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EFFECT ON GROWTH AND YIELD OF POTATO (*SOLANUM TUBEROSUM* L.) VAR. *KUFRI JYOTI* BY NITROGEN INTEGRATION WITH DIFFERENT ORGANIC SOURCES AND ITS AFTER EFFECT ON SOIL

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ABSTRACT

An experiment was conducted at the Research Farm, College of Agriculture, Central Agricultural University, Imphal during *rabi* season to study the effect of nitrogen integration through different sources *i.e.* FYM, vermicompost and urea at different levels of substitution *i.e.,* 25%, 50%, 75% and 100% to the recommended dose (RD) of nitrogen as urea by the organic sources. Supplementation of 75% RD of nitrogen from Urea *i.e.* 130 kg/ha and 25% RD of nitrogen from FYM *i.e.* 4 t/ha exhibited the highest growth, yield attributes and yield, net return per rupee investment and cost benefit ratio. Though the performance of the same level of substitution by vermicompost was next to FYM, it was not economical. While use of 100% RD of nitrogen from FYM *i.e.* 16 t/ha left higher residual available N and K and use of 50% RD of nitrogen from FYM *i.e.* 8 t/ha left higher residual P as compared to integration of chemical fertilizers with organic manures. However with the increase in level of FYM in integration the amount of residual nutrient in soil was also increased.

INTRODUCTION

During the green revolution, the strategy of intensive external input oriented agriculture has depleted soil fertility considerably in all major agricultural production systems. This has led to stagnation of food production inspite of consistent increment in food production. Moreover, intensive farming has led to over-production associated with environmental consequences largely affecting the soil health arising from long-term use of inorganic fertilizers in large quantities.Therefore time has come to focus on organic farming, to create a balance between soil organisms, plants, animals and humans. Organic manures are responsible for improving chemical, physical and physiochemical properties of soil.

In Manipur, the productivity of potato is only 100q/ha which is very low in terms of per ha yield as compared to all-India average. This is mainly due to the series of long term fertilizer application, which increases the crop yield in the initial year but adversely affect the sustainability at a later stage. Moreover conjunctive use of manures along with chemical fertilizers reduces the decline in organic carbon and gap between potential yield and actual yield is bridged to a large extent (Tolanur and Badanur, 2003). The use of only chemical fertilizers alone may not keep pace with time in maintaining the soil health and sustaining the productivity. It is also detrimental to human health and the environment (Arisha and Bardisi, 1999). So, it is desirable to develop a sustainable production system that gives optimum productivity with minimum environmental pollution by using organic manure as an alternative practice to mineral fertilization (Naeem *et al.*, 2006). Use of organic manure offers the twin benefits of soil quality and fertility enhancement while meeting a part of nutrient needs of crops (Choudhary *et al.*, 2011). Organic manure improves soil structure and water holding capacity, resulting in more extensive root development and enhanced soil micro flora and fauna activity, which results in availability of micronutrients available to plants (Zeidan, 2007).Therefore fertilizers are to be integrated with organic sources to replenish the continuous removal of plant nutrients. In the present study, an effort was made to evaluate the long term effect of integration of Urea with FYM and Vermicompost, a component of integrated plant nutrition system, applied to potato during Rabi season.

MATERIALS AND METHODS

A field study was carried out during rabi season 2011-12 and 2012-13 at the Research Farm, College of Agriculture, Central Agricultural University, Imphal. The experimental field was situated at 24º46 N latitude, 93º54 E longitude and at an altitude of 774.5 m above the mean sea level. The soil of the experimental site was clayey in texture, N and P content were medium (351.2 and 26.20 kg/ha respectively) while K content was high (309 kg/ha) with acidic reaction.

The recommended doses of urea, FYM and vermicompost were integrated different levels of substitution and which were compared against their sole application and altogether 10 treatment combination (including a control) were tested which were laid out in RBD replicating thrice. The treatment details were given in Table 1. Short duration and widely adaptable potato cultivar Kufri Jyoti was planted at a spacing of 60 x 20 cm with a depth of 10 cm. The crop was grown successfully under irrigated condition with recommended package of practices. The crop was irrigated 5 times at 15 days interval and kept the soil moist throughout the growing period. Earthing up was done at 25 DAP. Harvesting was done at 90 DAP. First of all dehaulming was done manually when the lower leaves of the crop started yellowing and after 1 week, the crop was harvested. And grading of tubers were done into three groups such as large (above 50g), medium (30-50g) and small (less than 30g).

RESULTS AND DISCUSSION

Application of 100% RD (recommended dose) of N from FYM (16 t/ha) showed maximum emergence of potato as emergence of potato mainly depends on soil temperature and available soil moisture and FYM has the capacity to conserve moisture thereby maintaining a favourable environment for sprouting of tubers by increasing soil temperature during the cold season of potato growing.

