Madras Agric. J., 86(10-12): 590-593 October - December 1999
https://doi.org/10.29321/MAJ.10.A00666

RATIONALIZED FERTILISER PRESCRIPTION FOR SUNFLOWER BASED ON SOIL TEST CROP RESPONSE STUDIES

S.MARAGATHAM and S. CHELLAMUTHU,
Dept. of Soil Science and Agricultural Chemistry
TNAU, Coimbatore 641 003.

ABSTRACT

Field experiments were conducted with maize as a gradient crop and sunflower as test crop in Inceptisols of Lower Bhavani project area at Agricultural Research Station, Bhavanisagar, Erode District. The concept of fertiliser prescription for specific yield target was adopted for optimizing the fertiliser dose for sunflower. A soil test calibration and fertiliser prediction for an yield target of 20 and 25 quintal of sunflower seed for $KMnO_4$-N, Olsen-P and Morgans Reagent-S were worked out.

KEY WORDS: Fertility gradients, Nutrient requirement, Soil and fertiliser efficiency, Yield targets, Fertiliser prescription equation

Oilseed production ranks second in importance next to food production. Among the oilseeds, sunflower is considered to be one of the most important crops, gaining popularity among the farmers due to its highest oil content coupled with good quality fatty acids. Like any other crop. Yield of sunflower is also affected by various factors, of which the nutrient supply stands first. The nutrient requirement of the crop can be met from the soil native source and or through external application of fertilisers. In the conventional methods, blanket recommendations are made without considering the uptake of nutrients by crops and contribution from the soil. Hence, the soil test calibration was undertaken for desired yield targets taking into account the uptake of nutrients and the contribution from the native source, which would result in higher production as well as better cost benefit ratios.

Previously Soil Test Crop Response Correlation project developed adjustment equation from multiple regression equations. The equations developed through Mitacherlich Bray and targeted yield approach have contributed additional strength to the soil testing in making fertiliser recommendation for field crops (Dhanapalan Mosi *et al.*, 1979; Velayutham,1979).This study was conducted to establish significant relationship between yield and crop response to fertiliser and to provide a calibration for fertiliser recommendation and to derive a basis for fertiliser recommendation for desired yield targets.

MATERIALS AND METHODS

Field trials were conducted at Agricultural Research Station, Bhavanisagar, Erode District, Tamilnadu State during 1994. The soil belongs to Irugur soil series, fine loamy, moderate and neutral in reaction. Fertility gradients with respect to nitrogen, phosphorus and sulphur were created in the experimental soil by applying graded doses of fertiliser (Table 1) and by growing fodder maize (variety Co1). Test crop trials with sunflower MSFH – 8 was conducted by superimposing 24 treatment combinations consisting of 5 levels of nitrogen (0,40,80,120,160 kg ha^{-1}), four levels of phosphorus (0,20,40,60 kg ha^{-1}) and 3 levels of sulphur (0,25,50 kg ha^{-1}), in a fractional factorial design.

Table 1. Graded doses of fertiliser applied to the exhaust crop of maize

Strip	Treatment contribution	N	In terms of nutrients P_2O_5	S
I	$N_0P_0S_0$	0	0	0
II	$N_{1/2}P_{1/2}S_{1/2}$	45	69	25
III	$N_1P_1S_1$	90	138	50
IV	$N_2P_2S_2$	180	276	100

Table 2. Available nutrient status of pre-sowing and post harvest soils of gradient experiment

Strip	Treatment			Pre-sowing Analysis (Kg ha^{-1})			Post-harvest Analysis (Kg ha^{-1})		
	N	P	S	$KMnO_4$-N	Olsen-P	Morgan's reagent-S	$KMnO_4$-N	Olsen-P	Morgan's reagent-S
I	N_0	P_0	S_0	167	16.8	21.0	158	15.0	20.5
				166	17.7	20.5	150	17.5	18.8
				155	21.5	22.0	161	20.5	23.0
				172	20.0	22.6	155	21.0	21.5
			Mean	165	19.0	21.5	156	18.5	20.9
II	$N_{1/2}$	$P_{1/2}$	$S_{1/2}$	173	18.8	22.5	220	28.0	24.5
				159	17.9	24.0	204	25.0	23.5
				164	20.5	17.0	199	23.0	25.4
				177	20.8	16.5	193	25.8	21.0
			Mean	168	19.5	20.0	204	25.5	23.6
III	N_1	P_1	S_1	181	21.5	22.0	217	29.0	31.0
				170	18.2	19.8	221	32.0	26.2
				168	18.6	23.0	234	30.5	28.9
				185	20.5	18.0	240	26.0	29.0
			Mean	176	19.7	20.7	228	29.4	28.7
IV	N_2	P_2	S_2	183	18.8	22.0	236	36.0	31.5
				159	20.5	19.8	221	30.5	30.4
				164	17.1	22.5	202	29.5	33.0
				174	16.8	19.7	225	38.0	35.5
			Mean	170	18.3	21	221	33.5	32.6

