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INFLUENCE OF SITE SPECIFIC NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF SOYBEAN IN NORTH EASTERN TRANSITIONAL ZONE OF KARNATAKA

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ABSTRACT

The target yield levels based on site specific nutrient managemnt for soybean genotypes, the treatment, JS 335 with target yield of 3.0 t ha^{-1} recorded significantly higher seed yield (3195 kg ha^{-1}) due to higher yield parameters such as number of pods plant^{-1} (62.61), pod weight (47.24 g plant^{-1}), seed yield (44.00 g plant^{-1}) and hundred seed weight (14.10) and growth parameters *viz*., plant hieght (58.70 cm), number of branches (5.44) and leaf area duration (70.26 days) at harvest as compared to JS 335 with farmers practice respectively. The SSNM technology may be the appropriate approach for optimum nutrient supply which improves the soil properties especially the soil health and productivity in a long run in comparison to other nutrient management technologies. It was inferred from the study that the target yield of 3.0 t ha^{-1} was significantly superior than other treatments.

INTRODUCTION

Soybean (*Glycine max* L.) is the one of the important pulse cum oil seed crop among all the seed crops. It has been termed as miracle bean because of higher protein (40%) and oil (20%) content. It is richest, cheapest and easiest source of best quality protein and fats and having a multiplicity of uses as food and industrial products therefore it is called "Wonder crop". Due to atmospheric nitrogen fixation in the soil to maintain the soil fertility and consequently beneficial effects on successive crops the crop is also called "Golden bean" or "Gold of soil". In India it is cultivated in 12.20 m ha with annual production of 11.99 m t and productivity of 983 kg ha^{-1}. Karnataka contributes 0.23 m ha with a production of 0.25 lakh m t with productivity of 1129 kg ha^{-1},(Anonymous 2015). The existing fertilizer recommendation for soybean often consists of fixed rates and timing of N, P and K for vast areas of production. Such recommendations are constant over the years over large areas. But crop growth and crop need for supplemental nutrients are strongly influenced by crop growing conditions, crop and soil management and climate which can vary greatly among field, season and year (Singh *et al*., 2015 and Umesh *et al*., 2014). The SSNM (site specific nutrient management) approach does not significantly aim to either reduce or increase fertilizer use. Instead, it aims to apply nutrients at optimal rates and times in order to achieve high yield and high efficiency of nutrient use by the crop, leading to high cash value of the harvest per unit of fertilizer invested (Shankar and Umesh, 2008). Considering the fertilizer cost and availability, this limited resource needs to be saved for sustainable crop production through improving the nutrient use efficiency by site specific application. The concept of site specific nutrient management (SSNM) for crop emerged in the mid-1990s. Site-specific nutrient management (SSNM) is a set of scientific principles for optimally supplying essential nutrients (Umesh *et al*., 2014). We need SSNM mainly for increasing nutrient use efficiency and profitability. Therefore, an experiment was conducted with the objective to study the effect of different target yield on soybean yield.

MATERIALS AND METHODS

The experiment was conduct at Agricultural Research Station, Janawada, Bidar to study the influence of site specific nutrient management on soybean (*Glycine max* L.) in north eastern transitional zone of Karnataka during *kharif* 2014 and 2015. Survey was conducted in surrounding villages of experimental site with 25 farmers growing soybean for their nutrient management (Singh *et al*., 2015). Based on their nutrient management practices, average quantity of fertilizers for farmer's practice treatment was worked out. The amount of fertilizer for SSNM treatments was calculated by using the formulae of IPNI web site (Doberman *et al*., 2004). FA = Nutrient uptake by crop per tonne grain yield $\times$ T ,Where,T = Targeted yield (t ha^{-1}). The composite soil samples from each treatment at 0-15 cm depth was collected and analyzed before the initiation of experiment during *kharif* 2014 and *kharif* 2015. The nutrient statuses of soils are mentioned in the Table 1. Nutrient removal by soybean crop per tonne seed yield was 75, 16.4, 39.0 NPK kg ha^{-1} (IPNI website) (Doberman *et al*., 2004). The nutrient ratings for soil available nutrient status are as below. If soil nutrient status was medium, apply exactly removal quantity, if soil nutrient status was low, apply 30 % more and if soil nutrient status was high, apply 30 % less. The available soil nutrient status of the soil before sowing of soybean during *kharif* 2014 and 2015 were low in nitrogen, medium in phosphorous and high in potash. The calculated fertilizer doses for different target yield of soybean are given in the Table 2. Fifty per cent of nitrogen through Urea and entire quantity of phosphorus through DAP (Diammonium Phosphate) and potassium through MOP (Murate of Potash) were supplied at the time of sowing as a basal dose to each plot and remaining 50 per cent of nitrogen was applied at 30 days after sowing. The soil samples were analyzed by adopting standard procedures (Nitrogen - Subbaiah and Assija method (1956), Phosphorus - Olsen *et al.* (1954), Potassium - Jackson (1973).The soil was medium deep black, neutral in reaction. The experiment was laid out in randomized block design with the eleven treatment and three replications. The data was analyzed statistically for test of significance following the procedure described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of target yield on growth parameters