The treatment receiving 75% RD of N from Urea + 25% RD of N from vermicompost exhibited the tallest plant height of 36.83 cm. This might be due to the fact that when urea is integrated with organic manure mineralization is faster and the process is faster in vermicompost than FYM which could be attributed to sufficient supply of nutrients for better plant growth. This result was in conformity with that of Anabousi *et al.* (1997). The application of 75% RD of N from Urea + 25% RD of N from FYM showed maximum number of leaves, stem and stolons with the values of 35.91, 11.91 and 18.22 respectively however which were at par with that of application of 75% RD of N from Urea + 25% RD of N from vermicompost, 50% RD of N from Urea + 50% RD of N from FYM and, 50% RD of N from Urea + 50% RD of N from vermicompost. This might be due to the integration of Urea and organic manures as organic manure slowly supplies sufficient nutrients during plant growth so more shoots and stolons were produced. These results were also noticed by Ayyub *et al.* (2006) and Anabousi *et al.* (1997). Similarly, leaf area, leaf area index and net assimilation rate were also highest in the treatment where 75% RD of N from Urea + 25% RD of N from FYM were applied with the respective values of 2252.1 cm^2, 0.814 and 0.707 g/dm^2/day. Higher production of leaf area might be due to the fact that there was corresponding increase in vegetative growth with higher application of nitrogen, thereby increasing the number of leaves. Moreover high value of LAI might be due to adequate receipt of sunlight and higher leaf production. As more leaf area was produced there would be more dry matter production of the plant in the same treatment by better nutrition. Ayyub *et al.* (2006) and Das *et al.* (2004) also reported similar findings.

There was significant effect of nutrient management practices on grade- wise tuber yield of potato. Irrespective of treatments, there was maximum production of 'C' grade tubers followed by 'B' and 'C' grade tubers. Maximum number of different grade of tubers were observed in T_5 where urea @130 kg/ha and FYM @ 4 t/ha were applied (90.90- A grade, 99.62- B grade and 123.55-C grade tubers) which were significantly better than the sole application of either organic and inorganic fertilizer sources. This indicated that supply of 100% nutrients was not much helpful in recording higher production of different grade tubers. While in fertilizer alone also due to leaching loss, sufficient nutrient might not be available during bulking stage. Parmar *et al.* (2007) also reported similar findings. Sharma *et al.* (2013) too reported integrated nutrient management on wheat improved the crop yields, produces quality grain as well as improved the soil fertility.This might be the reason of getting the highest tuber yield and maximum specific gravity were obtained in T_5 where 75% of N from Urea and 25% of N from FYM were supplied with the value of 171.01 q/ha and 1.67 respectively. Such a production of higher yield of tuber in integrated nutrient application was

Table 1: Effect of nitrogen in integration with different organic sources on yield attributes of potato (data pooled for two years)

Treatments	Emergence of potato (%)	Plant height (cm)	No. of leaves	No. of stem	No. of stolons	Leaf area (cm^2)	LAI(90 DAS)	NAR (g/dm^2/day) (60-90 DAS)
T_1 {Urea(174 kg/ha)}	91.92	23.55	29.21	7.73	12.93	1460.34	0.373	0.31
T_2 {VC (2 t/ha)}	91.48	20.17	27.27	6.49	11.92	1131.25	0.277	0.17
T_3 {FYM (16 t/ha)}	99.66	22.39	28.53	7.42	12.68	1412.52	0.340	0.20
T_4 {Urea (130 kg/ha) + VC (0.5 t/ha)}	91.12	36.83	35.03	11.02	17.96	1666.17	0.633	0.61
T_5 {Urea (130 kg/ha) + FYM (4 t/ha)}	90.97	31.45	35.91	11.91	18.22	2252.51	0.814	0.71
T_6 {Urea (87 kg/ha) + VC (1 t/ha)}	90.70	32.98	33.17	9.58	17.19	1612.14	0.463	0.55
T_7 {Urea (87 kg/ha) + FYM (8 t/ha)}	93.19	34.08	34.96	10.95	17.21	1634.27	0.503	0.60
T_8 {Urea (44 kg/ha) + VC (1.5 t/ha)}	90.97	26.52	30.03	8.43	13.80	1531.41	0.387	0.42
T_9 {Urea (44 kg/ha) + FYM (12 t/ha)}	93.31	29.23	31.75	8.96	14.94	1537.31	0.400	0.46
T_{10} Control	85.15	18.24	24.20	4.55	10.21	1080.35	0.220	0.12
SEd ±	0.14	2.70	1.57	1.13	0.61	63.59	0.05	0.042
CD (p= 0.05)	0.30	5.67	3.31	2.38	1.28	133.60	0.11	0.089