Employing the total uptake of N, P and S and the soil test values, the basic data viz., the nutrient requirement in kilogram to produce one quintal of seed yield per cent use efficiencies of soil and fertiliser nutrients were calculated. The basic parameters were calculated by whole field method, yield maximum method and yield response method developed in the All India Coordinated Project on STCR Correlation Studies (Ramamurthy et al., 1967; Maruthi sankar et al., 1983, 1989). The prescription equation was developed by using the parameters derived from yield maximum method. The initial and post harvest soil samples were analysed for $KMnO_4$-N, Organic carbon, Olsen-P, Bray-P and $CaCl_2$-S and Morgan's reagent –S.

RESULTS AND DISCUSSION

Fertility gradient experiment

The results of initial and post harvest soils elucidated the significant build up of available nutrients in all strips. The soil test values for $KMnO_4$-N, Olsen – P and Morgans reagent-S are given in Table 2. The post harvest soil analysis clearly showed a significant build up of soil N as compared to the initial level which ranged from 156-228 Kg ha^{-1}. Eventhough the experimental soil was sandy clay loam in texture with medium cation exchange capacity and the gradient crop being maize, a garden land crop, leaching losses would have been less resulting in the build up of N status in the soil (Saravanapandian, 1990).

Similar to soil N, fertility gradient was also created with respect to available P. This could be possible because the major portion of applied P would have been retained. Progressive and significant increase in available S among different strips might be possible due to addition of graded doses of fertiliser sulphur.

Test Crop Experiment

The mean values of available nutrient uptake and protein content in strips I,II,III and IV are

Table 3. Mean values of available nutrients, yield and nutrient uptake in strip I, II, III and IV.

Parameter	Strip I	Strip II	Strip III	Strip IV
$KMnO_4$-N (Kg ha^{-1})	166	212	235	226
Organic carbon (%)	0.36	0.40	0.43	0.44
Olsen-P (Kg ha^{-1})	18.14	25.3	29.3	33.8
Bray-P (Kg ha^{-1})	36.8	40.1	49.7	57.4
Morgan's reagent-S (Kg ha^{-1})	21.1	24	28.8	32.9
$Cacl_2$-S (Kg ha^{-1})	31.3	41.5	45.8	51.2
Grain yield (Kg ha^{-1})	1464	1657	1907	1992
Oil yield (Kg ha^{-1})	565	631	728.1	759
N uptake (Kg ha^{-1})	50.65	58.5	70.0	69.8
P uptake (Kg ha^{-1})	28.5	32.4	36.1	38.33
S uptake (Kg ha^{-1})	22.0	22.5	23.0	23.9
Protein content (%)	12.36	12.62	13.0	12.5

given in Table 3. The mean values of available $KMnO_4$ - N ranged from 166 - 226 Kg ha^{-1}. The seed and oil yield, protein content and uptake were also varied and increased from strip I to strip IV. This might be due to the creation of fertility variation in the soil.

Targeted yield equation

The basic parameters i.e., Nutrient requirement (NR), Soil efficiency (Cs) and Fertilizer efficiency (Cf) for nitrogen, phosphorus and sulphur were calculated by employing different methods. The fertiliser prescription equation is given in Table 4.

Targeted yield equation

$$FN = 13.45\,T - 0.70\,SN$$

$$FP_2O_5 = 5.36\,T - 2.31\,SP$$

$$FSO_4 = 4.71\,T - 5.07\,SS$$

where FN,FP,FS were Fertilizer N,P and S in Kg ha^{-1} respectively, T is the seed yield target in quintals ha^{-1} and SN,SP respectively were $KMnO_4$ -N, Olsen P and Morgan's reagent S in Kg ha^{-1}.

Among the different methods, yield maximum method registered higher response yardstick of 4.25 (Kg Kg-1). So the targeted yield was worked out employing the basic parameters obtained from yield maximum method.

