International Journal of Agricultural Sciences
Volume **15** | Issue 1 | January, 2019 | 115-119 ■ ISSN : 0973-130X
☞ DOI:10.15740/HAS/IJAS/15.1/115-119
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RESEARCH PAPER

Balance sheet of NPK in brinjal as influenced by doses of chemical fertilizers and foliar application of NAA

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Abstract : A research experiment was conducted two consecutive zaid (summer) seasons of 2012 and 2013 at the horticulture nursery, college of agriculture, Gwalior (M. P.) with five fertilizers doses and three concentration of NAA on summer brinjal (cv JB-64) in Factorial Randomized Block Design. The highest fruit yield (352.56 q/ha) was obtained with the application of 125 per cent RDF and 100 ppm foliar spray of NAA at 30 and 50 DAP stages. The second best combination was formed of 125 per cent RDF with 50 ppm NAA where the fruit yield was 339.07 q/ha. Application of nutrients at higher levels showed higher status in soil as compared to lower levels and the control plots showed maximum depletion in all the three (N, P and K) nutrients.

Key Words : Brinjal, Balance sheet, NPK, NAA

View Point Article : Bhadauria, Rohatash Singh, Nagaich, K.N., Singh, B.K. and Tomar, Debesh Singh (2019). Balance sheet of NPK in brinjal as influenced by doses of chemical fertilizers and foliar application of NAA. *Internat. J. agric. Sci.*, **15** (1) : 115-119, **DOI:10.15740/HAS/IJAS/15.1/115-119.** Copyright@2019: Hind Agri-Horticultural Society.

Article History : Received : 23.10.2018**; Revised :** 04.12.2018**; Accepted :** 10.12.2018

INTRODUCTION

Brinjal (*Solanum melongena* Linn.) is popular vegetable crop and it can be grown throughout the year in almost all the states of India except at higher altitudes. It is a versatile crop adapted to different agro-climatic regions and can be grown throughout the year. The crop is cultivated on small family farms and considered to be important source of nutrition and cash income for many resource poor farmers. Now-a-days demand for brinjal as a fruit vegetable is increasing rapidly among the vegetable consumers in view of its better fruit colour, size and taste. Average productivity of brinjal crop is quite low and there exists a good scope to improve its average productivity in India and Madhya Pradesh in particular to fulfill both domestic and national needs. Plant nutrition plays an important role for enhancing yield and quality in brinjal. Nitrogen along with phosphorus and potassium are known as the major plant nutrients as they are active participator and require comparatively in larger amount. The fruit yield of brinjal per unit area is very low in India compared to western countries. Nutrients requirement defer variety to variety due to its duration, growth and yielding behaviour. Very little work has been done on nutritional requirement of high yielding varieties

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of brinjal. The growth regulators like GA, IAA, NAA and 2-4 D are powerful stimulating agents for the growth and development of plants and finally for the reproduction. Nephthalane compounds have been reported to produce various useful growth formative effects and to regulate different phase of plant- life such as floral initiation, fruit-set and fruit yield in chilies and tomato. Meena and Dhaka (2003) observed significant improvement of plant growth regulators on growth and yield of brinjal under semi-arid conditions of Rajasthan. With this background, the present investigation was carried out to know influence of different NPK levels and NAA application on balance sheet of NPK after brinjal cultivation.

MATERIAL AND METHODS

The present experiment was carried out during two consecutive zaid (summer) seasons of 2012 and 2013 at the same site and same plots in horticulture nursery, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh. Geographically, Gwalior is situated at the latitude of 260 13' North and longitude 760 14' east with an altitude of 211.52 meters above mean sea level. The experimental soil was sandy loam in texture, with pH 8.27, EC 0.64 dSm^{-1}, Organic carbon 0.56 per cent with available N (210.3 kg ha^{-1}), P_2O_5 (9.72 kg ha^{-1}) and K_2O (396.3 kg ha^{-1}). The study involve fifteen treatment combinations consisting of five fertilizers dose *viz.*, F_0: Control, F_1: 50 per cent RDF, F_2: 75 per cent RDF, F_3: 100 per cent RDF and F_4: 125 per cent RDF and three concentration of NAA, *i.e.* NAA_0: Control, NAA_1 : 50 ppm and NAA_2: 100 ppm in Factorial Randomized Block Design with 3 replications. The recommended dose of fertilizer (RDF) adopted was 120:80: 60 kg of N: P: K / ha. Foliar spray of NAA was done at 30 and 50 Days after planting (DAP) and all other cultivation practices were adopted as per recommendations. for uptake of NPK, the shoot and fruit samples were first oven-dried and then ground into fine powder and preserved for analysis of N, P and K content as per standard method (Jackson, 1973). Available NPK content in soil before transplanting and after end of the crop were also determined as per standard method (Jackson, 1973).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Yield attributes and yield

