

Original Research Article

<https://doi.org/10.20546/ijcmas.2017.610.333>

Response of Urdbean [*Vigna mungo* (L.) Hepper] to Phosphorus Fertilization and Thiourea on Yield, Quality, Nutrient Content and Uptake

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ABSTRACT

A field experiment was conducted during *Kharif* season of 2015 on loamy sand soil to study the effect of phosphorus levels and thiourea on productivity, nutrient content and uptake of urdbean. Experiment consisted of four treatments of phosphorus levels (0, 20, 40 and 60 kg/ha) and five thiourea treatments (control, thiourea 500 ppm at branching, thiourea 500 ppm at branching and flowering, thiourea 1000 ppm at branching and thiourea 1000 ppm at branching and flowering) thereby making twenty treatment combinations tested in randomized block design with three replications. Result indicated that application of phosphorus up to 40 kg/ha significantly increased seed and straw yield, net returns, protein content in seed, nitrogen, phosphorus and potassium concentration in seed and straw and total uptake of nitrogen, phosphorus and potassium over preceding levels and remained at par with 60 kg/ha. Whereas, raising the level of phosphorus from 0 to 20 kg/ha registered the highest agronomic efficiency, apparent recovery and physiological efficiency of phosphorus after that, it showed significant decline upto 60 kg/ha. Application of thiourea 500 ppm at branching and flowering registered significantly higher concentration of N and P in seed and straw and total uptake of N, P and K as well as protein content in seed and available P₂O₅ in soil after crop harvest over thiourea (500 ppm) at branching and control. Whereas the highest agronomic efficiency and apparent recovery of P recorded under thiourea 500 ppm at branching and flowering and physiological efficiency under control.

Keywords

Phosphorus, Thiourea, Nutrient uptake and yield.

Article Info

Accepted:

23 September 2017

Available Online:

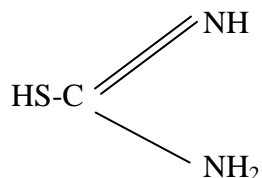
10 October 2017

Introduction

Pulses are the main source of dietary protein particularly for vegetarians and contribute about 14 per cent of the total protein of average Indian diet. Urdbean [*Vigna mungo* (L.) Hepper] is among the major pulses grown throughout the country during both in summer and rainy season. It is a self-pollinated leguminous crop containing 24% protein. The duration of the crop is very short; it fits well in various multiple and intercropping systems. After removing pods, its plant may be used as

good quality green or dry fodder or green manure. Being a legume, it also enriches soil by fixing atmospheric nitrogen. Phosphorus is a universally deficient plant nutrient in most of the soils of Rajasthan, particular in light textured soils. Application of phosphorus to pulse crop has been found very effective and called as master key element for increasing yield. Its play a vital role in growth and development of roots, phosphorus is also necessary for growth of Rhizobium bacteria

responsible for biological fixation of N to increase the efficiency of pulses as soil renovator and serves the dual purpose of increasing yield of main as well as succeeding crop. An adequate supply of phosphorus has been reported well for better growth, yield, quality and enormous nodule formation in legumes (Sammauria *et al.*, 2009). It acts as a structural component of membrane system of cells, chloroplasts and mitochondria. It is a constituent of energy phosphates like ADP and ATP, nucleic acids (DNA and RNA), nucleoproteins, purines, pyrimidine, nucleotides and several coenzymes. About 93-99 per cent of the total phosphorus is insoluble and hence directly not available to plants. Thiourea is a sulphhydryl compound (Jocelyn, 1972). It contains one -SH group (42.1% S) besides containing nitrogen (36.8%) in the form of NH₂ as evident from its structural formula given below.



Use of thiourea, recognized as plant growth regulator (Sahu and Solanki, 1991) may be helpful in this regard. The exogenous supply of growth regulators also modifies plant growth by hormonal control, differentiation, morphogenesis and key physiological processes such as carbon and nutrient assimilation, partitioning of photosynthates and utilization efficiency. Soaking of seeds and foliar spray of thiourea have been reported not only to improve growth and development of plants, but also the dry matter partitioning for increased seed yield (Arora, 2004).