Optimization of fertiliser doses for specific yield targets

A soil test calibration and fertiliser prediction using the prescription equation for an yield target of 20 and 25 quintals are given in Table 5. The results indicated that the fertiliser nutrients requirement for 20 quintals ha^{-1} would be 129 Kg ha^{-1} for N, 61 $Kgha^{-1}$ for P and 18 $Kgha^{-1}$ for S when the initial soil test values were 200 Kg $KMnO_4$-N, 20 Kg Olsen – P and 15 Kg Morgans' reagent S ha^{-1}. The fertiliser N requirment would be 266 kg ha^{-1} when the $KMnO_4$ - N was 100kg ha^{-1} and if the soil alkaline $KMnO_4$-N was 375 Kg

Table 4. Nutrient requirement and estimates of Cs and Cf by different methods

Nutrient	Whole field method			Yield maximum method			Yield response method		
	NR	Cs	Cf	NR	Cs	Cf	NR	Cs	Cf
Nitrogen	3.4446	0.1843	0.1941	3.536	0.1843	0.2629	3.477	0.1843	0.2018
Phosphorus	1.89	0.8306	0.9032	1.92	0.8306	0.8231	1.94	0.8306	0.656
Sulphur	1.5741	0.5653	0.4093	1.573	0.5653	0.334	1.635	0.5653	0.333
Response yardstick (Kg/Kg)		3.79			4.25			3.40	

Table 5. Fertiliser amounts for an yield target of 20 and 25 quintals ha^{-1}

Soil test $KMnO_4$-N Kg ha^{-1}	Nitrogen amounts (N) in Kg/ha^{-1}		Soil test Olsen-P Kg ha^{-1}	Phosphorous amounts (P_2O_5) in Kg ha^{-1}		Soil test Morgan's reagent-S Kg ha^{-1}	Sulphur amounts (SO_4) in Kg ha^{-1}	
	20 qha^{-1}	25 qha^{-1}		20 qha^{-1}	25 qha^{-1}		20 qha^{-1}	25 qha^{-1}
100	199	266	5	95	122	10	44	67
125	181	249	10	84	111	15	18	41
150	164	231	15	73	99	20		16
175	146	214	20	61	87	25		
200	129	196	25	49	76	30		
225	111	179	30	38	64	35		
250	94	161	35	26	53			
275	76	144	40	15	41			
300	59	126	45	3	30			
325	41	109	50	-	18			
350	24	91	55	-	6			
375	6.5	71	60	-	-			
400	-	56						
425	-	39						
450	-	21						
475	-	4						

ha^{-1}, the requirement was only 71 Kg ha^{-1} for achieving an yield target of 25 quintals ha^{-1}. The fertiliser P requirement would be 122 Kg ha^{-1} for 15 Kg ha^{-1} of Olsen P and fertiliser sulphur requirement would be 41 Kg ha^{-1} for 15 Kg ha^{-1} of Morgan's reagent-S to achieve an yield target of 25 quintals ha^{-1}.

REFERENCES

DHANAPALAN MOSI, A., NAIR, K. S., KRISHNAMOORTHY, S.,LAKSHMINARAYANAN, S., ABDUL HAKEEM, S. and KRISHNAN, A .P.(1979). Proc. Seminar on response of crop to application of P and K and soil fertility evaluation, Tamil Nadu Agricultural University, Coimbatore.

MARUTHI SANKAR, C. R. REDDY, K.C.K., SONAR, K.R. and DAFTARDAR, S.Y. (1989). Multicollinearity in soil test crop response data. **J. Maharastra Agric Univ., 16 (2)** : 259-262.

MARUTHISANKAR,C.R., VELAYUTHAM,M, REDDY, K.C.K. and SINGH, K.D. (1983). A New method for better estimation of soil, fertiliser efficiencies. **Indian J. Agric Sci, 53:** 314-319.

MURUGAPPAN, V. (1985). **Soil test crop response studies on sugarcane for efficient fertiliser use.** Ph.D. Thesis, Tamil Nadu Agricultural University,Coimbatore

MURUGESA BOOPATHI, P. (1988). **Soil test crop response studies on black gram for efficient phosphorus use.** M.Sc. (Ag).Thesis Tamil Nadu Agricultural University, Coimbatore.

RAMAMOORTHY, B., NARASHIMAN,R.K. and DINESH, R.S. (1967). Fertiliser application for specific yield targets of Sonara 64 (Wheat). **Indian Fmg., 17:** 43-45.

SARAVANAPANDIAN, P. (1990). **Soil fertility evaluation for efficient and economic use of nitrogen fertiliser with organics and inoculant for rice.** M.Sc.(Ag). Thesis, Tamil Nadu Agricultural University, Coimbatore.

VELAYUTHAM, M.(1979). Fertiliser recommendation based on targeted yield problems and prospects. **Fert.News 24 (9):** 12-20.

(Received : September 1998 Revised : May 2000)