Fertilizers doses :

Data presented in Table 1 showed clearly that, increasing recommended dose of fertilizers (RDF), to the growing brinjal plants, upto 125 per cent of recommended led to progressive significant rises in the fruits yield ha^{-1}, average fruit weight, circumference and volume of fruit. The application of 125 per cent RDF resulted in the highest and significantly more values of yield and yield attributes *viz.*, fruit weight, fruit yield per plant and per hectare as compared to control and suboptimal doses of RDF. The reason for enhancement in yield attributes could again be ascribed to the

Table 1: Effect of fertilizers dose and foliar application of NAA on yield attributes and yield of summer brinjal (Pooled data of two year)

Treatments	Yield attributes			Fruit yield (q/ha)
	Average fruit weight (g)	Circumference of fruit (cm)	Volume of fruit (cm^3)	
F_0 : Control	55.66	12.94	44.51	200.56
F_1 : 50% RDF	57.95	13.31	46.27	232.74
F_2 : 75% RDF	61.13	14.05	51.05	259.35
F_3 : 100% RDF	64.60	14.41	53.82	297.16
F_4 : 125% RDF	68.50	14.93	56.85	335.97
S.E. ±	0.76	0.08	0.84	2.08
C.D. (P=0.05)	2.17	0.24	2.39	5.94
NAA_0 : Control	57.73	13.50	48.14	244.80
NAA_1 : 50 ppm	62.21	13.86	50.05	266.33
NAA_2 : 100 ppm	64.77	14.43	53.31	284.35
S.E. ±	0.59	0.06	0.65	1.61
C.D. (P=0.05)	1.68	0.18	1.85	4.60

application of NPK favoured the metabolic and auxin activities in plant and ultimately resulted in increased fruit size, number of fruits per plant, fruit weight and yield per hectare. In fact, the essential elements, particularly the primary nutrient elements N, P and K are supplied to plants to increase crop production Prabhu *et al*. (2006).

NAA concentration:

Foliar application of NAA (at 30 and 50 DAP) produced significantly more value of yield attributes *viz.*, fruit weight circumference and volume fruit yield per plant and per hectare as compared to control. Maximum values noted with 100 ppm concentration. However, foliar application of NAA at 50 ppm concentration was also recorded significantly higher values of these parameters over control. Study on the fruit yield of brinjal clearly exhibited markedly superiority of both 50 and 100 ppm NAA over control. However, 100 ppm NAA brought about larger improvement than 50 ppm in the fruit yields over control. Increase in fruit yield in plant regulator-treated plots may presumably be due to the reason that such plants remained more physiologically active to build up sufficient food material for developing more number of flowers ultimately leading to higher number of fruits and consequently more yield. Better performance of NAA- treated plants in respect to fruit yield may also be attributed to the increased rate of photosynthesis in the treated crop due to more plant height and foliage as stated by Singh *et al.* (2011) and Moniruzzaman *et al.* (2014).

Table 2: Interaction effect of fertility levels and NAA on fruit yield (q/ha)

Treatments	F_0	F_1	F_2	F_3	F_4	NAA – Mean
NAA_0	192.18	202.74	238.77	274.00	316.29	244.80
NAA_1	198.74	236.90	257.42	299.50	339.07	266.33
NAA_2	210.77	258.58	281.85	318.00	352.56	284.35
F-Mean	200.56	232.74	259.35	297.16	335.97	

	F	NAA	F x NAA
S.E. ±	2.08	1.61	3.59
C.D. (P=0.05)	5.94	4.60	10.29

Table 3: Balance sheet of nitrogen (kg/ha) under different treatments (mean data of two year)

