Research Article
The J. Res. PJTSAU 51(1&2) 49-54, 2023

INFLUENCE OF LEVELS OF PHOSPHORUS AND MOLYBDENUM SEED TREATMENT ON PERFORMANCE OF SOYBEAN IN VERTISOLS OF TELANGANA

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Date of Receipt: 04-06-2023 Date of Acceptance: 18-06-2023

ABSTRACT

Field experiment entitled "Phosphorus and Molybdenum studies on productivity, quality and soil fertility of soybean – maize cropping system" was conducted during 2018-19 & 2019-20. at the Regional Sugarcane and Rice Research Station, Rudrur, Professor Jayashankar Telangana State Agriculture University situated at an altitude of 286.3. m above mean sea level (MSL) at 180 49'41' latitude and 78056'45" E longitude, (PJTSAU). The experiment consisted of 16 treatments *viz*., four levels of phosphorus (0, 30 60, and 90 kg P_2O_5 ha^{-1}) and four levels of seed treatment with molybdenum (0, 2, 4 and 6 g kg^{-1} seed) laid out in a randomized block design with factorial concept and replicated thrice. Perusal of mean results of two years indicated that interaction effect of varying levels of phosphorus and molybdenum seed treatment was significant on plant height at harvest. Phosphorus dose of 60 kg P_2O_5 ha^{-1} + molybdenum seed treatment @ 4 g kg^{-1} seed produced significantly higher plant height of 98.28 cm .Phosphorus dose of 90 kg P_2O_5 ha^{-1} + seed treatment with molybdenum @ 4 g kg^{-1} seed produced significantly higher number of pods 231.8 simlilar to that produced with 60 kg P_2O_5 ha^{-1} at similar level of molybdenum (226) and higher level of molybdenum 6 g kg^{-1} seed with 60 kg P_2O_5 ha^{-1} (225.8). Significantly higher grain yield was recorded at higher level of phosphorus at 90 kg P_2O_5 ha^{-1} with molybdenum seed treatment 4 g Mo per kg seed (3397kg ha^{-1}).

Keywords: Phosphorus, Molybdenum, Plant height, Number of pods, Test weight, Grain yield

Soybean (*Glycine max* L.) is basically a member of Fabaceae family and mainly supplies protein and oil. Its oil is considered the world's largest constituent of edible oils (Arif *et al*., 2010). It serve's as a good rotational crop and helps in enrichment of soil fertility. It is popularly called as "Golden bean or miracle bean" and one of the foremost important oil seed crop known for its excellent protein (42 - 45%), oil (20%) and starch content (21%). It gives 2-3 times more protein yield (kg ha^{-1}) than other pulses and becomes an economical source of protein. Soybean can substitute for meat and to some extent to milk (Endres *et al*., 2013). Mo requirement of soybean is higher in initial stages than at later stages. Soil-Mo may be hardly absorbed by soybean plants during the early growing period, that the Mo within or on the surface of the seeds may represent the only utilizable source of Mo, and that the Mo nutrition in this period strongly influences the later growth. The common method of correcting Mo deficiency in plants is treatment of the seeds with Mo. Up to the flower-bud-appearing stage, little absorption of Mo was detected. The Mo accumulation in the nodules may thus be highly dependent on the Mo contained in the seeds during the early growing period, and it can be said that the Mo contained in the seeds may play an important role in the early plant growth and probably in the nitrogen fixation by nodules(Junji Ishizuka,1982).

Phosphorus (P) is one of the most important nutrients for soybean crop, being absorbed from 0.2 to 0.4 kg. ha^{-1}.day^{-1} among phenological stages V_4(fourth trifoliate leaf) and R6(complete pod fill growth stages). This nutrient participates in many metabolic processes, such as in energy transfer (adenosine triphosphate (ATP)), photosynthesis, respiration, synthesis of nucleic acids and glucose, membrane synthesis and stability (phospholipids), activation and deactivation of enzymes (Thavarajah *et al*., 2010).

Hence the present study emphasises the importance of Mo and P in soybean cultivation.

