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Effect of integrated nutrient management on growth, biomass production, nitrogen uptake and soil status of Sunnhemp (*Crotalaria juncea*) and *dhaincha* (*Sesbania aculeata*)

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Abstract
A field experiment was conducted at the College Farm, Navsari Agricultural University, Navsari during *rabi* season of 2016-17 and 2017-18. There were four treatments comprising of Sunnhemp (*Crotalaria juncea*) and *dhaincha* (*Sesbania aculeata*). The soil of the experimental field was clayey in texture. The results revealed that green manuring of Sunnhemp either with PSM (soil application @ 2.5 l ha^{-1}) or with bio compost @ 10 t ha^{-1} were found at par and improved the growth attributes *viz*. plant height, number of nodules $plant^{-1}$and dry matter accumulation $plant^{-1}$. Treatment *dhaincha* + biocompost @ 10 t ha^{-1} registered significantly higher green matter (gm^{-2}) and green biomass production (23.77t ha^{-1}). However, green manuring of *dhaincha* either with biocompost @ 10 t ha^{-1} or with PSM (soil application @ 2.5 l ha^{-1}) were found better and remarkably improved dry matter (gm^{-2}), dry biomass production (4.29 t ha^{-1}), nitrogen uptake (kg ha^{-1}), organic carbon (%) and available nitrogen (kg ha^{-1}) in soil after harvest of crops.

Keywords: Sunnhemp, *dhaincha*, green manuring, PSM, biocompost, biomass production

Introduction
Performance of agricultural sector during last three decades of the twentieth century has been phenomenal with more than million tonnes of food grains in stores as buffer stock. If we introspect our agricultural development, certain missed dimensions become clear. Since, the future of India depends on agricultural growth, agriculture needs to be eco-friendly and production system must be sustainable to meet the basic needs of rapidly increasing population. To boost the agricultural production, the agronomists should think of harvesting higher yields from vertical rather than horizontal expansion of net cropped area. One of the most promising avenues of boosting crop production is to increase the intensity of cropping wherever production inputs are not limiting. Generally, cropping system in a particular area is used as it prevents problems such as pest protection, economizing nutrient management and many other benefits.

The basic concept of integrated nutrient management (INM) is the maintenance or adjustment of soil fertility and supply plant nutrient to an optimum level for sustaining the desired crop productivity through optimization of benefits from all possible sources of plant nutrients in an integrated manner (Tondon, 1992) [4].

The influence exerted by green manuring is mainly due to the organic matter and nitrogen it supplies. The humus compounds formed in the soil as a result of decomposition of plant tissues increase the adsportive capacity of soil and promotes aeration, drainage and granulation essential for successful plant growth. If the soil is heavy clay the crumb structure is promoted and the soil is brought into suitable condition for growing crops. It is generally considered that the best stage of turning under green manure crops is just when crop is at early flowering stage, which roughly coincides with a period of eight weeks from sowing in case of most of the crops (Khan and Mathur, 1953) [2].

Material and Methods
The field experiment was conducted at the College Farm, Navsari Agricultural University, Navsari during the year 2016-17 and 2017-18. The soil of the experimental field was clayey in texture, low in organic carbon (0.43%) and available nitrogen (221.7 kg ha^{-1}),

