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INFLUENCE OF VARIETIES AND CROP GEOMETRIES ON NUTRIENT CONTENT AND NUTRIENT UPTAKE OF NPK IN SOYBEAN (*GLYCINE MAX* (L.) MERRILL.)

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Abstract–A field experiment was conducted at College farm, Agricultural College, Polasa, Jagtial, PJTSAU, during the *kharif* season of 2018 to study the **"**Evaluation of varieties at varied crop geometry for yield maximization in soybean**".** The experiment was laid out in split-plot design with three replications to evaluate the performance of promising varieties of soybean (V_1- Basar, V_2- JS 335, V_3- KDS 756 and V_4- MACS 1281) and to standardize the crop geometry for Soybean varieties (S_1-45x10 cm, S_2-30x10 cm, S_3- 45 x 05 cm and S_4- 35 x 05 cm) under rainfed semi arid conditions of Telangana. Crop was shown on 03 July, 2018 at varied crop geometry and each variety was harvested according to their duration as variety KDS756 and JS335 were harvested at 95 DAS while MACS 1281 at 98 DAS and Basar was harvested at 103DAS respectively. The experimental soil was sandy clay loam in texture, slightly alkaline in reaction, medium inorganic carbon, low in available nitrogen, high in available phosphorus and available potassium. The results indicated that NPK content was found to have no significance due to varieties and crop geometry in seed and straw but NPK uptake was significantly higher with variety KDS 756 compared to rest of the varieties. NPK uptake was higher under crop geometry 30 x 10 cm which was at par with 45x05 cm and lowest at 45x10 cm which was mainly due to yield compensation at narrow geometry by higher plants per unit area.

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill.) is an important legume crop which provides vegetable protein for millions of people and several ingredients for different food products. It is often designated as wonder crop, is an important pulse as well as oil seed crop of the world. It is a legume crop belongs to family Leguminaceae and sub-family Papillionaceae. It has the ability to fix atmospheric nitrogen with the help of root nodule and also it adds organic matter to the soil, thereby increasing the productivity of soil.

It is a major legume crop recognized as an efficient producer of two scarce nutritional resources, i.e. high quality protein (40 to 42%) and oil 20% which are not only major component in the diet of vegetarian mass but also a boon to the developing countries so, it is referred as miracle crop of 21st century. It is a good source of is flavones and therefore helps in preventing heart diseases and cancer (Balasubramaniyan and Palaniappan, 2003). It has established its potential as an industrially and economically valuable oilseed crop in the world. Because of its high nutritional value and its varied form of uses, it is recognized as 'Golden Bean'. Now a days, the commercial use of soybean is also increased by producing soya food like soya meal, soya milk, bakery items, pharmaceuticals, cosmetics and other industrial products like oil, paint, varnishes, linoleum, rubber etc. is also being made. It is also a good source of cattle feed.

The major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Telangana and Andhra Pradesh. it grows in tropical, sub tropical and temperate climates. It is generally grown under rainfed conditions. Increase in seed yield of soybean can be achieved by the adoption of suitable variety, proper geometry of planting, improved agronomic practices and avoidable soil moisture stress at the critical growth period. Varieties play a unique role in maximization of yield by improving the fertilizer-use efficiency and water-use efficiency. Thus, the selection of suitable variety of soybean is of prime importance as the genetic potential of a variety limits the expression of its yield and affects plant growth in response of varying environmental condition.

The optimum number of plants per unit area is one of the important parameter in increasing the crop productivity. The optimum plant density with proper geometry of planting is dependent on variety, its growth habit and agro-climatic conditions. The competition for resources like nutrients, light, moisture and carbon di-oxide may be optimized by suitable geometry of plants. Hence, crop geometry and varieties are considered as main factors of crop production.

The present study is proposed to evaluate the varieties and crop geometry levels for achieving the higher yield of soybean with the following objectives.

MATERIALS AND METHODS

A field experiment was conducted at College farm, Agricultural College, Polasa, Jagtial, PJTSAU, during the *kharif* season of 2018 in split plot design with three replications. To evaluate the performance of promising soybean varieties, namely (V_1- Basar, V_2- JS 335, V_3- KDS 756 and V_4- MACS 1281) and to standardize the crop geometry for promising soybean varieties (S_1- 45 x 10 cm, S_2- 30 x 10 cm, S_3- 45 x 05 cm and S_4- 35 x 05 cm) under rainfed semi-arid conditions of Telangana. The experimental soil was sandy clay loam with pH 7.4, medium in organic carbon (0.5%), low in available nitrogen (247.3 kg ha^{-1}), high in available phosphorus (23.05 kg ha^{-1}) and potassium (326.8 kg ha^{-1}). The crop was supplied with recommended dose of fertilizer, i.e. 60 kg N, 60 kg P_2 O_5 and 40 kg K_2Oha^{-1}, through urea, single super phosphate and muriate of potash respectively.