Tr. No.	Treatments	Balance sheet of nitrogen (kg/ha) Initial – N (kg/ha)	N-added (kg/ha)	Total initial-N (kg/ha)	N-Uptake by crop (kg/ha)	Appropriate N- balance (kg/ha)	Actual N- balance after harvest of crop (kg/ha)	N- D/B* Over initial (kg/ha)
		A	B	C=(A+B)	D	E=(C-D)	F	G= (F-A)
T_1	F_0 x NAA_0	210.3	0.0	210.3	84.86	125.4	202.4	-7.9
T_2	F_0 x NAA_{50}	210.3	0.0	210.3	87.77	122.5	200.8	-9.5
T_3	F_0 x NAA_{100}	210.3	0.0	210.3	94.62	115.7	192.6	-17.7
T_4	F_1 x NAA_0	210.3	60.0	270.3	89.59	180.7	204.4	-5.9
T_5	F_1 x NAA_{50}	210.3	60.0	270.3	104.52	165.8	206.2	-4.1
T_6	F_1 x NAA_{100}	210.3	60.0	270.3	114.09	156.2	210.6	+0.3
T_7	F_2 x NAA_0	210.3	90.0	300.3	105.41	194.9	212.6	+2.3
T_8	F_2 x NAA_{50}	210.3	90.0	300.3	113.64	186.7	206.2	-4.1
T_9	F_2 x NAA_{100}	210.3	90.0	300.3	123.98	176.3	208.6	-1.7
T_{10}	F_3 x NAA_0	210.3	120.0	330.3	120.85	209.5	212.6	+2.3
T_{11}	F_3 x NAA_{50}	210.3	120.0	330.3	131.98	198.3	218.2	+7.9
T_{12}	F_3 x NAA_{100}	210.3	120.0	330.3	138.7	191.6	222.4	+12.1
T_{13}	F_4 x NAA_0	210.3	150.0	360.3	139.41	220.9	220.6	+10.3
T_{14}	F_4 x NAA_{50}	210.3	150.0	360.3	149.49	210.8	220.8	+10.5
T_{15}	F_4 x NAA_{100}	210.3	150.0	360.3	155.58	204.7	218.6	+8.3

F_0 : Control, F_1 : 50% RDF, F_2 : 75% RDF, F_3 : 100% RDF, F_4 : 125% RDF

Balance sheet of nutrients:

After analyzing the soil and plants (shoot + fruits) samples for uptake of N, P and K, their balance sheet was prepared by deducting respective initial values of these nutrients from actual balance at harvesting.

Balance sheet of N:

It is clear from balance sheet of nitrogen (Table 3),

Table 4: Balance sheet of phosphorus (kg/ha) under different treatments (mean data of two year)

Tr. No.	Treatments	Balance sheet of phosphorus (kg/ha)						
		Initial – P (kg/ha)	P-added (kg/ha)	Total initial-P (kg/ha)	P-Uptake by crop (kg/ha)	Appropriate P-balance (kg/ha)	Actual P- balance after harvest of crop (kg/ha)	P- D/B* Over initial (kg/ha)
		A	B	C=(A+B)	D	E=(C-D)	F	G= (F-A)
T_1	F_0 x NAA_0	9.72	0.00	9.72	9.44	0.28	9.34	-0.38
T_2	F_0 x NAA_{50}	9.72	0.00	9.72	9.77	-0.05	9.45	-0.27
T_3	F_0 x NAA_{100}	9.72	0.00	9.72	10.69	-0.97	9.56	-0.16
T_4	F_1 x NAA_0	9.72	17.47	27.19	10.81	16.38	11.2	+1.48
T_5	F_1 x NAA_{50}	9.72	17.47	27.19	12.62	14.57	10.86	+1.14
T_6	F_1 x NAA_{100}	9.72	17.47	27.19	13.44	13.75	12.02	+2.30
T_7	F_2 x NAA_0	9.72	26.20	35.92	12.72	23.20	11.74	+2.02
T_8	F_2 x NAA_{50}	9.72	26.20	35.92	13.72	22.20	12.05	+2.33
T_9	F_2 x NAA_{100}	9.72	26.20	35.92	14.98	20.94	13.55	+3.83
T_{10}	F_3 x NAA_0	9.72	34.93	44.65	14.6	30.05	12.05	+2.33
T_{11}	F_3 x NAA_{50}	9.72	34.93	44.65	15.94	28.71	13.28	+3.56
T_{12}	F_3 x NAA_{100}	9.72	34.93	44.65	16.58	28.07	12.86	+3.14
T_{13}	F_4 x NAA_0	9.72	43.67	53.39	16.85	36.54	13.08	+3.36
T_{14}	F_4 x NAA_{50}	9.72	43.67	53.39	18.06	35.33	12.75	+3.03
T_{15}	F_4 x NAA_{100}	9.72	43.67	53.39	18.78	34.61	11.86	+2.14

