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B Chandra Sheker
Department of Soil Science and Agricultural Chemistry, College of Agriculture, University of Agricultural Sciences, Dharwad Karnataka, India

BM Radder
Department of Soil Science and Agricultural Chemistry, College of Agriculture, University of Agricultural Sciences, Dharwad Karnataka, India

VB Kuligod
Department of Soil Science and Agricultural Chemistry, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India

YR Aladakatti
Department of Agronomy, AICRP on Cotton, ARS, Dharwad farm, UAS, Dharwad, Karnataka, India

Arigela Kiran
Department of Soil Science and Agricultural Chemistry, University of Mahatma Phule Krishi Vidyapeeth, Rahuri, Mahrastra, India.

Vijay Kumar Didal
Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India

Correspondence
B Chandra Sheker
Department of Soil Science and Agricultural Chemistry, College of Agriculture, University of Agricultural Sciences, Dharwad Karnataka, India

Major Nutrient (N, P, K and S) Uptake of Soybean [*Glycine max* (L.) Merill] Growing Soils in Dharwad Taluk, Karnataka

B Chandra Sheker, Bm Radder, VB Kuligod, YR Aladakatti, Arigela Kiran and Vijay Kumar Didal

Abstract
The present investigation was carried out to study the uptake of major nutrients in soybean growing soils of Dharwad taluk during 2015-16 *kharif* season. For this purpose 51 representative soybean growing soils of Dharwad taluk were selected. The study revealed that major nutrient uptake in below average yield category ranged from 50.15 to 69.82 with a mean value of 64.24, 12.28 to 17.35 with a mean value of 14.87, 41.69 to 54.96 with a mean value of 50.35 and 7.45 to 10.12 with a mean value of 9.21 kg ha^{-1} of nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) respectively. The major nutrient uptake in above average yield category ranged from 72.28 to 81.31 with a mean value of 76.21, 16.66 to 18.55 with a mean value of 17.64, 60.63 to 70.15 with a mean value of 65.82 and 10.34 to 13.52 with a mean value of 11.86 kg ha^{-1} of nitrogen, phosphorus, potassium and sulphur respectively. Positive and significant correlation relationship between nitrogen, phosphorus, potassium and sulphur uptake and grain yield was recorded with the correlation values of 0.943**, 0.717**, 0.981** and 0.986** respectively

Keywords: Nitrogen, Phosphorus, Potassium, Sulphur and Nutrient uptake

1. Introduction
Soybean [*Glycine max* (L.) Merill], was introduced in India during 1960's and is gaining rapid recognition as a highly desirable legume and oil seed crop. Soybean being the "Golden Bean", of the 20th century is a species of legume, native to East Asia, widely grown for its edible bean which has numerous uses. Soybean is described variously as a "miracle bean", "crop of the planet", "God sent golden bean" and "greater bean," etc. The plant is classed as an oilseed rather than a legume by the Food and Agricultural Organization (FAO). It is now the largest oilseed crops in India after groundnut. It grows in varied agro-climatic conditions. An increase in population pressure increased the demand of edible oil greatly in last decade. As a result there is an increase in the area of oil seed crops in the country. Among the oil seed crops, Soybean is largely popularized in recent years in the country as well as in Karnataka. It also enriches the soil through symbiotic N-fixation and its residual nitrogen is about 30-40 kg nitrogen per hectare for succeeding crops (Apeji, 1988) [2]. The soybean contains 40-43 percent protein, 24-26 percent oil content and also consists of high percentage of amino acids which are essential in human nutrition. In addition to this, soybean protein has five per cent lysine, which is deficient in most of the cereals and enriching the cereal flour with soybean improves the nutritive quality. Its oil content belongs to the linolenic unsaturated fatty acid group without cholesterol.

Karnataka is one of the major soybean growing state occupying about 2.470 lakh ha with an annual production of 3.001 lakh MT with the productivity of 1215 kg ha^{-1} (Anonymous, 2014) [1]. In India, major soybean producing states are Madhya Pradesh, Uttar Pradesh, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh and Karnataka. Being an easy care crop, it is widely acceptable by majority of farmers and it gets its preference for all type of soils (Jagdish and Hajare, 1992) [7]. Introduction of soybean has led to a shift in the cropping system from fallow–wheat/ chickpea to soybean–wheat/chickpea system (Jagdish and Singh, 1997) [8].

