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Effect of integrated nutrient management on growth, yield, nutrient uptake and economics of fodder sugar beet (*Beta vulgaris*) varieties

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Abstract
A field experiment was conducted during *rabi* season of 2016-17 at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari to study the "Effect of integrated nutrient management on growth, yield, quality and economics of fodder sugar beet (*Beta vulgaris*) varieties. Total ten treatment combinations comprising of two varieties *viz*., V_1: JK kuber and V_2: JK magnolia and five levels of integrated nutrient management *i.e.* F_1 : 100% RDF (RDF: 120 : 60 : 60 NPK kg/ ha), F_2 : 75% RDF+ 25% N through BC, F_3 : 75% RDF + 25% N through BC + bio-fertilizer (*Azotobacter* + PSB + Potash solubilizing bacteria, 10^8 CFU/ml, 1.25 lit/ha each), F_4 : 50% RDF + 50% N through BC and F_5: 50% RDF + 50% N through BC + bio-fertilizer (*Azotobacter* + PSB + Potash solubilizing bacteria, 10^8 CFU/ml, 1.25 lit/ha each) were evaluated in factorial randomized block design with four replications. Significantly improved plant height, number of leaves per plant, dry matter accumulation per plant, root length and fresh foliage yield as well as N, P and K uptake by foliage was observed in JK magnolia (V_2), while root weight, fresh root yield and total fresh biomass yield as well as N, P and K uptake by root were significantly higher in JK kuber (V_1). All the growth and yield parameters, fresh root yield, fresh foliage yield and total fresh biomass yield as well as N, P and K uptake by root and foliage were significantly influenced due to integrated nutrient management. All these parameters beared higher values with application of 50% RDF + 50% N through BC + bio-fertilizer (F_5) followed by 75% RDF + 25% N through BC + bio-fertilizer (F_3). Maximum net realization (₹ 108353 ha^{-1}) and BCR (3.14) were registered under JK kuber (V_1) followed by JK magnolia (V_2) with net realization of ₹ 98119 ha^{-1} and BCR of 2.94. Whereas looking to the integrated nutrient management, application of 50% RDF + 50% N through BC + bio-fertilizer (F_5) accrued the maximum net realization of ₹ 114897 ha^{-1} and BCR of 3.25 followed by application of 75% RDF + 25% N through BC + bio-fertilizer (F_3) with net realization of ₹ 110147 ha^{-1} and BCR of 3.17d.

Keywords: Integrated nutrient management, *Azotobacter*, biofertilizer, sugar beet, Varieties, Net realization

Introduction
India supports nearly 20 per cent of the world's livestock being the leader in cattle (16%), buffalo (55%), goat (20%) and sheep (5%) population. The livestock sector contributes 32 per cent of the agricultural output which is 22 per cent of the total GDP in India. Deficiency in feed and fodder has been identified as one of the major component in achieving the desired level of livestock production. The shortage in dry fodder is 21.8 per cent compared with requirement of 560 million tones for the current livestock populations (Anonymous 2009) [1]. The low productivity and poor performance of the livestock are mainly due to unavailability of nutritious fodder in sufficient quantity. The availability of nutritious fodder is inadequate in the country. India faces a net deficit of 61 per cent green fodder, 21.9 per cent dry crop residues and 64 per cent feed. The most important constraints in the fodder production and productivity are the non-availability of improved variety of fodder crop.
Sugar beet (*Beta vulgaris*) belonging to family *Amaranthaceae*, is a biennial crop grown for its fleshy and swollen roots. It is being cultivated in many parts of the world for sugar, fodder and vegetable purpose. It can be successfully grown as a fodder crop and used as valuable source of green fodder. The high crude protein and sugar content makes it more palatable, nutritious and energy feed and having a good scope for livestock industry in India. However, its cultivation in India as fodder crop is not common. The objective of the present study was to evaluate the effect of integrated nutrient management on growth, yield and economics of fodder sugar beet varieties.

Materials and Methods

A field experiment was conducted during *rabi* season of 2016-17 at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari. Geographically, Navsari is situated at 20º 57' North latitude, 72º 54' East longitudes and has an altitude of 10 meters above the mean sea level. It is located 12 km away in the East from the great historical place "Dandi" on the Arabian seashore. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction (pH: 8.14), low in available nitrogen (231 kg/ha), moderately high in available phosphorus (37 kg/ha), fairly rich in available potassium (458 kg/ha) and moderately high in organic carbon (0.72%).