F_0 : Control, F_1 : 50% RDF, F_2 : 75% RDF, F_3 : 100% RDF, F_4 : 125% RDF

Table 5 : Balance sheet of potassium (kg/ha) under different treatments (mean data of two year)

Tr. No.	Treatments	Balance sheet of potassium (kg/ha)						
		Initial – K (kg/ha)	K-added (kg/ha)	Total initial-K (kg/ha)	K-Uptake by crop (kg/ha)	Appropriate K- balance (kg/ha)	Actual K - balance after harvest of crop (kg/ha)	K - D/B* Over initial (kg/ha)
		A	B	C=(A+B)	D	E=(C-D)	F	G= (F-A)
T_1	F_0 x NAA_0	396.3	0.0	396.3	99.9	296.4	332.0	-64.3
T_2	F_0 x NAA_{50}	396.3	0.0	396.3	103.7	292.6	344.6	-51.7
T_3	F_0 x NAA_{100}	396.3	0.0	396.3	111.0	285.3	358.2	-38.1
T_4	F_1 x NAA_0	396.3	25.2	421.5	109.5	312.1	336.4	-59.9
T_5	F_1 x NAA_{50}	396.3	25.2	421.5	122.8	298.7	342.2	-54.1
T_6	F_1 x NAA_{100}	396.3	25.2	421.5	134.2	287.3	316.2	-80.1
T_7	F_2 x NAA_0	396.3	37.8	434.1	117.4	316.7	327.5	-68.8
T_8	F_2 x NAA_{50}	396.3	37.8	434.1	126.6	307.6	362.2	-34.1
T_9	F_2 x NAA_{100}	396.3	37.8	434.1	135.2	299.0	370.2	-26.1
T_{10}	F_3 x NAA_0	396.3	50.4	446.7	130.4	316.4	358.6	-37.7
T_{11}	F_3 x NAA_{50}	396.3	50.4	446.7	139.1	307.6	357.6	-38.7
T_{12}	F_3 x NAA_{100}	396.3	50.4	446.7	142.3	304.4	350.2	-46.1
T_{13}	F_4 x NAA_0	396.3	63.0	459.3	142.6	316.7	358.2	-38.1
T_{14}	F_4 x NAA_{50}	396.3	63.0	459.3	152.4	306.9	355.4	-40.9
T_{15}	F_4 x NAA_{100}	396.3	63.0	459.3	160.7	298.6	356.7	-39.6

F_0 : Control, F_1 : 50% RDF, F_2 : 75% RDF, F_3 : 100% RDF, F_4 : 125% RDF different treatment combinations show depletion or build up in our initial status in soil. Maximum depletion (-17.7 kg/ha) was observed under F_0 x NAA_{100} whereas, maximum built-up (+12.1 kg/ha) recorded under F_3 x NAA_{100} treatment combination.

Balance sheet of P:

It is evident from balance sheet of phosphorus (Table 4); different treatment combinations show depletion or build up as compared to initial status in soil. Maximum depletion (-0.38 kg/ha) was observed under F_0 x NAA_0, whereas, maximum built-up (+3.83 kg/ha) recorded under F_2 x NAA_{100} treatment combination.

Balance sheet of K:

It is revealed from balance sheet of potassium (Table 5); all the treatment combinations show depletion in K status as compared to initial status in soil. Maximum depletion (-80.1 kg/ha) was observed under F_1 x NAA100 whereas, minimum depletion (-26.1 kg/ha) recorded under F_2 x NAA 100 treatment combination.

It is clear from the balance sheet of nutrients, that the application of nutrients at higher levels showed higher status in soil as compared to lower levels.

It is clear from results of the balance sheet of nutrients that the application of nutrients at higher levels showed higher status in soil as compared to lower levels and the control plots showed maximum depletion in all the three (N, P and K) nutrients. These findings are similar of those Shahi *et al*. (2002) and Ugade *et al.* (2014).

Conclusion:

From the present study, it is concluded that the application of 125 per cent of RDF *i.e*. 150 kg N, 100 kg P_2O_5 and 75 kg K_2O/ha and twice foliar spray of NAA @100 ppm before flowering (30 and 50 DAP), produced maximum fruit yield of summer brinjal and retained more nutrients after end the crops.

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