Materials and Methods

A field experiment was conducted during *kharif* season of 2015 at the Agronomy Farm,

S.K.N. College of Agriculture, Jobner (Rajasthan). Soil of the experimental field was loamy sand in texture with alkaline reaction (pH 8.2), low in organic carbon (0.15%) and available nitrogen (132.4 kg/ha), medium in available phosphorus (16.26 kg/ha) and potassium (154.2 kg/ha). Experiment was laid out in randomized block design with twenty treatment combinations comprised of four phosphorus levels (0, 20, 40 and 60 kg/ha) and five thiourea treatments viz., (control, 500 ppm spray at branching, 500 ppm spray at branching and flowering, 1000 ppm spray at flowering and 1000 ppm spray at branching and flowering). The urdbean variety T-9 was sown using seed rate 15 kg/ha with a row spacing of 30 cm at the depth of 4-5 cm. Uniform dose of nitrogen 25 kg/ha was applied to all the plots by adjusting the nitrogen supplied by DAP and remaining through urea at the time of sowing. Whereas, phosphorus was applied as per treatments through DAP. Foliar spray of thiourea was done 500 ppm and 1000 ppm solution at branching and flowering stages as per treatment while applying the spray treatment, teepol (0.05 ml/L.), a spreading agent was mixed with the spray solution. N concentration was determined by modified kjeldhal method while total P determined using sulphuric-nitric-perchloric acid digest procedure. K was determined by tri acid digestion procedure on flame photometer.

Results and Discussion

Effect of phosphorus levels

Successive increase in phosphorus levels significantly increased number of pods/plant, number of seeds/pod, test weight, seed yield, straw yield and biological yield upto 40 kg/ha, which was comparable with application of highest level of 60 kg/ha and no significant effect was observed on harvest index (Table 1). The increase in seed yield with 60 kg/ha was 13.4 and 53.5% over 20

kg/ha and control, respectively. This could be attributed due to better root proliferation, higher root development, increased availability and uptake of nutrients, energy transformation and metabolic processes in plant. The higher crop growth with more supply of phosphorus might regulate starch/sucrose ratio in source leaves and reproductive organs. The beneficial effect of phosphorus on fruiting of plants and better translocation of desired metabolites to the yield contributing parts of the plant might attributed to more seed yield. The improvement in straw yield might be due to the fact that phosphorus tends to increased growth and development in terms of plant height, branches and dry matter by improving nutritional environment of rhizosphere and plant system leading to higher plant metabolism and photosynthetic activity.

These findings corroborate the results of Tanwar *et al.*, (2003), Rathore *et al.*, (2010) and Kumawat *et al.*, (2013) in urdbean and Singh and Sekhon (2007) in mungbean. The application of phosphorus 40 kg/ha recorded the significantly higher net returns (Rs. 52267/ha) over preceding levels and remained at par with 60 kg/ha.

The increase in net returns might be due to higher seed and straw yield obtained under the treatment. A significant increased protein content in seed, nitrogen, phosphorus and potassium concentration in seed and straw and their uptake were observed with the application of phosphorus upto 40 kg/ha (Table 2). As stated that application of phosphorus might have nutritional environment in rhizospheric as well as in plant leading to increased uptake and translocation of nutrients especially of N, P and K in reproductive structures which led to higher content and uptake. Further, the significant and positive correlation of yield with nutrients also evidenced for higher content of nutrients. Since, uptake of N, P and

K is the function of seed and straw yield and their content, the significant increase in concentration of these nutrients coupled with increased seed and straw yield enhanced the total uptake of N, P and K. Protein content is essentially the manifestation of N concentration in seed. Hence, increased N concentration might have increased the protein content. These results are close in conformity with the findings of Srinivasarao and Ali (2006) in urdbean and Kumawat *et al.*, (2014) in greengram. Raising the level of phosphorus from 0 to 20 kg/ha registered the highest agronomic efficiency, apparent recovery and physiological efficiency of phosphorus after that, it showed significant decline upto 60 kg/ha. Whereas, the available phosphorus in soil after crop harvest increased significantly upto 40 kg/ha and remained at par with 60 kg/ha (Table 3).