Nitrogen is an integral component of many compounds, including chlorophyll and enzymes, essential for plant growth processes. It is an essential component of amino acids and related proteins. Nitrogen is essential for carbohydrate use within plants and stimulates root growth and development as well as the uptake of other nutrients. This element encourages above

ground vegetative growth and gives a deep green color to the leaves (Brady, 1990) [4]. Nitrogen, phosphorus, and potassium have great effects in plant growth and development. Their deficiencies or excesses result in marked effects on the growth and yield of crops. Nitrogen is a chlorophyll component, and it promotes vegetative growth and green colouration of foliage (Jones, 1983) [10]. Phosphorus plays a major role in photosynthesis, respiration, energy storage, cell division, and maturation. Potassium is important in plant metabolism, protein synthesis, and chlorophyll development (Remison, 2005) [12]. Sulphur is essential for synthesis of proteins, vitamins and sulphur containing essential amino acids and is also associated with nitrogen metabolism. The good yield of soybean can be achieved by balanced and adequate supply of phosphate, sulphur and other deficient, nutrients (Dhage *et al.* 2014) [6].

2. Materials and Methods

2.1 Location of the study area:

The study area is Dharwad *taluk* in Dharwad district, Karnataka. The study area lies between 15^0 21' to 15^0 31' N latitude and 74^0 48' to 75^0 9' E longitude. The location of study the area is presented in Figure 1**.** The study area is situated in Northern Transitional Zone (Zone-8) of North Karnataka. The location of soil samples in selected villages of Dharwad taluk are presented in Figure 2. The area receives a mean annual rainfall of 716.2 mm.

2.2 Preparation of plant sample

The five plant samples collected for estimating the dry matter production and nutrient uptake from each field at peak flowering stage (55-60 DAS), samples were thoroughly washed with distilled water and dried in hot air oven at 65 °C. Dried samples were powdered in a Willey mill to considerable fineness before storing them in polythene bags for further analysis.

2.3 Total nitrogen (N) content (%)

The per cent nitrogen content of the plant samples was estimated by micro Kjeldahl distillation method (Tandon, 1998) [13] after digesting the sample with concentrated H_2SO_4 and presence digestion mixture ($CuSO_4$ + K_2SO_4 + Selenium powder).

2.4 Digestion of plant samples

Powdered plant samples were treated with concentrated HNO_3 overnight for pre digestion. Then, the pre-digested samples were treated with a di-acid mixture (HNO_3:$HClO_4$) (10:4) and digested on a sand bath till colourless white precipitate was obtained. The residue was dissolved in 6N HCl, filtered and then the content was made to a known volume by using 6N HCl. This digest was used for further nutrient analysis.

2.5 Total phosphorus

Phosphorus in digested plant samples was determined by vanado molybdo phosphoric yellow colour method (Tandon, 1998) [13] using spectrophotometer at 470 nm wavelength.

2.6 Total potassium

Potassium in the di-acid digested was estimated with the help of flame photometer after appropriate dilution (Tandon, 1998) [13].

2.7 Total sulphur

Sulphur in the di-acid digested was estimated by turbidimetric method as outlined by (Tandon, 1998) [13].

2.8 Nutrient uptake studies

The major nutrient uptake by soybean crop at flowering stage was worked out by using following formula.

$$\text{Major nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient content (\%)} \times \text{Dry matter yield (kg ha}^{-1})}{100}$$

2.9 Crop cutting experiment on the fields of selected farmers

Crop cutting experiment from the selected farmers fields were carried out. In each of the fields at the time of harvest in area of 3 × 3 m was selected randomly at three different spots. Plants were uprooted in the selected area and pods were separated from plants, yields were recorded by taking average from all the three spots and expressed in quintals per hectare. Average grain yield of these fifty one fields was calculated. Based on this average grain yield, these fifty one fields were divided into below average yield category and above average yield category.

3. Results and Discussion

3.1 Nutrient uptake studies

3.1.1 Nitrogen

At flowering stage, the nitrogen uptake in below average yield category ranged from 50.14 to 69.81 kg ha^{-1} with a mean value of 64.24 kg ha^{-1} and standard deviation of 5.271 (Table 1). In above average yield category it ranged from 72.28 to 81.30 kg ha^{-1} with a mean value of 76.21 kg ha^{-1} and standard deviation of 2.691 (Table 1). The mean nitrogen uptake in below average yield category was found to be lower than above average yield category.