A field experiment was laid out in factorial randomized block design with four replications, comprising of two varieties *viz.*, V_1: JK kuber and V_2: JK magnolia and five levels of integrated nutrient management *i.e.*, F_1 : 100% RDF (RDF: 120 : 60 : 60 NPK kg/ ha), F_2 : 75% RDF+ 25% N through BC, F_3 : 75% RDF + 25% N through BC + bio-fertilizer (*Azotobacter* + PSB + Potash solubilizing bacteria, 10^8 CFU/ml, 1.25 lit/ha each), F_4 : 50% RDF + 50% N through BC and F_5 : 50% RDF + 50% N through BC + bio-fertilizer (*Azotobacter* + PSB + Potash solubilizing bacteria, 10^8 CFU/ml, 1.25 lit/ha each). Sowing of fodder sugar beet was done manually at 45 x 20 cm spacing on raised beds (60 cm breadth x 20 cm depth). The recommended fertilizer dose (100% RDF) of N, P and K was 120, 60 and 60 kg/ha respectively, of which half dose of N and full dose of P and K were applied as basal while remaining half dose of N was applied in two equal splits at 45 and 90 DAS as per treatments. Nitrogen, phosphorus and potash were supplied through urea, single super phosphate and muriate of potash, respectively. Bio compost was applied on the basis of N content as per treatment at 20 days before sowing. Biofertilizer (*Azotobacter*, PSB and Potash solubilizing bacteria) were applied as seed inoculation at 24 hrs before sowing as per the treatments. All other recommended practices were followed. The data recorded for different parameters were statistically analysed with the help of analysis of variance (ANOVA) technique for a factorial randomised block design.

Results and Discussion

Growth and yield attributes

Growth and yield parameters *viz.*, plant height, number of leaves per plant, dry matter accumulation per plant, root length and root weight were significantly influenced by different varieties (Table 1). JK magnolia (V_2) recorded significantly higher value for plant height, number of leaves per plant, dry matter accumulation per plant and root length as compared to JK kuber (V_1). While root weight was significantly higher in JK kuber (V_1). The difference in growth and yield attributes might be due to genetic make up of plant itself. These findings are in close agreement with those reported by Sanghera *et al.* (2016) [4].

Significant difference were observed among integrated nutrient management for growth and yield attributes (Table 1). Application of 50% RDF + 50% N through BC + bio-fertilizer (F_5) produced significantly higher plant height, which was statistically at par with 75% RDF + 25% N through BC + bio-fertilizer (F_3) and 50% RDF + 50% N through BC (F_4). Number of leaves per plant, dry matter accumulation per plant, root length and root weight were recorded significantly higher under 50% RDF + 50% N through BC + bio-fertilizer (F_5) but it remained statistically at par with 75% RDF + 25% N through BC + bio-fertilizer (F_3).

Yield

Significant differences in fresh root yield, fresh foliage yield and total fresh biomass yield were recorded due to varieties and integrated nutrient management (Table 1). Among the two varieties, JK kuber (V_1) produced significantly higher fresh root yield (38.33 t/ha) and total fresh biomass yield (52.99 t/ha) as compared to the JK magnolia (V_2). Increased value of fresh root yield and total fresh biomass yield was attributed to higher value of root weight. In case of fresh foliage yield, JK magnolia (V_2) produced significantly higher (16.67 t/ha) as compared to JK Kuber (V_1). This results might be due to overall improvement in vegetative growth as evidenced by higher plant height and number of leaves due to its genetic character of faster canopy development. These results are in line with those reported by Singh and Grag (2013) [7].

Among the integrated nutrient management, application of 50% RDF + 50% N through BC + bio-fertilizer (F_5) being statistically at par with 75% RDF + 25% N through BC + bio-fertilizer (F_3) and 50% RDF + 50% N through BC (F_4), produced significantly higher fresh root yield (38.28 t/ha), fresh foliage yield (17.06 t/ha) and total biomass yield (55.34 t/ha). This might be due to adequate supply of nutrient from inorganic fertilizers with use of organic manure and bio-fertilizers. Bio-compost contains more essential plant nutrients, vitamin, hormones, enzymes and other beneficial microbes *etc*. had better effect on yield attributes due to improvement in the soil fertility. It also releases the nutrients slowly for the benefits of crop during entire crop growth period. These findings are in agreement with Bhullar *et al.* (2010) [2].

Table 1: Effect of integrated nutrient management on growth, yield attributes and yield of fodder sugar beet varieties

Treatments	Plant height (cm)	No. of leaves	Dry matter accumulation per plant (g)	Root length (cm)	Root weight (g)	Yield (t/ha)		
						Fresh Root	Fresh foliage	Total fresh Biomass
Varieties (V)								
JK kuber	43.95	18	125	19.82	488	38.33	14.66	52.99
JK magnolia	46.88	22	156	22.12	410	32.92	16.67	49.58
SEm±	0.95	0.4	2.45	0.31	9	8.98	3.50	9.54
CD (P=0.05)	2.75	1.2	7.11	0.89	26	26.07	10.16	27.70
Integrated nutrient management (F)								
100% RDF (RDF: 120 : 60 : 60 NPK kg/ ha)	40.67	18	119	18.69	391	32.03	14.00	46.03
75% RDF+ 25% N through BC	44.17	19	131	20.22	435	34.05	15.50	49.54
75% RDF + 25% N through BC + Bio-fertilizer (*Azotobacter* + PSB + Potash solubilizing bacteria)	47.12	21	149	22.25	471	37.57	16.08	53.65
50% RDF + 50% N through BC	46.10	20	145	20.62	446	36.20	15.69	51.89
50% RDF + 50% N through BC + Bio-fertilizer	49.00	22	158	23.09	500	38.28	17.06	55.34