Plant height of soybean differed significantly due to different target yield levels in their pooled data. At harvest, pooled mean indicated that significantly higher plant height (58.70 cm) was recorded with JS 335 with target yield of 3.0 t ha^{-1} which was on par with DSB 21 with target yield of 3.0 t ha^{-1} (56.03 cm), DSB 21 with target yield of 2.0 t ha^{-1} (43.39 cm) and JS 335 with target yield of 2.0 t ha^{-1} (45.01 cm) recorded significantly lower plant height among the different target yield levels. The treatment JS 335 with farmer's practice noticed significantly lower plant height (31.80 cm). The number of branches $plant^{-1}$ were higher with JS 335 with target yield of 3.0 t ha^{-1} (5.44) which was on par with DSB 21 with target yield of 3.0 t ha^{-1} (5.19). Significantly lower numbers of branches were recorded in DSB 21 with target yield of 2.0 t ha^{-1} (4.02) among different target yield levels. It was JS 335 with farmer's practice which noticed significantly lower number of branches $plant^{-1}$ (2.95) in their pooled data. Different target yield levels influenced the leaf area duration significantly during 30-60 DAS in their pooled mean. Among the different target yield levels, significantly higher leaf area duration was noticed in JS 335 with target yield of 3.0 t ha^{-1} (70.26 days) during both the years of investigation but was found to be on par with DSB 21 with target yield of 3.0 t ha^{-1} (67.05 days). The treatment JS 335 with farmer's practice recorded significantly lower leaf area duration (38.06 days) (Table 3). The nutrient might have played a potent role on enhanced cell division and elongation of leaves resulting in higher biomass (Singh *et al.*, 2015). Better crop growth in this treatment might have lead to the production of higher number of leaves and inturn enhanced leaf area (Suri and Sarita 1996). Further, this has resulted in increased LAD which is indicative of high mobilizable protein pools available at the beginning of the reproductive phase and later on greater plant bearing capacity. Similar results have been reported by Kumar *et al*. (2014) in maize and Prakash *et al*. (2014).

Effect of target yield on yield parameters

The JS 335 with target yield of 3.0 t ha^{-1} (62.61) recorded significantly higher number of pods $plant^{-1}$ as compared to rest of the target yield treatments but was on par with DSB 21 with target yield of 3.0 t ha^{-1} (58.56) and DSB 21 with target yield of 2.0 t ha^{-1} (44.75) and JS 335 with target yield of 2.0 t ha^{-1} (47.23) recorded significantly lower number of pods among the different target yield levels. Significantly lower numbers of pods were recorded with JS 335 with farmer's practice (33.02) among all the treatments. The pod weight $plant^{-1}$ and seed yield $plant^{-1}$ varied significantly due to different target yield. Among the different target yield levels, pod weight $plant^{-1}$ and seed yield $plant^{-1}$ were significantly higher in JS 335 with target yield of 3.0 t ha^{-1} (47.24 g $plant^{-1}$ and 44.00 g $plant^{-1}$, respectively) over rest of the treatments but it was on par with DSB 21 with target yield of 3.0 t ha^{-1} (45.09 g $plant^{-1}$ and 41.15 g $plant^{-1}$, respectively) and significantly lower pod weight was noticed in DSB 21 with target yield of 2.0 t ha^{-1} (34.91 g $plant^{-1}$ and 31.45 g $plant^{-1}$, respectively) and JS 335 with target yield of 2.0 t ha^{-1} (36.22 g $plant^{-1}$ and 33.19 g $plant^{-1}$, respectively). Significantly lower pod weight and seed yield (25.59 g $plant^{-1}$ and 23.20 g $plant^{-1}$, respectively) was recorded with JS 335

Table 1: The nutrient status of soil (kg ha^{-1}) before sowing of soybean during *kharif*, 2014 and 2015