Crop was shown on on 3^{rd} July, 2018 at varied geometry levels and each variety was harvested according to their duration as variety KDS 756, JS 335 was harvested at 95 DAS while MACS 1281 at 98 DAS and Basar was harvested at 103 DAS respectively. The observations were recorded on pH, E C, OC, at intial and final harvest. Available nitrogen content of the soil was estimated by alkaline permanganate method (Subbiah and Asija, 1956) and it is expressed in (kg ha^{-1}). Available phosphorous was extracted from soil by Olsen's extractant (0.5 N NaHCO3 with pH 8.5). The phosphorous content in the extract was determined by ascorbic acid method (Olsen, 1954). The intensity of color was measured with spectrophotometer at 420 nm and was expressed in P (kg ha^{-1}). Available potassium was extracted from the soil using neutral normal ammonium acetate in 1:5 ratio and the readings were measured using flame photometer (Jackson, 1967).

NPK uptake in Plant and seed samples collected for recording dry matter estimation at harvest were ground and digested for chemical analysis. The nitrogen content in dry matter samples were estimated by modified Micro Kjeldal method after digesting the powdered plant sample with H_2SO_4 and H_2O_2 (Piper, 1966). Phosphorus and potassium contents were determined in the triacid extracts after digesting the plant material with triacid mixture of 9:4:1 (HNO_3:H_2SO_4:$HClO_4$) (Piper, 1966). The phosphorus content in the plant was determined by Vanadomolybdo phosphoric yellow colour method using Calorimeter (Jackson, 1967) and potassium content was determined using Flame Photometer (Piper, 1966). The nitrogen (N), phosphorus (P) and potassium (K) contents thus obtained were expressed in percentage. The uptake of N,P and K by the crop was computed and expressed in $kgha^{-1}$as follows:

$$\text{Uptake of nutrient (kgha}^{-1}) = \frac{\text{Nutrient content (\%)}}{100} \times \text{Yield (kgha}^{-1})$$

RESULTS AND DISCUSION

Nutrient analysis in soil and plant

Physico-chemical properties of soil at harvest

Data on pH, EC and OC (%) was collected after harvest of soybean crop and presented in Table 1. A perusal of the same indicated that the above parameters (pH, E.C and O.C) did not change after harvest of the crop. The soils were noticed to be slightly alkaline in reaction and medium in organic carbon. It was found no significant among the varieties, crop geometry and in their interaction.

Available NPK in soil at harvest

Available NPK of soil was significantly influenced

Table 1. Physico-chemical properties of the soil in the experimental plot

Properties	values	Methods used
Soil texture	Sandyclayloam	Bouyoucos Hydrometer method (Piper,1966)
Sand (%)	65.86	
Silt (%)	6.36	
Clay (%)	27.76	
Chemical components		Methods used
pH	7.41	Make-Elico,Model-LI612 pH analyser (Jackson, 1967)
Electrical conductivity (dSm^{-1})	0.49	SYSTRONICS Conductivity TDS meter308 (Jackson, 1967)
Organiccarbon (%)	0.53	Walkley and Black rapid titration method (Piper, 1966).
Available Nitrogen ($kgha^{-1}$)	247.5	Alkaline permanganate method using KELPLUSSUPRA LX – analyser (Subbaiah and Asija, 1956)
Available P_2O_5 ($kgha^{-1}$)	23.05	Olsen's method for extraction and Ascorbic acid method for estimation by using UV-VIS spectrophotometer (Make-systronics, Model-108)at420 nm (Olsen's *et al*., 1954)
AvailableK_2O ($kgha^{-1}$)	326.84	Neutralnormal ammoniumacetate methodusing (Make-Elico, Model- CL361), Flamephotometer (Piper, 1966)

by varieties and crop geometry (Table 3). Available nitrogen was higher with variety JS 335 (241.2 kg ha^{-1}) which was followed by MACS 1281 (231.6 kg ha^{-1}), Basar (228 kg ha^{-1}) and KDS 756 (197.3 kg ha^{-1}). While available phosphorus was higher with variety JS 335 (18.4 kg ha^{-1}) was at par with MACS 1281 (16.4 kg ha^{-1}) which was in turn at par with Basar (15.7 kg ha^{-1}). Basar was at par with KDS 756 (15.5 kg ha^{-1}). Available potassium of MACS 1281 (305.5 kg ha^{-1}) was at par with Basar (303.6 kg ha^{-1}). Higher uptake of nutrients was due to higher dry matter accumulation in respective varieties.