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MATERIALS AND METHODS

Field experiment entitled "Phosphorus and Molybdenum studies on productivity, quality and soil fertility of soybean – maize cropping system" was conducted during 2018-19 & 2019-20.at the Regional Sugarcane and Rice Research Station, Rudrur, Professor Jayashankar Telangana State Agriculture University situated at an altitude of 286.3m above mean sea level (MSL) at 180 49'41' latitude and 78056'45" E longitude, (PJTSAU). The soil of the experimental site was clay loam with a pH of 7.9, electrical conductivity 0.24 dSm^{-1}, low in organic carbon (0.41 %), medium in available N (151 kg ha^{-1}) and available P (42 kg P_2O_5 ha^{-1}) and available K (372 kg ha^{-1}). Initial available Mo (0.29 ppm) was above critical level. The experiment consisted of 16 treatments *viz*., four levels of phosphorus (0, 30 60, and 90 kg P_2O_5 ha^{-1}) and four levels of seed treatment with molybdenum (0, 2, 4 and 6 g kg^{-1} seed) laid out in a randomized block design with factorial concept and replicated thrice.

RESULTS AND DISCUSSION

An overview of the average data of two years of study period on plant height, number of pods $plant^{-1}$ and grain yield (kg ha^{-1}) indicated that they were significantly influenced by application of varying levels of phosphorus and seed treatment with molybdenum.

Effect of different phosphorus levels

Pooled mean

Application of 60 kg P_2O_5 ha^{-1} resulted in significantly higher mean plant height (91.71 cm) at harvest, higher number of pods $plant^{-1}$ (200.7) on par with 90 kg P_2O_5 ha^{-1}(199.6) and significantly higher test weight (14.11g).But application, 90 kg P_2O_5 ha^{-1} recorded significantly higher grain yield (3229 kg ha^{-1}) over 60 (2926 kg ha^{-1}) ,30(2043 kg ha^{-1}) and 0(1576 kg ha^{-1}) kg P_2O_5 ha^{-1}).

Year wise

At harvest all levels of phosphorus increased plant height significantly over control. Phosphorus application of 90 kg P_2O_5 ha^{-1} resulted in maximum plant height ((91.52 and 91.90cm) on par to 60 kg P_2O_5 ha^{-1} (87.73 and 89.94cm) and 30 kg P_2O_5 ha^{-1}((88.93 and 82.98 cm). Lowest plant height was observed at no P application (81.85 and 82.98 cm) during both the years. This increase could be because of the fact that phosphorus acts a critical character in root development and is vital for respiration, energy synthesis and plant photosynthesis, which resulted in improved growth (Ali *et al*., 2014). Results are in confirmation by (Jabbar *et al*., (2012) who found taller plants height of the mungbean crop plant with an increase in phosphorus dose.

It can be observed that from data that number of number of pods $plant^{-1}$ was influenced significantly by different phosphorus levels during both the years .Application of 90 kg P_2O_5 ha^{-1}(201.8 and 204.0) and 60 kg P_2O_5 ha^{-1} (197.5 and 197.4) produced higher number of pods $plant^{-1}$ and differed significantly with 30 kg P_2O_5 ha^{-1} (171.2 and 173.1) and 0 kg P_2O_5 ha^{-1} (118.7 and 120.1). (Table 1)

Application of 60 kg P_2O_5 ha^{-1} recorded significantly higher test weight (14.21 g and 14.02g) over,90 (13.47g and 13.67g), 30 (13.57 g and 13.58g) and 0 (13.09 g) kg P_2O_5 ha^{1}during both the years.

Varying levels of phosphorus fertilization had significant effect on grain yield of soybean. Higher grain yield of 3123 and 3335 kg ha^{-1} was produced with phosphorus fertilization @90 kg P_2O_5 ha^{-1} which was significantly superior over other levels of phosphorus applied @60(2827 and 3026 kg ha^{-1}),30(1941 and 2144 kg ha^{-1}) and 0(1443 and 1709 kg ha^{-1})kg P_2O_5 ha^{-1} during 2018 and 2019.