Treatments	RI						RII						RIII					
	Kharif, 2014			*Kharif*, 2015			*Kharif*, 2014			*Kharif*, 2015			*Kharif*, 2014			*Kharif*, 2015		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
T_1	238	21.4	385	242	22.4	372	240	20.7	382	246	20.8	375	244	20.8	384	243	22.6	371
T_2	263	22.6	397	250	22.3	386	268	21.7	392	254	21.9	386	264	21.8	385	251	24.5	376
T_3	263	24.8	411	255	23.7	402	273	24.1	385	266	22.6	391	272	22.7	391	271	23.8	378
T_4	262	24.5	418	250	23.1	404	250	23.9	398	270	23.8	396	279	23.1	396	273	24.1	376
T_5	238	13.9	371	236	21.7	362	267	13.2	362	242	20.7	371	240	21.1	365	235	20.4	250
T_6	225	14.5	387	262	15.4	396	251	22.9	374	256	21.6	391	261	22.6	376	274	21.5	386
T_7	263	20.5	394	242	21.7	400	272	24.6	402	276	22.3	398	275	24.8	391	272	23.9	391
T_8	275	21.9	407	270	22.3	401	264	24.0	406	282	23.3	394	278	23.1	376	277	24.5	400
T_9	238	23.1	417	265	23.4	410	278	24.4	415	277	22.2	401	277	23.9	386	278	24.2	406
T_{10}	263	23.7	414	279	24.5	405	275	24.6	412	278	21.8	402	279	24.5	392	278	24.0	405
T_{11}	275	13.6	368	243	14.8	362	252	15.1	371	262	18.1	371	250	20.4	360	274	20.3	370

T_1: JS 335 + Target yield 2.0 t ha^{-1}
T_2: JS 335 + Target yield 2.5 t ha^{-1}
T_3: JS 335 + Target yield 3.0 t ha^{-1}
T_4: JS 335 + Target yield 3.5 t ha^{-1}
T_5: JS 335 + Farmer's practice
T_6: JS 335 + RDF
T_7: DSB 21 + Target yield 2.0 t ha^{-1}
T_8: DSB 21 + Target yield 2.5 t ha^{-1}
T_9: DSB 21 + Target yield 3.0 t ha^{-1}
T_{10}: DSB 21 + Target yield 3.5 t ha^{-1}
T_{11}: DSB 21 + RDF

Table 2: The calculated fertilizer dose for different targeted yield for soybean during *kharif*, 2014 and 2015

Sl. No.	Treatment	Fertilizer dose (kg ha^{-1})		
		N	P	K
1	Target yield of 2.00 t ha^{-1}	195	33	55
2	Target yield of 2.50 t ha^{-1}	244	41	68
3	Target yield of 3.00 t ha^{-1}	293	49	82
4	Target yield of 3.50 t ha^{-1}	341	57	96
5	RDF	40	80	25
6	Farmer's practice	18	46	0

Table 3: Growth parameters of soybean at harvest as influenced by site specific nutrient management in soybean (Pooled data of two year)

Treatment	Plant height (cm)	Number of branches	LAD (30-60 DAS)
T_1: JS 335 + Target yield 2.0 t ha^{-1}	45.01	4.17	53.87
T_2: JS 335 + Target yield 2.5 t ha^{-1}	49.75	4.61	59.54
T_3: JS 335 + Target yield 3.0 t ha^{-1}	58.70	5.44	70.26
T_4: JS 335 + Target yield 3.5 t ha^{-1}	51.94	4.81	62.16
T_5: JS 335 + Farmer's practice	31.80	2.95	38.06
T_6: JS 335 + RDF	43.52	4.03	52.09
T_7: DSB 21 + Target yield 2.0 t ha^{-1}	43.39	4.02	51.92
T_8: DSB 21 + Target yield 2.5 t ha^{-1}	48.01	4.45	57.46
T_9: DSB 21 + Target yield 3.0 t ha^{-1}	56.03	5.19	67.05
T_{10}: DSB 21 + Target yield 3.5 t ha^{-1}	48.01	4.45	57.46
T_{11}: DSB 21 + RDF	41.87	3.88	50.11
SEm±	1.53	0.14	1.83
CD at 5%	4.52	0.41	5.42

Table 4: Yield parameters of soybean as influenced by site specific nutrient management in soybean