Effect of thiourea

Foliar application of thiourea (Thiourea 500 ppm at branching, 1000 ppm at branching, 500 ppm at branching and flowering and 1000 ppm at branching and flowering) significantly increased yield attributes *viz.*, number of pods per plant and number of seeds per pod over control. Thiourea was applied at both the stages even at lower concentration (500 ppm at branching and flowering) significantly enhanced the seed yield (1167 kg/ha) over its application at one stage and remained at par with its higher concentration at both the stages. Significant improvement in the seed yield due to foliar spray of 500 ppm thiourea was also reported by Burman *et al.*, (2008) and Bamaniya (2009) in mungbean. While explaining the role of sulphhydryl compounds in maize productivity, Sahu and Solanki (1991) were of the view that probably photosynthates transport was improved because of improved dry matter partitioning. The partitioning of dry matter in plants depends on its distribution between leaves, stem and sink.

Table.1 Effect of phosphorus fertilization and thiourea on yield attributing characters, seed, straw, biological yield, harvest index and net returns

Treatments	Number of pods per plant	Number of seeds per pod	Test weight	Seed yield (Kg/ha)	Straw yield (Kg/ha)	Biological yield (Kg/ha)	Harvest Index	Net returns (Rs./ha)
Phosphorus levels (Kg/ha)								
Control	16.7	5.9	34.2	770	1516	2286	33.68	28980
20	22.5	7.1	36.9	1042	1995	3037	34.30	45254
40	27.2	7.8	39.2	1164	2272	3436	33.87	52267
60	28.6	8.2	39.9	1182	2317	3499	33.78	52400
SEm±	0.6	0.2	0.7	22	51	76	0.65	1100
CD(P=0.05)	1.6	0.5	2.1	62	145	217	NS	3144
Thiourea								
Control	18.6	5.6	33.9	775	1508	2283	33.93	28857
500 ppm at branching	22.2	6.9	36.6	1031	2015	3046	33.83	44626
500 ppm at branching and flowering	27.4	8.1	39.8	1167	2270	3437	33.95	52564
1000 ppm at branching	22.8	7.2	36.9	1039	2042	3081	33.70	44739
1000 ppm at branching	27.8	8.5	40.5	1187	2290	3477	34.13	52839
SEm ±	0.6	0.2	0.8	24	57	85	0.73	1230
CD (P=0.05)	1.8	0.6	2.4	69	162	242	NS	3515
CV (%)	9.15	9.86	7.60	8.05	9.72	9.59	7.45	9.53

Table.2 Effect of phosphorus fertilization and thiourea on N, P, K concentration, protein content and their uptake

Treatments	N concentration (%)		Total N uptake (Kg/ha)	Protein content (%)	P concentration (%)		Total P uptake (Kg/ha)	K concentration (%)		Total K uptake (Kg/ha)
	Seed	Straw			seed	straw		Seed	Straw	
Phosphorus levels (Kg/ha)										
Control	3.11	1.40	45.59	19.44	0.350	0.166	5.28	0.765	1.617	30.45
20	3.41	1.56	67.26	21.31	0.388	0.185	7.83	0.846	1.760	44.00
40	3.66	1.68	81.51	22.88	0.418	0.199	9.50	0.899	1.864	52.90
60	3.74	1.70	84.36	23.38	0.420	0.210	9.95	0.908	1.877	54.31
SEm±	0.05	0.03	1.94	0.36	0.006	0.004	0.20	0.013	0.027	0.85
CD(P=0.05)	0.15	0.09	5.54	1.03	0.019	0.012	0.56	0.037	0.078	2.43
Thiourea										
Control	3.15	1.39	45.95	19.69	0.340	0.160	5.11	0.822	1.750	33.07
500 ppm at branching	3.40	1.53	66.72	21.25	0.391	0.180	7.75	0.852	1.775	44.97
500 ppm at branching and flowering	3.64	1.70	81.88	22.75	0.421	0.210	9.80	0.867	1.790	51.24
1000 ppm at branching	3.45	1.57	68.76	21.56	0.394	0.186	7.99	0.856	1.778	45.62
1000 ppm at branching	3.76	1.73	85.10	23.50	0.424	0.214	10.05	0.875	1.804	52.19
SEm±	0.06	0.03	2.17	0.40	0.007	0.005	0.22	0.014	0.030	0.95
CD (P=0.05)	0.17	0.10	6.19	1.15	0.021	0.014	0.63	NS	NS	2.72
CV (%)	5.75	7.30	10.77	6.42	6.370	8.73	0.93	5.86	5.93	7.25