Effect of molybdenum seed treatment

Different levels of molybdenum did not significantly influence plant height. But significantly higher number of pods $plant^{-1}$ (170.1), were recorded with molybdenum seed treatment @ 6 g kg^{-1} seed on par with 4g (169.3) kg^{-1} seed. Contrary to this maximum test weight (13.84 g) was recorded with molybdenum seed treatment @ 2 g kg^{-1} seed and followed by 4 (13.76 g), 6g (13.68 g) over no seed treatment with molybdenum (13.08 g). Grain yield increased significantly with 6 g kg^{-1} seed (2583kg ha^{-1}) on par with 4 g kg^{-1} seed (2577 kg ha^{-1}) and statistically superior over 2g kg^{-1} seed (2419 kg ha^{-1}) and no seed treatment (2196 kg ha^{-1})

Different molybdenum seed treatment levels did not influence plant height significantly any how significantly higher number of pod $plant^{-1}$ was noticed with molybdenum seed treatment @ 4 g kg^{-1} seed

Table 1. Influence of levels of phosphorus and molybdenum seed treatment on performance of soybean in vertisols

Treatments	Plant height (cm) at harvest			No .of pods per plant $^{-1}$			100 seed weight (g)			Seed yield (kg ha^{-1})		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
Phosphorus level (P_2O_5 kg ha^{-1})												
P_1 - 0	81.85	82.98	82.42	118.7	120.1	119.4	13.03	13.16	13.09	1443	1709	1576
P_2 - 30	88.93	90.12	89.52	171.2	173.1	172.1	13.57	13.58	13.57	1941	2144	2043
P_3 - 60	91.52	91.90	91.71	197.5	204.0	200.7	14.21	14.02	14.11	2827	3026	2926
P_4 - 90	87.73	89.94	88.83	201.8	197.4	199.6	13.47	13.67	13.57	3123	3335	3229
S. Em±	1.24	1.26	1.25	5.2	2.3	2.7	0.19	0.18	0.18	31	49	27
CD (p=0.05)	3.59	3.65	3.62	14.9	6.5	7.8	0.55	0.52	0.53	89	141	78
Molybdenum level as seed treatment (g kg^{-1})												
Mo_1 – 0	85.66	86.10	85.88	150.8	145.4	137.8	13.07	13.13	13.08	2079	2312	2196
Mo_2 - 2	88.56	89.09	88.83	162.1	163.6	150.0	13.87	13.82	13.84	2335	2502	2419
Mo_3 - 4	87.94	90.19	89.07	189.3	192.3	169.3	13.76	13.78	13.76	2440	2714	2577
Mo_4 – 6	87.85	89.56	88.71	187.0	193.3	170.1	13.63	13.73	13.68	2480	2685	2583
S. Em±	1.24	1.26	1.25	5.2	2.3	2.7	0.19	0.18	0.18	31	49	27
CD (p=0.05)	NS	NS	NS	14.9	6.5	7.8	0.55	0.52	0.53	89	141	78
Interaction (P × Mo)												
S. Em±	2.48	2.53	2.51	10.3	4.5	5.4	0.38	0.36	0.36	62	97	54
CD (p=0.05)	7.18	7.30	7.24	29.8	13.1	15.7	NS	NS	NS	178	281	157
CV (%)	4.92	4.93	4.93	10.4	4.5	5.4	4.91	4.56	4.65	5	7	4

(189.3 and 193.3) on par with 6 g kg^{-1} seed (187 and 192.3) which was significantly superior over 2 g kg^{-1} seed (162.1 and 163.6) and no seed treatment (150.8 and 145.4) during both years .Seed treatment with molybdenum increased test weight significantly at all levels over no seed treatment during both the years. Maximum test weight was recorded with molybdenum seed treatment @ 2 g kg^{-1} seed (13.87 and 13.82) followed by 4g (13.76g and 13.78 g) and 6g (13.63 g and 13.73g). Lower test weight was observed with no seed treatment with molybdenum (13.07 g and 13.13g). Data on grain yield revealed that in comparision to no seed treatment (2079 and 2312 kg ha^{-1}) and molybdenum seed treatment @ 2 g kg^{-1} seed(2335 and 2502 kg ha^{-1}) ,molybdenum seed treatment @ 4 g kg^{-1} seed (2440 and 2714 kg ha^{-1}) and 6 g kg^{-1} seed(2480 and 2685 kg ha^{-1}) recorded significantly superior grain yield during both the years.

