ha^{-1}, 25 kg P_2O_5 ha^{-1}applied singly and control. The difference between treatments was not found significant with respect to protein content. Similar results were also reported by Singh and Yadav (1997) [22] higher protein content and protein yield was recorded with 30 kg S ha^{-1} and 5 kg Zn ha^{-1} seeds and stalk of mungbean.

Dual seed inoculation with PSB + *Trichoderma* recorded higher protein content in grain which was found significantly superior over PSB and *Trichoderma* alone. Jutur and Reddy (2007) [19] have also reported positive correlation between PSB and protein content. Vinale *et al*. (2008) [28] reported that *Trichoderma* spp. induced genes were associated with protein metabolism.

Amongst bio – inoculants, dual seed inoculation of PSB + Trichoderma recorded maximum protein yield (176.57 and 185.49 kgs/ha) of moong bean which was significantly superior over seed inoculation with PSB and Trichoderma during both the years of study. Seed inoculation with Trichoderma recorded lowest protein yield (147.68 and 159.55 kgs/ha).

The protein content in pulses is recognized as an important nutritional trait and emphasis is also given to increased grain legume yield coupled with improved protein content with suitable agronomic manipulation.

Effect of fertility levels on economics and production efficiency

Owing to better utilization of applied resources, 50 kg P_2O_5 ha^{-1} + 25 kg S ha^{-1} + 3 kg Zn ha^{-1}recorded higher gross returns (56,480 and 60,853 Rsha^{-1}),net returns (38,690 and 41,655 Rs ha^{-1}) and B: C ratio (2.18 and 2.42) and production efficiency (15 and 16 kg $ha^{-1}day^{-1}$;597 and 672Rs $ha^{-1}day^{-1}$) over lower fertility levels(Table 5).Seed inoculation with PSB + *Trichoderma* recorded higher gross returns (45,055 and 47,608 Rs ha^{-1}),net returns (28,785 and 30,606 Rs ha^{-1}) and B: C ratio (1.72 and 1.89 Rs ha^{-1}) and production efficiency (12 and 13 kg $ha^{-1}day^{-1}$) and (455 and 486 Rs $ha^{-1}day^{-1}$) over PSB and *Trichoderma* alone during both the years of experimentation. These results were in conformity with Singh and Singh (2012) [24] with combined inoculation of PSB and PGPR along with 50 kg P_2O_5 ha^{-1} and Singh and Yadav (2008) [23] with the combined application of 60 kg P_2O_5 ha^{-1} along with seed inoculation with *Rhizobium* + PSB in pigeon pea.

Application of 50 kg P_2O_5 ha^{-1} + 25 kg S ha^{-1} + 3 kg Zn ha^{-1} along with PSB + *Trichoderma* found significantly superior over 25 kg P_2O_5 ha^{-1} + 25 kg S ha^{-1} + 3 kg Zn ha^{-1} along with PSB + *Trichoderma* during both the years of experimentation in respect to grain yield, stalk yield, phosphorus, sulphur and zinc uptake in grain during both the years of experimentation.

Table 1: Effect of fertility levels and bioinoculants on yield attributes, grain yield, protein yield (kg ha^{-1}) and protein content (%) of mungbean

Treatment	Yield attributes						Yield (kg ha^{-1})				Quality parameter	
Fertility levels (kg ha^{-1})	Pods $plant^{-1}$		Grains pod^{-1}		100-seeds weight (g)		Grain yield		Protein yield		Protein content (%)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Control	11.23	11.57	9.46	9.64	2.21	2.35	528.25	553.45	113.78	115.42	20.28	21.20
25	12.08	12.29	9.85	9.96	2.37	2.41	555.09	587.50	121.12	131.67	21.43	21.84
25 P_2O_5 + 25 S	12.17	12.62	10.55	10.39	2.50	2.53	605.42	655.84	134.44	146.65	21.90	22.29
25 P_2O_5 + 3 Zn	12.14	12.29	10.25	10.31	2.41	2.48	580.86	645.45	120.82	131.31	21.53	21.95
25 P_2O_5+ 25 S + 3 Zn	12.42	12.82	10.65	10.80	2.59	2.67	625.80	696.44	136.01	141.40	22.57	22.84
50 P_2O_5	12.19	13.02	10.74	10.59	2.64	2.74	701.50	723.24	156.93	160.98	22.92	23.34
50 P_2O_5 + 25 S	12.84	13.51	11.06	11.40	2.84	2.89	832.47	873.69	195.08	202.24	23.51	24.06
50 P_2O_5 + 3 Zn	12.47	13.24	10.80	10.90	2.78	2.84	770.80	824.77	183.55	197.03	23.04	23.71
50 P_2O_5 + 25 S + 3 Zn	13.02	13.8	11.14	11.72	2.91	3.07	930.05	994.38	225.17	230.32	23.96	24.32
S.Em ±	0.297	0.355	0.221	0.327	0.13	0.149	21.00	35.54	8.49	7.16	0.55	0.56
CD (P=0.05)	0.892	1.065	0.664	0.980	0.40	0.44	62.96	106.54	25.47	21.48	1.65	1.69
Bioinoculants												
PSB	12.10	12.73	10.34	10.64	2.58	2.65	658.97	727.29	147.68	159.55	21.76	22.40
Trichoderma	11.26	11.29	9.58	9.598	2.12	2.29	642.46	661.70	138.06	140.63	21.16	21.87
PSB + *Trichoderma*	13.50	14.36	11.57	11.67	3.05	3.05	741.99	795.92	176.57	185.49	24.13	24.24
S.Em ±	0.168	0.137	0.106	0.114	0.08	0.09	8.41	10.77	2.62	4.01	0.30	0.24
CD (P=0.05)	0.483	0.395	0.306	0.329	0.23	0.27	24.13	30.90	7.51	11.51	0.87	0.69
	NS	NS	NS	NS	NS	NS	S	S	NS	NS	NS	NS

