Yield and economics of soybean as influenced by various levels of nitrogen and phosphorus

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Abstract
A field experiment was conducted at Main Agricultural Research Station, Dharwad on medium black soil during Kharif-2015. There were twelve treatment combinations consisted of three levels of nitrogen (20, 40 and 60 kg N ha\(^{-1}\)) and four levels of phosphorus (40, 60, 80 and 100 kg P\(_2\)O\(_5\) ha\(^{-1}\)). Significantly higher soybean seed yield (25.77 q ha\(^{-1}\)), haulm yield (31.32 q ha\(^{-1}\)), net returns (72438 Rs. ha\(^{-1}\)) and B:C ratio (3.38) recorded with combined application of nitrogen @ 60 kg ha\(^{-1}\) and phosphorus @ 80 kg ha\(^{-1}\) compared to other treatments and it was on par with application of nitrogen @ 60 kg ha\(^{-1}\) and phosphorus @ 100 kg ha\(^{-1}\). Application of nitrogen @ 60 kg, phosphorus @ 80 kg and potash @ 25 kg per hectare found optimum to obtain substantial soybean seed yield.

Keywords: Soybean, nitrogen, phosphorus, yield and economics.

Introduction
Soybean (\(Glycine\) \textit{max} L. Merrill), is an introduced and commercially exploited crop in India. The crop is also called as “Golden Bean” or “Miracle crop” of the 21\(^{st}\) century on account of its multiple uses. It has highest protein 40 \%, oil 20 \%, rich in lysine and vitamins A, B and D and also rich in mineral salts. Among the nutrients; nitrogen is a major essential plant nutrient element. Soybean being a legume crop is capable of fixing atmospheric nitrogen through symbiosis but the symbiotic N-fixation alone is not enough to meet high N-requirement of this crop (Ashour and Thalooth, 1983) \[2\]. Application of small amount of fertilizer N at sowing time as a starter dose for the crop improves the biological nitrogen fixation (BNF). Nitrogen tends primarily to encourage above ground vegetative growth and to impart deep green colour to the leaves. Plants receiving insufficient nitrogen are stunted in growth with restricted root systems. The leaves turn yellow or yellowish green and tend to drop off. Phosphorus stimulates rhizobial activity, nodule formation and thus helps in N\(_2\)-fixation. It increases the water use efficiency, improves storage quality and hardness of the bean seed coat. As phosphorus plays a role in photosynthesis, respiration, energy storage and transfer, cell division and enlargement, it has been shown to be important for growth, development and yield of soybean (Kakar et al., 2002) \[7\]. It helps in uptake of more nutrients and balances the nitrogen deficiency in soil and assists in seed maturation. Thus, it is needed to find out proper amount of nitrogen and phosphorus required for achieving better yield of soybean. Hence, in order to verify and workout the optimum nitrogen and phosphorus dose the present investigation was undertaken.

Material and Methods
The field experiment was carried out at Main Agricultural Research Station, Dharwad, during kharif-2015 to study the "yield and economics of soybean as influenced by various levels of nitrogen and phosphorus"

The experiment was replicated thrice in Randomized Complete Block Design in factorial concept. There were twelve treatment combinations consisted of three nitrogen levels (20, 40 and 60 kg N ha\(^{-1}\)) and four phosphorus levels (40, 60, 80 and 100 kg P\(_2\)O\(_5\) ha\(^{-1}\)). One of the treatment combinations comprised the recommended dose of 40 kg N, 80 kg P\(_2\)O\(_5\) and 25 kg K\(_2\)O per hectare. The soil was medium deep black with pH 7.10. The available N, P\(_2\)O\(_5\) and K\(_2\)O contents were 252, 32.5 and 292.8 kg ha\(^{-1}\), respectively. FYM @ 5 t ha\(^{-1}\) was applied 15 days before sowing of the crop. The gross plot size was 5.0 m \(\times\) 3.6 m and net plot size was 4.8 m \(\times\) 3.0 m.

Seeds were treated using \textit{Rhizobium} and Phosphorus solubilizing bacteria @ 1250 g per hectare. Two seeds per hill were dibbled 5 cm deep in furrows at a spacing of 30 cm x 10 cm. Recommended dose of K\(_2\)O @ 25 kg ha\(^{-1}\) was applied at the time of sowing. N and P\(_2\)O\(_5\) were applied as basal as per the treatments. The crop was harvested at its physiological maturity.
The data was statistically analysed as per the procedure given by Gomez and Gomez (1984) [6].