medium in available phosphorus (40.75 kg ha^{-1}) and fairly rich in available potassium (321.40 kg ha^{-1}). The soil was slightly alkaline in reaction (pH 7.8). The treatment consisted of integrated nutrient management *viz*., Fallow (T_1), *dhaincha* + PSM (soil application @ 2.5 l ha^{-1}) (T_2), sunnhemp + PSM (soil application @ 2.5 l ha^{-1}) (T_3), *dhaincha* + bio compost @ 10 t ha^{-1} (T_4), sunnhemp + bio compost @ 10 t ha^{-1} (T_5) imposed during *rabi* season replicated five times in randomized block design. The seeds were treated with thiram @ 3 g kg^{-1} seed in both the years before sowing. Sowing was done with recommended seed rate of 80 kg ha^{-1}. The required quantity of seeds was worked out as per treatment and broadcasted in respective plots. The sunnhemp and *dhaincha* crop was fertilized with 25-50-00 NPK kg ha^{-1} in addition to organic treatments. The quantity of urea and single super phosphate was worked out as per treatment. The full quantity of urea and single super phosphate was uniformly applied just before sowing as basal dose. The crop was manured with biocompost @ 10 t ha^{-1}. The desired quantity was worked out and applied to sunnhemp and *dhaincha* crop as per treatments and uniformly spread and mixed in particular plots before sowing. The required quantity of PSB as per treatment @ 2.5 l ha^{-1} was worked out and procured from Biofertilizer Unit, NMCA, Navsari. The bio-fertilizer culture was thoroughly mixed with biocompost and uniformly spread and mixed in respective plots. The green manure crops were cut close to the ground and chopped into small pieces and kept in respective plots. The biomass was incorporated by ploughing with local plough at 45 DAS in both years.

Results and Discussion: Effect on growth attributes

Data presented in Table 1 indicated that all the growth attributes *viz*., plant height, number of nodule $plant^{-1}$ and dry matter accumulation $plant^{-1}$ were significantly influenced by the integration of organic sources at 30 DAS and 45 DAS. At all these growth stages green manuring of sunnhemp either with biocompost @ 10 t ha^{-1} (T_5) or with PSM (soil application @ 2.5 l ha^{-1}) (T_3) significantly improved the growth in terms of plant height at 45 DAS, number of nodule $plant^{-1}$ and dry matter accumulation $plant^{-1}$ over rest of the treatments. However, at 30 DAS significantly highest plant height was observed under T_5 and found superior to remaining treatments. This might be due to the application of biocompost that maintained water stable aggregates and enriched organic matter leading to increase in availability of respiratory substances for microorganisms providing a better condition for growth. However, increase in root nodules might be due to the soil application PSM in higher amount that made symbiotic relationship with plant roots. Similar results of effect of INM on green manures also reported by Chaudhari *et al.* (2013) [1] with *dhaincha* at Navsari (Gujarat) and Tripathi *et al.* (2013) [5] with sunnhemp at Pratapgarh, (UP).

Table 1: Growth attributes of Sunnhemp and *dhaincha* as influenced by different treatments

Treatments	Plant height (cm)		No of nodules $plant^{-1}$		Dry matter accumulation $plant^{-1}$ (g)	
	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS
T_1: Fallow	-	-	-	-	-	-
T_2: *Dhaincha* + PSM (Soil application @ 2.5 l ha^{-1})	14.40	33.20	7.16	12.44	0.33	1.16
T_3: Sunnhemp + PSM (Soil application @ 2.5 l ha^{-1})	43.20	74.22	9.28	16.50	0.57	1.55
T_4: *Dhaincha* + Bio compost @ 10 t ha^{-1}	14.90	34.82	7.40	12.32	0.35	1.22
T_5: Sunnhemp + Bio ompost @ 10 t ha^{-1}	46.46	76.20	8.96	16.42	0.60	1.59
S.Em+	0.64	1.68	0.18	0.41	0.01	0.04
CD (P=0.05)	1.86	4.89	0.54	1.19	0.03	0.13
CV %	6.76	9.70	7.11	8.97	7.28	10.23
Interaction effects with Y						
S.Em+	0.90	2.37	0.26	0.58	0.02	0.06
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Effect on yield attributes and biomass production

Yield attributes and biomass production (Table 2) *viz.*, green matter, dry matter, green biomass and dry biomass production were favourably influenced by INM treatments. Treatment *dhaincha* + biocompost @ 10 t ha^{-1} (T_4) recorded significantly highest green matter and green biomass production over rest of the treatments. In case of dry matter and dry biomass production, green manuring of *dhaincha* either with biocompost @ 10 t ha^{-1} (T_4) or with PSM (soil application @ 2.5 l ha^{-1}) (T_2) recorded maximum value compared to rest of the treatments. This might be due to the application of biocompost that improved soil physico-chemical properties favouring better growth and development of *dhaincha*. The positive and synergistic effect of PSM on yield of *dhaincha* was probably not only because of improvement in available P but also their tremendous contribution towards the maintenance of a suitable condition for growth and development. These findings are in close agreement of effect of INM on yield of green manures reported by Tripathi *et al.* (2013) [5] in Sunnhemp at Pratapgarh, (UP).