Table 2: Effect of fertility levels and bioinoculants on grain yield of Mungbean in 2011 – 12

Treatments	Control	25 kg P_2O_5	25 kg P_2O_5 + 25 kg S	25 kg P_2O_5 + 3 kg Zn	25 kg P_2O_5 + 25 kg S + 3 kg Zn	50 kg P_2O_5	50 kg P_2O_5 + 25 kg S	50 kg P_2O_5 + 3 kg Zn	50 kg P_2O_5 + 25 kg S + 3 kg Zn	Mean
PSB	488.85	507.83	564.42	563.08	600.34	688.52	851.47	787.83	878.36	658.97
Trichoderma	517.36	546.38	566.81	558.85	583.60	642.33	719.05	716.95	930.79	642.46
PSB + *Trichoderma*	578.55	611.06	685.03	620.67	693.46	773.64	926.89	807.63	981.01	741.99
Mean	528.25	555.09	605.42	580.86	625.80	701.50	832.47	770.80	930.05	681.14

	S.Em±	CD (P=0.05)
B at same T	25.24	72.38
T at same/diff B	29.42	86.33

Table 3: Effect of fertility levels and bioinoculants on grain yield of Mungbean in 2012 – 13

Treatments	Control	25 kg P_2O_5	25 kg P_2O_5 + 25 kg S	25 kg P_2O_5 + 3 kg Zn	25 kg P_2O_5 + 25 kg S + 3 kg Zn	50 kg P_2O_5	50 kg P_2O_5 + 25 kg S	50 kg P_2O_5 + 3 kg Zn	50 kg P_2O_5 + 25 kg S + 3 kg Zn	Mean
PSB	512.34	545.55	647.24	593.70	682.33	749.21	939.07	882.26	993.94	727.29
Trichoderma	501.02	542.99	626.76	651.91	638.72	639.41	717.55	688.65	948.33	661.70
PSB + *Trichoderma*	647.01	673.97	693.51	690.73	768.27	781.12	964.46	903.39	1040.88	795.92
Mean	553.45	587.50	655.84	645.45	696.44	723.24	873.69	824.77	994.38	728.31

	S.Em±	CD (P=0.05)
B at same T	32.32	92.69
T at same/diff B	44.26	130.66

Table 4: Effect of fertility levels and bioinoculants on N, P, K, S (%) and zinc content (ppm) grain and stalk of mungbean