The increase in yield attributes was probably due to source and sink relationship. The improvement in photosynthesis and carbohydrate metabolism resulting into greater formation of photosynthates and metabolites in source and later on translocated in the newly formed sinks i.e., reproductive structures (flowering and seed setting) which ultimately increased pods per plant and test weight (Pareek ,(2005)These consequences are in close complement with conclusions of Padhi *et al.* (2018), they found utilization of molybdenum resulted in maximum performance and performance related attributes in mung bean. While in the occasion of phosphorus application, rise in phosphorus doses up to 60 kg ha^{-1} caused in greater pods followed by P at 90 kg ha^{-1} and less pods observed in control treatments. Rise in the important attributes may be because of holding of extra nodules that actually provide enough nitrogen for vegetative growth (Ali *et al.,* 2010). These achievements were in accordance with Khan *et al.* (2017) who described that the pods numbers improved by enhancement in phosphorus. Ali *et al.* (2014) also explained that applied phosphorus of 65 kg ha^{-1} improved pointedly pods numbers of mung bean.

Increase in seed yield with application of molybdenum might be due to increased growth characters like nodulation, plant height and yield attributing characters viz; pods per plant, seeds per pod. These results are in agreement with those conveyed by Pattanayak *et al.* (2000) who confirmed that the yield of mungbean increased with increasing molybdenum levels compared to control. The reason for the increase in seed yield with higher phosphorus could be due to the development of the root, the greater absorption of nutrients and a greater accumulation of dry matter during the growth period and the translocation of more photosynthesis to the seed (Anwar *et al.*, 2018). Phosphorus fertilizer helped the crop create extra seeds and other reproductive measures that eventually subsidised to yield (Rani *et al.*, 2016).

Interaction

However interaction effect of varying levels of phosphorus and molybdenum seed treatment was not significant on plant height at harvest and test weight. But significant on number of pods $plant^{-1}$ and grain yield. Application of P @ 90 kg P_2O_5 ha^{-1} along with molybdenum seed treatment @ 4 g kg^{-1} seed recorded significantly higher number of pods (231.8) $plant^{-1}$ on par with P @ 60 kg P_2O_5 ha^{-1} along with seed treatment with molybdenum @ 6 g kg^{-1} seed (225.8) or 4g kg^{-1} seed (225) over rest of the treatment combinations. Phosphorus fertilization @90 kg P_2O_5 ha^{-1} along with molybdenum seed treatment @4 g kg^{-1} seed produced significantly superior grain yield(3397 kg ha^{-1}) on par to seed treatment @6g kg^{-1} seed at same level of phosphorus(3294 kg ha^{-1}).

The synergistic effect of Mo with phosphorus might have enhanced the phosphorus availability to plants thereby leading to higher plant metabolic processes. Phosphorus is the major constituent of cell nucleus and growing root tips, which helps in cell division and root elongation thus increasing the nodule number and size. (Table 2)

CONCLUSION

For profitable soybean cultivation ,it can be recommended to enhance phosphorus dose to 90kg P_2O_5 ha^{-1} along with molybdenum seed treatment @4 g kg^{-1}

REFERENCES

Ali, A., A. Amjadi, A. Javed and Y. Muhammad. 2010. Effects of phosphorus in combination with rhizobium inoculation on growth and yield parameters of mung bean. Crop. Environ., 1(1): 53- 56.

Table .2 Interaction effect of levels of phosphorus and molybdenum seed treatment on growth and yield of soybean