Table 2: Effect of nitrogen in integration with different organic sources on yield and specific gravity of potato (data pooled for two years)

Treatments	No. of tubers per plot			Total no. of tubers	Yield (q/ha)	Specific gravity
	Large grade	Medium grade	Small grade			
T_1 {Urea(174 kg/ha)}	59.37	83.75	108.16	251.28	117.03	1.13
T_2 {VC (2 t/ha)}	49.08	74.89	97.91	221.88	104.65	1.08
T_3 {FYM (16 t/ha)}	56.61	81.81	104.50	241.92	114.59	1.10
T_4 {Urea (130 kg/ha) + VC (0.5 t/ha)}	81.31	93.48	120.55	295.34	152.38	1.60
T_5 {Urea (130 kg/ha) + FYM (4 t/ha)}	90.90	99.62	123.55	314.07	171.01	1.71
T_6 {Urea (87 kg/ha) + VC (1 t/ha)}	69.72	88.56	114.01	272.29	132.03	1.38
T_7 {Urea (87 kg/ha) + FYM (8 t/ha)}	78.45	91.15	117.03	286.63	140.00	1.45
T_8 {Urea (44 kg/ha) + VC (1.5 t/ha)}	62.63	89.56	111.08	263.27	120.48	1.17
T_9 {Urea (44 kg/ha) + FYM (12 t/ha)}	65.45	86.34	113.65	265.44	128.15	1.23
T_{10} Control	39.18	66.77	89.88	195.83	85.20	1.07
SEd±	4.55	2.89	3.25		5.28	0.09
CD (p= 0.05)	9.56	6.07	6.84		11.10	0.19

Table 3: Effect of nitrogen in integration with different organic sources on residual available N, P and K content in soil (after two crop season)

Treatments	Available N, P and K (kg/ha)		
	N	P	K
T_1 {Urea(174 kg/ha)}	446.73	25.65	309.12
T_2 {VC (2 t/ha)}	452.11	30.20	352.38
T_3 {FYM (16 t/ha)}	476.75	30.04	364.64
T_4 {Urea (130 kg/ha) + VC (0.5 t/ha)}	450.75	28.72	341.43
T_5 {Urea (130 kg/ha) + FYM (4 t/ha)}	452.22	30.44	358.51
T_6 {Urea (87 kg/ha) + VC (1 t/ha)}	450.78	29.36	348.14
T_7 {Urea (87 kg/ha) + FYM (8 t/ha)}	453.81	34.75	362.92
T_8 {Urea (44 kg/ha) + VC (1.5 t/ha)}	452.01	30.18	350.60
T_9 {Urea (44 kg/ha) + FYM (12 t/ha)}	467.81	30.41	361.39
T_{10} Control	319.72	24.81	297.90
SEd±	20.04	2.47	16.52
CD (p= 0.05)	42.11	5.19	

also reported by Parmar *et al.* (2007) and Chettri *et al.* (2004). And higher specific gravity in T_5 may be attributed to balance application of nutrients from both organic and inorganic sources which help in accumulation of photosynthates in tubers. This finding was also supported by Jaipaul *et al.* (2011).

There was significant difference in available nutrient content of soil due to different treatments. The reduction of available N, P and K was observed in the control, which might be due to removal of native nutrients by the crop. Maximum N and K was observed in T_3 where 100% RD of N was supplied from FYM (16 t/ha) with the value of 476.75 and 364.64 kg/ha respectively. This might be due to higher mineralization of nitrogen through increased microbial activity as a result of incorporation of FYM. Damse *et al.* (2014) observed application of reduced dose of chemical fertilizers along with combination of two or three organic manures was found beneficial for garlic in rabi season. The same result was also opined by Acharya *et al.* (1988), Kumazuara (1984), Gill and Meelu (1980). And the highest residual P content of soil was observed in T_7 where 50% RD of N from Urea + 50% RD of N from FYM was supplied with the value of 34.75 kg/ha. This might be due to mineralization of phosphorous in the organic form and formation of stable humic complexes applied through FYM. Similar finding was also reported by Achharya *et al.* (1988).

The cost of cultivation of potato varied from Rs. 73260 to 97260 /ha owing to the use of different doses and sources of fertilizers. The cost of cultivation was the lowest in the control and highest in the treatment where 100% RD of N was applied from FYM with the value of Rs. 97260. Owing to the highest production of tuber in the treatment T_5 where 75% RD of N from Urea + 25% RD of N from FYM was applied the gross return was highest giving a value of Rs. 222313/ha while the cost of production was the lowest among the integrated treatments resulting to the highest net return of Rs. 141623/ ha. Due to higher net return the benefit cost ratio was also highest with the value of 1:1.76. Kumar *et al.* (2009) reported similar findings of higher net return and cost benefit ratio in integrated treatment.

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