Among the geometry levels, available NPK was significantly higher under wider spacing compared to closer spacing. However, available nitrogen recorded was higher under 45 x 10 cm (227.2 kg ha^{-1}) which was at par with 30 x 05 cm (225.7 kg ha^{-1}) which was in turn at par with 45 x 05 cm (224.2 kg ha^{-1}). 45 x 05 cm was at par with 30 x 10 cm (221.1 kg ha^{-1}). Available phosphorus of 45 x 05 cm (15.9 kg ha^{-1}) was at par with 30 x 10 cm (15.7 kg ha^{-1}). Available potassium was significantly higher under 45 x 10 cm compared to other geometries. Higher N, P and K content in soil indicates less uptake by the plants in respective geometry levels that leads to low seed yield.

N, P and K uptake at flowering

NPK uptake was significantly influenced by varieties and crop geometry (Table 4). Nitrogen uptake was higher with variety KDS 756 (113.5 kg ha^{-1}) which was at par with Basar (110.8 kg ha^{-1}) which was in turn at par with MACS 1281 (107.9 kg ha^{-1}). Lowest uptake was noticed by JS 335 (98.8 kg ha^{-1}). Phosphorus uptake was higher with variety KDS 756 (16.9 kg ha^{-1}) and was at par with Basar (16.4 kg ha^{-1}). Potassium uptake was higher with variety KDS 756 (60.2 kg ha^{-1}) and was followed by Basar (57.1 kg ha^{-1}), MACS 1281 (54.9 kg ha^{-1}) and JS 335 (52.9 kg ha^{-1}). This was due to higher seed yield of respective varieties which ultimately resulted in higher nutrient uptake.

Among the geometry levels, NPK uptake was significantly higher under medium spacing compared to wider spacing. However, highest N uptake was recorded under 30 x 10 cm (110.8 kg ha^{-1}) which was at par with 45 x 05 cm (109.2 kg ha^{-1}). Spacing of 30 x 05 cm (106.2 kg ha^{-1}) was at par with 45 x 10 cm (104.8 kg ha^{-1}). Phosphorus uptake was higher with spacing of 30 x 10 cm (17.4 kg ha^{-1}) which was at par with 45 x 05 cm (15.9 kg ha^{-1}). Potassium uptake was significantly higher under 30 x 10 cm compared to other geometries. It was due to higher N, P and K content in seed and also due to higher seed yield with medium spacing (30 x 10 cm). These results were in accordance to Yadav *et al.* (1991).

The interaction between varieties and crop geometry was found no significant on NPK uptake at flowering.

N, P and K uptake at harvest

NPK uptake was significantly influenced by varieties and crop geometry and was presented in Table 5. Variety KDS 756 (136.2, 18.4 and 42.2 kg ha^{-1}) produced significantly higher NPK uptake which was followed by Basar (127.4, 16.9 and 40.4 kg ha^{-1}), MACS 1281 (124.6, 15.9 and 38.5 kg ha^{-1}) and JS 335

(118.5, 14.1 and 37.4 kg ha^{-1}). This was due to higher seed yield of respective varieties which ultimately resulted in higher nutrient uptake.

Among the geometry levels NPK uptake was significantly higher with spacing of 30 x 10 cm compared to wider spacing (45 x 10 cm). However, highest N uptake was recorded under 30 x 10 cm (129.2 kg ha^{-1}) while P and K uptake was significantly higher under 30 x 10 cm (18.2 and 41.7 kg ha^{-1}) compared to other geometries. It was due to higher N, P and K content in seed and also due to higher seed yield with medium spacing 30 x 10 cm. These results were in accordance to Yadav *et al*. (1991).

The interaction between varieties and crop geometry was non significant on NPK uptake at harvest.