Treatment	Number pods $plant^{-1}$	Pod weight (g $plant^{-1}$)	Seed yield (g $plant^{-1}$)	Hundred seed weight (g)	Seed Yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
T_1: JS 335 + Target yield 2.0 t ha^{-1}	47.23	36.22	33.19	10.64	2450	5279	31.7
T_2: JS 335 + Target yield 2.5 t ha^{-1}	51.92	40.04	36.48	11.69	2708	5580	32.67
T_3: JS 335 + Target yield 3.0 t ha^{-1}	62.61	47.24	44	14.1	3195	5903	35.12
T_4: JS 335 + Target yield 3.5 t ha^{-1}	53.64	41.8	37.69	12.08	2827	5703	33.14
T_5: JS 335 + Farmer's practice	33.02	25.59	23.2	9.13	1731	4919	26.03
T_6: JS 335 + RDF	44.85	35.03	31.52	10.68	2369	5099	31.72
T_7: DSB 21 + Target yield 2.0 t ha^{-1}	44.75	34.91	31.45	10.61	2361	5079	31.73
T_8: DSB 21 + Target yield 2.5 t ha^{-1}	49.78	38.64	34.98	11.21	2613	5389	32.65
T_9: DSB 21 + Target yield 3.0 t ha^{-1}	58.56	45.09	41.15	13.19	3049	5680	34.93
T_{10}: DSB 21 + Target yield 3.5 t ha^{-1}	50.45	38.64	35.45	11.36	2613	5228	33.32
T_{11}: DSB 21 + RDF	43.82	33.69	30.79	10.46	2279	4910	31.7
S.Em±	1.54	1.23	1.08	0.34	83	54	0.31
CD at 5%	4.53	11.21	3.2	1.02	246	160	0.93

with farmer's practice. Significant difference was noticed among different target yield levels, but varieties did not show any significant variation with respect to test weight. This might due to enhanced growth parameters in respective treatments as reported by the Saraswathi *et al*. (2015).

The seed yield of soybean differed significantly in treatments of different target yield levels in pooled data. The data indicated that the target yield treatment JS 335 with target yield of 3.0tha^{-1} recorded significantly higher seed yield (3195 kg ha^{-1}) over rest of the treatments, but was found to be on par with that of DSB 21 with target yield of 3.0 t ha^{-1} (3049 kg ha^{-1}) among different target yield levels. Significantly lower seed yield was noticed in target yield treatments of DSB 21 with target yield of 2.0 t ha^{-1} (2361 kg ha^{-1}) and JS 335 with target yield of 2.0 t ha^{-1} (2450 kg ha^{-1}) as compared to rest of the target yield levels. Similar trend was also observed in the pooled mean too. Among all the treatments, significantly lower seed yield (1731 kg ha^{-1}) was noticed with JS 335 with farmer's practice. The pooled mean indicated that, haulm yield varied significantly due to different target yield levels in both the years as well as in their pooled data. Among the different target yield treatments, significantly higher haulm yield was noticed in JS 335 with target yield of 3.0 t ha^{-1} (5903 kg ha^{-1}) as compared to other target yield treatments, but it was found at par with that of DSB 21 with target yield of 3.0 t ha^{-1} (5680 kg ha^{-1}). Whereas, significantly lower haulm yield was noticed in DSB 21 with target yield of 2.0 t ha^{-1} (5079 kg ha^{-1}) and JS 335 with target yield of 2.0 t ha^{-1} (5279 kg ha^{-1}) as compared to rest of the target yield level treatments. Similar trend was observed for individual years of study. Significantly lower haulm yield was recorded with JS 335 with recommended dose of fertilizers (4919 kg ha^{-1}) among all the treatments. The targeted yield of 3.5 t ha^{-1} has not been achieved which might be due to abnormal weather condition during first year of the experimentation, maximum production potential of crop was achieved only up to 3.0 t ha^{-1}, also due to lower growth and yield parameters, lower uptake of nutrient and finally lower dry matter production. The highest grain yield of soybean in case of the achieved targeted yield was mainly due to the fact that higher total dry matter accumulation. Similar trend was also noticed in harvest index of soybean. This in turn might be due to the availability of balanced and higher nutrition. Similar findings were reported by Ashok *et al*. (2013), Umesh *et al*. (2014), Saraswathi *et al*. (2015) and Shreeharshkumar and Gaddanakeri (2015)

These results suggest that the target yield based on SSNM equation not only optimizes the crop yield to the desired level but maintains the better soil health which is a prime factor for sustainable crop production. The results indicated that the maximum potential yield of soybean genotypes was achieved upto target yield of 3.0 t ha^{-1}. Therefore, target yield concept was better tool to enhance the yield levels in soybean in same piece of land.

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