This higher nitrogen uptake by the soybean plants in above average yield category plants may be due to higher organic matter status in these soils that led to slow breakdown of nitrogenous compounds making steady supply of nitrogen throughout the growth period. Chavan *et al.* (1997) [5] reported that higher nitrogen uptake was recorded in those soils, which were having sufficient organic matter status. The variation in nitrogen uptake by plants in different soils is attributed to variation in nitrogen status along with moisture and organic matter content of the soils.

3.1.2 Phosphorus

Phosphorus uptake by plants in below average yield category ranged from 12.27 to 17.35 kg ha^{-1} with a mean value of 14.87 kg ha^{-1} and standard deviation of 1.455 (Table 1). In above average yield category it ranged from 16.65 to 18.54 kg ha^{-1} with a mean value of 17.64 kg ha^{-1} and standard deviation of 0.580 (Table 1). The mean phosphorus uptake in below average yield category was found to be lower than above average yield category.

The higher mean phosphorus uptake by plants of above average yield category is mainly attributed to sufficient quantity of available soil phosphorus. Bidari (2000) [3] reported that uptake of phosphorus varied with location, cultivation practices followed by farmers particularly the quantum of fertilizers and manures applied.

3.1.3 Potassium

The uptake of potassium in below average yield category ranged from 41.68 to 54.95 kg ha^{-1} with a mean value of 50.45 kg ha^{-1} and standard deviation of 3.785 (Table 1). The potassium uptake by plants in above average yield category it ranged from 60.63 to 70.15 kg ha^{-1} with a mean value of 65.82 kg ha^{-1} and standard deviation of 3.048 (Table 1). The mean potassium uptake in below average yield category was found to be lower than above average yield category.

Though, the soils in both below average and above average yield categories were medium to high in available potassium status. Higher potassium uptake by soybean plants of above average yield category might be due to sufficient phosphorus supply. The interaction between phosphorous and potassium is synergistic. Since available phosphorous and potassium status of soils of above average yield category was medium to high, there was higher potassium uptake recorded in this category. Higher dry matter accumulation in plants of above average yield category may be another reason for higher N, P and K uptake. Higher available soil phosphorous and potassium increases the uptake of potassium at all stages of plant growth (Jain and Dixit, 1987) [9].

3.1.4 Sulphur

The sulphur uptake by soybean plants in below average yield category varied from 7.45 to 10.12 kg ha^{-1} with a mean value of 9.21 kg ha^{-1} and standard deviation of 0.836 (Table 1). The sulphur uptake by plants in above average yield category ranged from 10.34 to 13.52 kg ha^{-1} with a mean value of 11.86 kg ha^{-1} and standard deviation of 1.069 (Table 1). This is attributed to sufficient level of available sulphur content in the soils of above average yield category. Pradeep *et al.* (2006) [11] reported that higher sulphur uptake in above average yield category fields than below average yield category fields.

4. Correlation between nutrient uptake by soybean plant at flowering stage and grain yield:

Positive and significant correlation relationship between nitrogen, phosphorus, potassium and sulphur uptake and grain yield was recorded with correlation values of 0.943**, 0.717**, 0.981** and 0.986** respectively (Table 2).

5. Conclusion

All major nutrient uptake in above average yield category was found to be higher than that of below average yield category, it might be due to the higher nutrient status in the soils of above average yield category. The higher nutrient uptake may be also due to the higher dry matter production in the soils of above average yield category than below average yield category.

Table 1: Uptake of major nutrients by soybean crop at flowering stage of below and above average yield category

	Nitrogen	Phosphorus	Potassium	Sulphur
	kg ha^{-1}			
Below average yield category				
Minimum	50.15	12.28	41.69	7.45
Maximum	69.82	17.35	54.96	10.12
Mean	64.24	14.87	50.45	9.21
Standard deviation	5.271	1.455	3.785	0.836
Above average yield category				
Minimum	72.28	16.66	60.63	10.34
Maximum	81.31	18.55	70.15	13.52
Mean	76.21	17.64	65.82	11.86
Standard deviation	2.691	0.580	3.048	1.069