Initial soil fertility level of soybean

pH	EC	OC	N	P_2O_5	K_2O
7.3	0.4	0.5	247.5	23.4	325.8

Table 2. pH, EC and OC of soil after harvest of soybean as influenced by varieties and crop geometry

Treatments	pH	EC	OC
Mainplots: Varieties			
V_1:Basar	7.4	0.5	0.5
V_2:JS 335	7.4	0.5	0.5
V_3:KDS 756	7.4	0.4	0.5
V_4:MACS1281	7.4	0.5	0.6
S.Em±	0.04	0.02	0.01
CD(P=0.05)	NS	NS	NS
Subplots: Cropgeometry (cm)			
S_1: 45 × 10	7.4	0.4	0.5
S_2: 30 × 10	7.3	0.5	0.5
S_3: 45 × 05	7.4	0.4	0.5
S_4: 30 × 05	7.4	0.5	0.5
S.Em±	0.04	0.01	0.02
CD(P=0.05)	NS	NS	NS
Interaction V×S			
S.Em±	0.08	0.03	0.04
CD(P=0.05)	NS	NS	NS
Interaction S ×V			
S.Em±	0.09	0.04	0.04
CD(P=0.05)	NS	NS	NS

CONCLUSION

From the above studies it concluded that among the varieties tested NPK content and plant uptake of nutrients was higher with KDS 756 and was followed by Basar. It can be inferred that these

Table 3. Available N, P_2O_5, K_2O of soil at harvest stages of soybean as influenced by varieties and crop geometry.

Treatments	Available nutrient(kg ha^{-1})		
	N	P	K
Mainplots: Varieties			
V_1: Basar	228.0	15.7	303.6
V_2: JS 335	241.2	18.4	312.9
V_3: KDS 756	197.3	15.5	300.3
V_4: MACS1281	231.6	16.4	305.5
S.Em±	1.4	0.6	0.7
CD(P=0.05)	4.9	2.0	2.3
Subplots: Cropgeometry (cm)			
S_1: 45 × 10	227.2	17.7	308.1
S_2: 30 × 10	221.1	15.7	303.2
S_3: 45 × 05	224.1	15.9	304.8
S_4: 30 × 05	225.7	16.5	306.2
S.Em±	1.3	0.2	0.4
CD(P=0.05)	3.8	0.5	1.2
Interaction V×S			
S.Em±	2.7	0.6	1.0
CD(P=0.05)	NS	NS	NS
Interaction V×S			
S.Em±	2.8	1.1	1.3
CD(P=0.05)	NS	NS	NS

Table 4. NPK plant uptake (kgha^{-1}) at flowering stage of soybean as influenced by varieties and crop geometry

Treatments	Plant uptake (kg ha^{-1})		
	N	P	K
Mainplots: Varieties			
V_1:Basar	110.8	16.4	57.1
V_2:JS 335	98.8	13.4	52.9
V_3:KDS 756	113.5	16.9	60.2
V_4:MACS1281	107.9	15.3	54.9
S.Em±	1.0	0.3	0.2
CD(P=0.05)	3.4	0.9	0.6
Subplots: Crop geometry (cm)			
S_1: 45 × 10	104.8	14.2	54.0
S_2: 30 × 10	110.8	17.4	58.7
S_3: 45 × 05	109.2	15.9	57.0
S_4: 30 × 05	106.2	14.6	55.5
S.Em±	0.92	0.2	0.3
CD(P=0.05)	2.72	0.7	0.8
Interaction V×S			
S.Em±	1.9	0.5	0.5
CD(P=0.05)	NS	NS	NS
Interaction S ×V			
S.Em±	1.9	0.5	0.3
CD(P=0.05)	NS	NS	NS

Table 5. NPK Plant uptake (kg ha^{-1}) at harvest stage of soybean as influenced by varieties and crop geometry

Treatments	Plant uptake (kg ha^{-1})		
	N	P	K
Mainplots: Varieties			
V_1:Basar	127.4	16.9	40.4
V_2:JS 335	118.5	14.1	37.4
V_3:KDS 756	136.2	18.4	42.2
V_4:MACS1281	124.6	15.9	38.5
S.Em±	0.6	0.2	0.3
CD(P=0.05)	1.9	0.9	1.0
Subplots: Crop geometry (cm)			
S_1: 45 × 10	124.1	15.20	37.7
S_2: 30 × 10	129.2	18.2	41.7
S_3: 45 × 05	127.7	16.7	40.2
S_4: 30 × 05	125.6	15.5	38.8
S.Em±	0.3	0.2	0.3
CD(P=0.05)	1.0	0.7	0.8
Interaction V×S			
S.Em±	0.8	0.5	0.5
CD(P=0.05)	NS	NS	NS
Interaction S×V			
S.Em±	1.1	0.5	0.5
CD(P=0.05)	NS	NS	NS

varieties are well suited to semiarid rainfed area of Telangana. Under crop geometry of 30 x 10 cm which gave highest NPK content and uptake of nutrient and lowest at 45x10 cm which was mainly due to yield compensation at narrow geometry by higher plants per unit area.

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