Treatment	Nitrogen content (%)				Phosphorus content (%)				Potassium content (%)				Sulphur content (%)				Zinc content (ppm)			
	Grain		Stalk		Grain		Stalk		Grain		Stalk		Grain		Stalk		Grain		Stalk	
Fertility levels	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	211-12	2012-13	2011-12	2012-13	2011-12	2012-13
Control	3.24	3.39	1.39	1.31	3.06	3.10	0.16	0.17	0.97	1.01	2.43	2.44	0.211	0.220	0.087	0.098	38.02	40.27	92.02	93.66
25	3.43	3.49	1.41	1.46	3.28	3.30	0.17	0.18	1.05	1.07	2.45	2.49	0.221	0.230	0.093	0.103	40.37	41.86	100.44	103.07
25 P_2O_5 + 25 S	3.50	3.56	1.48	1.54	3.36	3.40	0.18	0.18	1.15	1.17	2.49	2.5	0.257	0.264	0.118	0.121	42.55	44.15	104.13	106.92
25 P_2O_5 + 3 Zn	3.44	3.51	1.43	1.51	3.35	3.36	0.18	0.18	1.08	1.10	2.48	2.50	0.244	0.252	0.102	0.113	46.13	47.16	109.36	110.58
25 P_2O_5+ 25 S + 3 Zn	3.61	3.65	1.49	1.56	3.55	3.57	0.19	0.19	1.16	1.18	2.50	2.53	0.261	0.279	0.122	0.128	44.89	48.06	113.56	117.77
50 P_2O_5	3.66	3.73	1.53	1.57	3.59	3.66	0.18	0.20	1.17	1.19	2.51	2.55	0.250	0.256	0.109	0.113	50.60	51.24	106.12	108.08
50 P_2O_5 + 25 S	3.76	3.85	1.67	1.72	3.65	3.72	0.19	0.21	1.19	1.22	2.54	2.58	0.271	0.281	0.131	0.140	51.40	54.00	111.58	114.19
50 P_2O_5 + 3 Zn	3.68	3.79	1.58	1.63	3.60	3.70	0.18	0.19	1.18	1.20	2.52	2.56	0.263	0.272	0.113	0.119	55.99	56.89	115.75	119.08
50 P_2O_5 + 25 S + 3 Zn	3.83	3.89	1.70	1.78	3.76	3.83	0.20	0.21	1.21	1.24	2.59	2.59	0.280	0.291	0.137	0.142	62.72	63.33	118.67	121.64
S.Em ±	0.08	0.09	0.135	0.153	0.092	0.094	0.01	0.01	0.09	0.10	0.09	0.12	0.006	0.006	0.011	0.009	1.75	1.59	2.02	1.96
CD (P=0.05)	0.26	0.27	0.405	0.459	0.27	0.283	0.03	0.03	0.29	0.32	0.29	0.36	0.018	0.019	0.032	0.026	5.24	4.77	6.05	5.89
Bioinoculants																				
PSB	3.48	3.58	1.54	1.58	3.38	3.43	0.18	0.19	1.13	1.15	2.47	2.50	0.251	0.261	0.105	0.119	48.88	49.24	106.60	109.48
Trichoderma	3.38	3.50	1.43	1.48	3.29	3.32	0.16	0.17	1.04	1.06	2.45	2.47	0.231	0.238	0.081	0.094	43.55	45.13	102.43	105.54
PSB + *Trichoderma*	3.86	3.87	1.59	1.63	3.74	3.81	0.21	0.22	1.21	1.25	2.58	2.60	0.270	0.283	0.151	0.146	51.80	54.62	114.85	116.64
S.Em ±	0.04	0.03	0.052	0.062	0.049	0.052	0.00	0.00	0.052	0.05	0.046	0.05	0.002	0.002	0.005	0.005	0.70	0.78	1.74	1.70
CD (P=0.05)	0.14	0.11	0.150	0.178	0.14	0.15	0.01	0.01	0.149	0.15	0.133	0.14	0.005	0.006	0.016	0.014	2.00	2.24	5.00	4.87

Table 5: Effect of fertility levels and bioinoculants on economics and production efficiency (kg ha^{-1} day^{-1} and (Rs ha^{-1} day^{-1}) of mungbean production

Treatment	Gross Returns (Rs kg^{-1})		Net Returns (Rs kg^{-1})		B:C ratio		Production efficiency			
							(kg ha^{-1} day^{-1})		(Rs ha^{-1} day^{-1})	
Fertility levels (kg ha^{-1})	**2011**	**2012**	**2011-12**	**2012-13**	**2011-12**	**2012-13**	**2011-12**	**2012-13**	**2011-12**	**2012-13**
Control	32463	33548	18149	19234	1.18	1.34	8.61	8.93	293	310
25 P_2O_5	33751	35938	18588	20775	1.22	1.37	8.95	9.48	300	335
25 P_2O_5 + 25 S	36860	41086	20155	24090	1.29	1.49	9.77	10.58	331	403
25 P_2O_5 + 3 Zn	35279	39365	19873	23732	1.26	1.45	9.35	10.41	321	379
25 P_2O_5+ 25 S + 3 Zn	38086	44181	21139	27234	1.32	1.62	10.09	11.23	341	439
50 P_2O_5	42439	45395	26432	29388	1.65	1.83	11.26	11.67	426	474
50 P_2O_5 + 25 S	50563	52006	33016	34458	1.91	2.19	13.43	14.09	533	556
50 P_2O_5 + 3 Zn	46843	50965	30594	33927	1.88	2.10	12.43	13.30	493	547
50 P_2O_5 + 25 S + 3 Zn	56481	60853	38690	41655	2.18	2.42	14.82	16.04	597	672
S.Em ±	1268	2044	1268	2274	0.07	0.12	0.35	0.57	21	35
CD (P=0.05)	3802	6128	3802	6818	0.21	0.36	1.04	1.72	64	105
PSB	40098	43413	23883	27311	1.46	1.66	10.63	11.73	386	444
Trichoderma	39102	43276	22877	27251	1.44	1.73	10.31	10.67	370	442
PSB + *Trichoderma*	45055	47757	28785	30270	1.72	1.89	11.96	12.84	455	486
S.Em ±	505	1103	505	1080	0.03	0.06	0.14	0.17	8	17
CD (P=0.05)	1449	3163	1449	3098	1.18	0.17	0.41	0.50	23	50

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