Note: Average Soybean crop yield - 14.67 q ha^{-1}

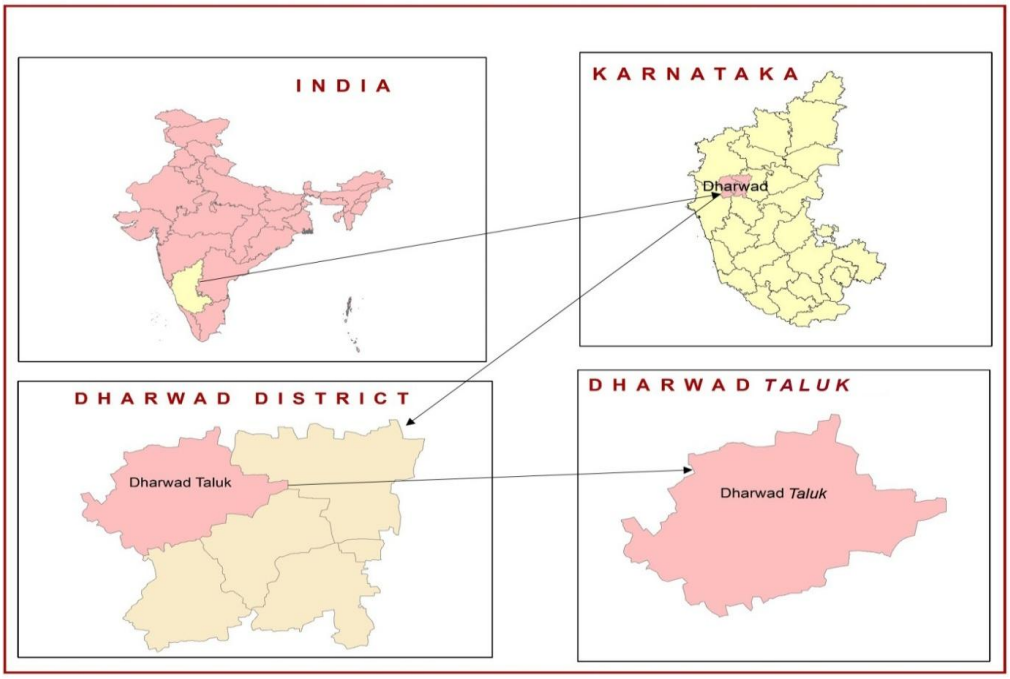

Fig 1: Location of study area

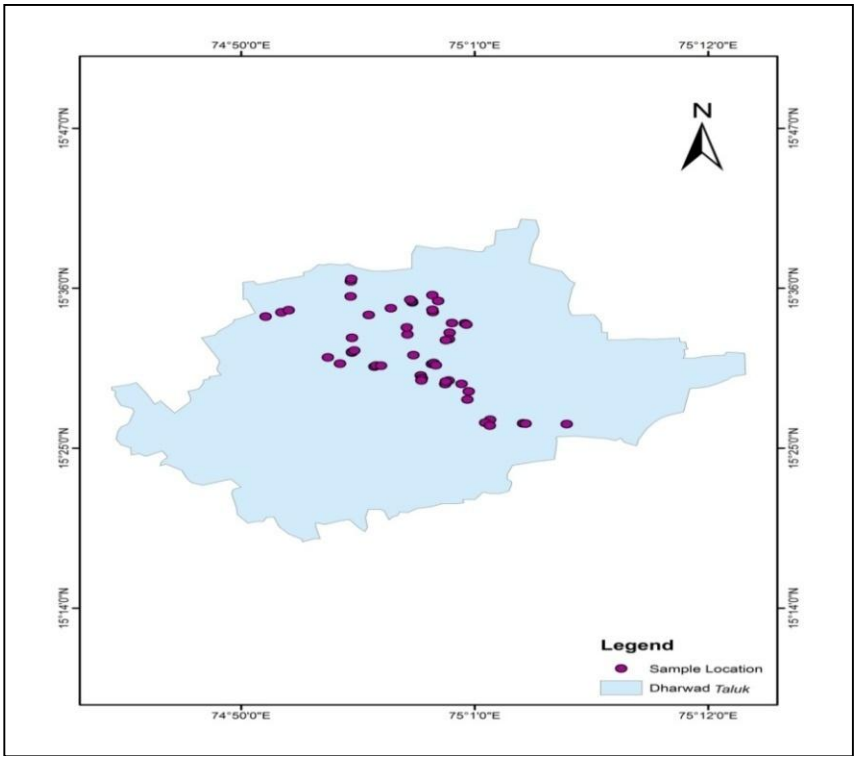

Fig 2: Location of soil samples in Dharwad taluk

Table 2: Correlation coefficients between major nutrients uptake by crop and yield

	Yield	N	P	K	S
Yield	1				
N	0.943**	1			
P	0.717**	0.697**	1		
K	0.981**	0.937**	0.759**	1	
S	0.986**	0.920**	0.725**	0.967**	1

**. Correlation is significant at the 0.01 level *. Correlation is significant at the 0.05 level

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