Table.3 Effect of phosphorus fertilization and thiourea phosphorus use efficiency and available phosphorus in soil after crop harvest

Treatments	Agronomic efficiency of P (kg seed/kg P)	Apparent recovery of P (%)	Physiological efficiency of P (kg seed/kg uptake of P)	Available P ₂ O ₅ (kg/ha)
Phosphorus levels (kg/ha)				
Control	-	-	-	15.02
20	13.60	12.77	108.73	17.10
40	9.85	10.57	95.15	18.25
60	6.87	7.79	89.96	18.35
SEm±	0.21	0.21	2.11	0.25
CD(P=0.05)	0.59	0.60	6.02	0.72
Thiourea				
Control	7.53		113.93	14.80
500 ppm at branching	10.02		99.90	17.23
500 ppm at branching and flowering	11.34		89.49	18.12
1000 ppm at branching	10.10		97.70	17.28
1000 ppm at branching and flowering	11.54		88.69	18.47
SEm±	0.27		2.72	0.28
CD (P=0.05)	0.76		7.78	0.81
CV (%)	7.93		8.33	5.70

The beneficial role of thiourea sulphhydryl compound in improving the translocation of photosynthates for yield formation has been proved in pot study under laboratory condition at BARC, Mumbai which concluded that the efficiency of transport of labelled sucrose (14-C) from stem to pod of mustard was increased by 35.1-44.1 with foliar spray treatments as compared to unsprayed control (Srivastava *et al.*, 2008). Further, increase in biological yield as well as seed yield was the cumulative effect of improved growth parameters due to foliar spray treatments. Foliar spray of thiourea 500 ppm at branching and flowering remained at par with thiourea spray 1000 ppm at branching and flowering. The increase in yield attributes and yield obtained with thiourea application was most probably due to increased crop photosynthesis favoured by both improved photosynthetic efficiency and source to sink relationship. Also, the increase in yield due to application of thiourea might be the result of concomitant increase in number of pods per plant, number of seeds

per pod and plant growth characters viz. plant height, dry matter accumulation, number of nodules per plant, which are consistent with findings of (Meena and Sharma (2005) in mothbean and Bamaniya (2009) in mungbean. Thiourea 500 ppm at branching and flowering fetched significantly highest net returns (Rs 52564/ha) in comparison to rest of treatments.

Foliar spray of thiourea (Thiourea 500 ppm at branching, 1000 ppm at branching, 500 ppm at branching and flowering and 1000 ppm at branching and flowering) significantly increased the protein content, N and P concentration in seed and straw and total N, P and K uptake by urdbean (Table 2) compared to control. Since, uptake of nutrients is the function of seed and straw yields and their concentration at cellular level and both resulted in enhanced uptake of nutrients. Thiourea application might have helped in improvement in metabolic processes of plants and better growth and development owing to greater absorption of nutrients from rhizosphere. It also might be due to metabolic

role of SH-group in root physiology and biochemistry. Thiourea creates better microbial population in soil which are responsible to mobilize essential nutrients. These findings are in line with those of Meena and Sharma (2005) and Singh (2007). Application of thiourea 500 ppm at branching and flowering registered significantly highest agronomic and apparent recovery of P than rest of treatments. Whereas, the highest physiological efficiency recorded under control (Table 3).

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How to cite this article:

Sanju Choudhary, O.P. Sharma, Gopal Lal Choudhary and Lali Jat. 2017. Response of Urdbean [*Vigna mungo* (L.) Hepper] to Phosphorus Fertilization and Thiourea on Yield, Quality, Nutrient Content and Uptake. *Int.J.Curr.Microbiol.App.Sci*. 6(10): 2841-2847.
doi: <https://doi.org/10.20546/ijcmas.2017.610.333>