	Plant height(cm)					Number of pods plant					Grain yield (kg ha^{-1})				
	P_1	P_2	P_3	P_4	Mean	P_1	P_2	P_3	P_4	Mean	P_1	P_2	P_3	P_4	Mean
$M0_1$	73.08	91.95	95.10	83.38	85.88	83.4	162.6	164.6	181.8	148.1	1440	1762	2461	3120	2196
$M0_2$	83.90	97.22	86.08	88.13	88.83	110.9	165.2	187.6	187.6	162.8	1590	2110	2870	3106	2419
$M0_3$	83.00	87.27	87.73	98.28	89.07	127.6	178.7	226.0	231.8	190.8	1623	2070	3217	3397	2577
$M0_4$	89.69	81.66	97.93	85.56	88.71	155.5	182.0	225.8	197.3	190.1	1651	2228	3158	3294	2583
Mean	82.42	89.52	91.71	88.83		119.4	172.1	200.7	199.6		1576	2043	2926	3229	
Interaction	levels of phosphorus		molybdenum seed treatment		Interaction	levels of phosphorus		molybdenum seed treatment		Interaction	levels of phosphorus		molybdenum seed treatment		Interaction
SEm±	1.25		1.25		2.51	2.7		2.7		5.4	28		28		55
CD (*P 0.05*)	3.62		NS		7.24	7.8		7.8		15.7	80		80		160
	P_1:0 P_2O_5 kg ha^{-1}		P_2:30 P_2O_5 kg ha^{-1}		P_3:60 P_2O_5 kg ha^{-1}	P_4:90 P_2O_5 kg ha^{-1}		Mo_1 – 0g Mo kg^{-1}		Mo_2 – 2g Mo kg^{-1}	Mo_2 – 4g Mo kg^{-1}		Mo_2 – 6g Mo kg^{-1}		

Ali, M.A., A. Ali, M.I. Ahmed, S.W. Hassan, S.R. Khan and A.A. Abid. 2014. Phosphorus effect on growth and yield parameters on mung bean. Sci. Int., 26(4): 1821-1824.

Anwar, S., Z.U. Rehman, B. Saeed, M. Islam, M.O. Kham and J. Ahmad. 2018. Response of mung bean to organic sources and nitrogen levels. Pure Appl. Biol., 7(2): 692-699.

Arif M, Jan MT, Khan NU, Khan A, Khan MJ, Munir I. Effect of seed priming on growth parameters of Soybean. Pakistan Journal of Botany. 2010; 42(4):2803-2812

Endres, J., Barter, S., Theodora, P and Welch, P. (2013). Soybean enhanced lunch acceptance by preschoolers. *Journal of American Dietetic Association. 103:* 346-351

Jabbar, B.K.A and H.M. Saud. 2012. Effects of phosphorus on biological nitrogen fixation in soybean under irrigation using saline water. Glob. J. Sci. Front. Res. Agric. Biol., 12(1): 1-10.

Junji Ishizuka.1982 Characteristics of molybdenum absorption and translocation in soybean plants. *Soil Science and Plant Nutrition*. 28 (1): 63-77

Khan, F.U., A.A. Khan, A. Iqbal, A. Ali, M. Iqbal, M. Alamzeb, M.F. Jan and B. Parmar. 2017. Effect of phosphorus and rhizobium inoculation on yield and yield components of mungbean. J. Pharm. Phytochem., 4(3): 252-258.

Padhi, P.P. and S.K. Pattanayak. 2018. Effect of lime coating and molybdenum seed treatment on nodulation, growth and yield of different pulses. Int. J. Curr. Microbiol. App. Sci., 7(2): 1417- 1426. https://doi.org/10.20546/ijcmas.2018.702.171

Pareek N. Effect of sulphur and molybdenum on growth, yield and quality of cowpea [Vigna unguiculata (l.) walp] under rainfed condition. M.Sc. (Ag.) Thesis, Sri Karan Narendra Agric. Univ., Jobner; c2005.

Pattanayak, S.K., D. Das, M.R. Jena and R.K. Nayak. 2000. Seed treatment of green gram with molybdenum and cobalt: Effect on nodulation, bio-mass production on N uptake in an acid soil. *J. Ind. Soc. Soil. Sci., 48: 769-773.*

Rani, M., P. Ved and K. Khalil. 2016. Response of mung bean to phosphorus, Sulphur and PSB during summer season. Agric. Sci. Digest., 36(2): 146-148. https://doi.org/10.18805/asd.v36i2.10637

Thavarajah, D.,Havarajah, P.S.E.E, C and Vandenberg, A.2010. Phytic acid and Fe and Zn concentration in lentil (*Lens culinaris* L.) seeds is influenced by temperature during seed filling period. *Food Chemistry*.122(1) :254-259.