Table 2: Yield attributes and biomass production of Sunnhemp and *dhaincha* as influenced by different treatments

Treatments	Green matter (g m^2)	Dry matter (g m^2)	Green biomass production (t ha^{-1})	Dry biomass production (t ha^{-1})
T_1: Fallow	-	-	-	-
T_2: *Dhaincha* + PSM (Soil application @ 2.5 l ha^{-1})	2084.35	408.24	20.94	4.12
T_3: Sunnhemp + PSM (Soil application @ 2.5 l ha^{-1})	1682.24	255.94	16.67	2.51
T_4: *Dhaincha* + Bio compost @ 10 t ha^{-1}	2345.33	427.24	23.77	4.29
T_5: Sunnhemp + Bio compost @ 10 t ha^{-1}	1819.95	263.41	18.20	2.60
S.Em+	69.00	12.45	0.67	0.14
CD (P=0.05)	201.41	36.34	1.96	0.40
CV %	11.00	11.63	10.67	12.95
Interaction effects with Y				
S.Em+	97.58	17.61	0.95	0.20
CD (P=0.05)	NS	NS	NS	NS

Effect on N uptake and soil status

Data in Table 3 showed that treatments *dhaincha* + biocompost @ 10 t ha^{-1} recorded higher nitrogen uptake (kg ha^{-1}) by crops and available soil nitrogen which was statistically at par with *dhaincha* + PSM (soil application @ 2.5 l ha^{-1}). Significantly more organic carbon content was observed under green manuring of *dhaincha* with biocompost @ 10 t ha^{-1} and was at par with T_2 and T_5 and found superior to other treatments. This might be due to the beneficial effects of PSM and addition of nitrogen in soil through biocompost which in turn increased efficiency of applied nitrogen. Enhancement on organic carbon of soil might be due to the addition of biocompost in higher amount in *dhaincha* that may have increased the soil organic matter and subsequently the soil organic carbon. Higher nitrogen, phosphorous and potassium content in *dhaincha* as compared to sunnhemp as well as application of higher quantity of organic sources (biocompost and PSM) and their complementary effects on nitrogen availability. The findings are in accordance with those reported by Tripathi *et al.* (2013) [5] with sunnhemp at Pratapgarh, (UP) and Maitra *et al.* (2008) [3] with sunnhemp at Barrackpore, (West Bengal).

Table 3: Nitrogen uptake and soil status after harvest of sunnhemp and *dhaincha* as influenced by different treatments

Treatments	Nitrogen uptake (kg ha^{-1})	Organic carbon (%)	Available N (kg ha^{-1})
T_1: Fallow	-	0.43	208.54
T_2: *Dhaincha* + PSM (Soil application @ 2.5 l ha^{-1})	76.38	0.50	249.94
T_3: Sunnhemp + PSM (Soil application @ 2.5 l ha^{-1})	39.25	0.48	238.96
T_4: *Dhaincha* + Bio compost @ 10 t ha^{-1}	77.69	0.52	262.48
T_5: Sunnhemp + Bio compost @ 10 t ha^{-1}	42.44	0.50	241.79
S.Em±	2.21	0.01	6.27
CD (P=0.05)	6.44	0.03	18.78
CV %	11.83	5.85	5.83
Interaction effects with Y			
S.Em±	3.12	-	-
CD (P=0.05)	NS	-	-

Conclusion

It is, therefore, concluded from the present investigation that *rabi* green manuring of *dhaincha* either with PSM (soil application @ 2.5 l ha^{-1}) or with biocompost @ 10 t ha^{-1} to achieve higher growth, biomass production, nitrogen uptake and improving soil status.

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