(*Azotobacter* + PSB + Potash solubilizing bacteria)								
SEm±	1.50	0.6	3.88	0.49	14	14.20	5.53	15.09
CD (P=0.05)	4.35	1.9	11.25	1.41	41	41.23	16.06	43.79

RDF, Recommended dose of fertilizer; BC, Biocompost; PSB, Phosphorus Solubilizing Bacteria

Nutrient uptake

Nutrient uptake *i.e.,* N, P and K by root and foliage was significantly influenced by varieties and integrated nutrient management (Table 2). Nutrient uptake *i.e.,* N, P and K by root and foliage was recored significantly higher in JK kuber and JK magnolia, respectively. Since nutrient uptake is a function of root and foliage production. The rapid increase in root and foliage biomass in variety JK Kuber and JK magnolia, respectively has demanded more nutrients, thus resulting in higher rate of N, P and K uptake (Shalaby *et al.* 2011) [5].

Under different integrated nutrient management, applications of 50% RDF + 50% N through BC + bio-fertilizer (F_5) recorded significantly higher nutrient uptake *i.e.,* N, P and K by root and foliage but it remain statistically at par with 75% RDF + 25% N through BC + bio-fertilizer (F_3) and 50% RDF + 50% N through BC (F_4). The increased nutrient uptake might be due to improvement in soil physical, chemical and biological properties through combine use of organic manure, inorganic fertilizers and bio-fertilizers (Gatmanski, 1991) [3].

Table 2: Effect of integrated nutrient management on nutrient uptake and economics of fodder sugar beet varieties

Treatments	Nutrient uptake by root (kg/ha)			Nutrient uptake by foliage (kg/ha)			Gross realization (₹/ha)	Net realization (₹/ha)	B:C ratio
	N	P	K	N	P	K			
Varieties (V)									
JK kuber	245	89.69	356	304	51.68	567	158983	108353	3.14
JK magnolia	210	77.06	298	337	58.25	628	148749	98119	2.94
SEm±	6	2.42	8	9	1.43	15	--	--	--
CD (P=0.05)	19	7.04	22	25	4.16	45	--	--	--
Integrated nutrient management (F)									
100% RDF (RDF: 120 : 60 : 60 NPK kg/ ha)	194	72.66	280	265	47.03	509	138085	87998	2.76
75% RDF+ 25% N through BC	213	77.36	308	302	52.53	583	148632	98217	2.95
75% RDF + 25% N through BC + Bio-fertilizer (*Azotobacter* + PSB + Potash solubilizing bacteria)	246	90.61	348	332	56.09	623	160936	110147	3.17
50% RDF + 50% N through BC	230	83.96	334	333	56.77	607	155663	104920	3.07
50% RDF + 50% N through BC + Bio-fertilizer (*Azotobacter* + PSB + Potash solubilizing bacteria)	256	92.29	366	372	62.41	665	166015	114897	3.25
SEm±	10	3.84	12	14	2.27	25	--	--	--
CD (P=0.05)	29	11.14	35	40	6.58	71	--	--	--

RDF, Recommended dose of fertilizer; BC, Biocompost; PSB, Phosphorus Solubilizing Bacteria

Economics

The economic parameters for fodder sugar beet were calculated and presented in Table 2. Among two varieties, JK kuber (V_1) secured maximum net realization of ₹ 108353 ha^{-1} and BCR value of 3.14 followed by JK magnolia (V_2) with net realization of ₹ 98119 ha^{-1} and BCR value of 2.94. In case of integrated nutrient management, maximum net return of ₹ 114897 ha^{-1} and BCR value of 3.25 were achieved with application of 50% RDF + 50% N through BC + bio-fertilizer (F_5) followed by application of 75% RDF + 25% N through BC + bio-fertilizer (F_3) with net return of ₹ 110147 ha^{-1} and BCR with 3.17.

On the basis of results obtained in present investigation, it can be concluded that for achieving higher yield, profitability and quality of fodder sugar beet with lowest cost of cultivation, variety JK kuber should be grown with application of 50% RDF (RDF: 120 : 60 : 60 N, P_2O_5, K_2O kg ha^{-1}) + 50% N through bio-compost.

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