Results and Discussion
Seed yield and haulm yield
Application of nitrogen @ 60 kg ha$^{-1}$ recorded significantly higher seed yield (24.44 q ha$^{-1}$) and haulm yield (29.75 q ha$^{-1}$) compared to 20 (17.45 and 21.40 q ha$^{-1}$, respectively) and 40 (22.42 and 27.35 q ha$^{-1}$, respectively) kg N ha$^{-1}$. Among the phosphorus levels, application of phosphorus @ 80 kg ha$^{-1}$ recorded significantly higher seed yield (22.57 q ha$^{-1}$) and haulm yield (27.52 q ha$^{-1}$) compared to 60 (20.73 and 25.32 q ha$^{-1}$, respectively) and 40 (19.47 and 23.81 q ha$^{-1}$, respectively) kg P$_2$O$_5$ ha$^{-1}$ however, it was on par with 100 (22.97 and 28.00 q ha$^{-1}$, respectively) kg P$_2$O$_5$ ha$^{-1}$. In combined application of nitrogen @ 60 kg ha$^{-1}$ and phosphorus @ 80 kg ha$^{-1}$ recorded significantly higher seed yield (25.77 q ha$^{-1}$) and haulm yield (31.32 q ha$^{-1}$) compared to other treatment combinations however, it was on par with application of nitrogen @ 60 kg ha$^{-1}$ and phosphorus @ 100 (26.07 and 31.67 q ha$^{-1}$) kg ha$^{-1}$ (Table-1). With respect to harvest index Non-significant difference among treatment combinations noticed. It is mainly attributed to application of nitrogen and phosphorus accelerated the photosynthetic rate leading to more production of carbohydrates, it involved in nodulation and being the constituent of ATP which regulate vital metabolic processes in the plant, helping in root formation and nitrogen fixation results in positive effect on photosynthesis which in turn favors better growth and yield of the crop. These results are in line with the findings of Yadav and Chandel (2010) [11], Sohrabi et al. (2012) [10], Bhattacharjee et al. (2013) [3] and Dhage et al. (2014) [4].

Economics
Application of nitrogen @ 60 kg ha$^{-1}$ recorded significantly higher gross returns, net returns and B:C ratio (97535 ₹ ha$^{-1}$, 67672 ₹ ha$^{-1}$ and 3.26, respectively) compared to 20 (69647, 40287 and 2.37, respectively) and 40 (89470, 59858 and 3.02, respectively) kg N ha$^{-1}$. Among the phosphorus levels, application of phosphorus @ 80 kg ha$^{-1}$ recorded significantly higher gross returns, net returns and B:C ratio (90070 ₹ ha$^{-1}$, 59921 ₹ ha$^{-1}$ and 2.98, respectively) compared to 60 (82730 ₹ ha$^{-1}$, 53656 ₹ ha$^{-1}$ and 2.84, respectively) and 40 (77706 ₹ ha$^{-1}$, 49707 ₹ ha$^{-1}$ and 2.77, respectively) kg P$_2$O$_5$ ha$^{-1}$ however, it was on par with 100 (91697 ₹ ha$^{-1}$ and 60473 ₹ ha$^{-1}$ and 2.93, respectively) kg P$_2$O$_5$ ha$^{-1}$. In combined application of nitrogen @ 60 kg ha$^{-1}$ and phosphorus @ 80 kg ha$^{-1}$ recorded significantly higher gross returns, net returns and B:C ratio (102839 ₹ ha$^{-1}$, 72438 ₹ ha$^{-1}$ and 3.38, respectively) compared to other treatment combinations however, it was on par with application of nitrogen @ 60 kg ha$^{-1}$ and phosphorus @ 100 (72559 ₹ ha$^{-1}$, 102035 ₹ ha$^{-1}$ and 3.31, respectively) kg ha$^{-1}$ (Table-2). These results are in conformity with the findings of Saini and Chogtham (2010) [8], Geeta and Radder (2015) [5], Anon (2011) [1] and Singh et al. (2013) [3].

References


